THE NATIONAL SHIPBUILDING RESEARCH PROGRAM

CONSUMABLE GUIDE ELECTROSLAG WELDING OF 4 TO 24 INCH THICK CARBON STEEL CASTINGS

U.S. DEPARTMENT OF TRANSPORTATION MARITIME ADMINISTRATION

IN COOPERATION WITH NEWPORT NEWS SHIPBUILDING
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CONSUMABLE GUIDE ELECTROSLAG WELDING OF 4 TO 24 INCH THICK CARBON STEEL CASTINGS

AUGUST 1986

BY:

NEWFORT NEWS SHIPBUILDING
4101 WASHINGTON AVENUE
NEWPORT NEWS, VA 23607

UNDER:

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The purpose of this report is to present the results of a research and development project which was initiated by the members of the Ship Production committee of the Society of Naval Architects and Marine Engineers (SNAME) and financed largely by the U. S. Maritime Administration, the U. S. Navy, and Newport News Shipbuilding (NNS). The focus of this project was directed to the development, testing and qualification of consumable guide Electroslag Welding of carbon steel castings from 4 to 24 inches in thickness.

Mr. B. C. Howse of NNS was the Chairman of the SP-7 Panel and Mr. M. I. Tanner also of NNS, was the SP-7 Program Manager. Mr. R. W. Heid, NNS, was the Project Manager, and Messrs. L. A. Craig and P. D. Thomas of NNS were the Principal Investigators.

Special acknowledgement is extended to the members of SP-7 Welding Panel of the SNAME Ship Production Committee who served as technical advisors in the preparation of inquiries and evaluation of subcontract proposals, and to Mr. M. I. Tanner for making possible the report compilation.
This paper presents the results of an SP-7 Welding Panel research and development project recently completed by Newport News Shipbuilding. The focus of this project was directed toward the development, testing and qualification of consumable guide Electroslag Welding of carbon steel castings from 4 to 24 inches in thickness.

Consumable guide Electroslag Welding is a high deposition rate welding process that is ideally suited for use on thick members. This process has increased resistance to hot cracking, porosity, and underhead cracking, and results in minimal angular distortion. Joint preparation and fitup requirements are simplified and result in high quality weld deposits.

The project consisted of cast carbon steel (MIL-S-15083 Grade B) weldments ranging from 4 to 24 inches thick. Nondestructive testing included magnetic particle and radiographic inspection. Destructive testing included tensiles, Charpy V-notch impacts, and side bends. It is concluded that the use of consumable quide Electroslag Welding is an efficient process for joining thick carbon steel castings when postweld heat treatment can be used to achieve acceptable mechanical properties. Deposition rates of up to 85 lbs/hr can be achieved.
Purpose

The purpose of this study was to develop techniques, test, and qualify the multiple consumable guide electroslag welding process for joining 4 to 24 inch thick carbon steel castings.

Background

Cast steel hull components have always presented unique problems for welding fabrication and repair. With conventional multi-pass welding processes the requirements for joint configuration and preparation, preheating and interpass temperature control methods, weld sequencing for distortion control, and in-process dimensional checks become fabrication bottlenecks.

The multiple consumable guide electroslag welding (ESW) process provides an alternative to these problems. The American Welding Society (AWS) in AWS A3.0 "Welding Terms and Definitions" defines electroslag welding as:

A welding process producing coalescence of metals with molten slag which melts the filler metal and the surfaces of the work to be welded. The molten weld pool is shielded by this slag which moves along the full cross-section of the joint as welding progresses. The process is initiated by an arc which heats the slag. The arc is then extinguished and the conductive slag is maintained in a molten condition by its resistance to electric current passing between the electrode and the work.

AWS defines a variation of ESW, consumable guide electroslag welding (ESW-CG) as:

A method of electroslag welding in which filler metal is supplied by an electrode and its guiding member.

Initially, electroslag welding was patented in the United States in 1938 (and later in 1940) as the "Hopkins Process" after its inventor, R. J. Hopkins. The process and equipment were actually developed by the Russians; most notably B. E. Paton, at the Paton Institute in Kiev, Ukraine, USSR. Their
work began around 1951 and the ESW process was unveiled at the Brussels, Belgium World Fair in 1958.

The advantages of using ESW include:

- high deposition rates
- 100% operating efficiency
- high quality weld deposits
- increased resistance to hot cracking, porosity, and underbead cracking.
- minimal joint preparation and fitup requirements
- minimal angular distortion

Its disadvantages include a microstructure with extremely large grain sizes, low toughness without post weld heat treatment (PWHT), susceptibility to shrinkage or solidification cracking in the absence of an adequate run-off and relatively high operator skill level.

Even though the shipbuilding industry has used this process, very little work has been done in the U.S. on welding thick members. Newport News Shipbuilding has used electroslag welding since 1971. During construction of Liquified Natural Gas (LNG) tankers and Ultra Large Crude Carriers (ULCC), both the “plate crawler” and single electrode consumable guide versions of the process were used extensively. The plate crawler ESW method, as shown in figure 1, was used for vertical butt welds in side shell and bulkhead plating. The single electrode ESW-CG method, as shown in figure 2, was used primarily to weld butt joints in transverse frames. Multiple electrode ESW-CG, as shown in figure 3, can be used for joining shaft strut arms, rudder stocks and other thick castings. In many cases, it has not been feasible to cast these items in one piece because of their size. The ESW-CG process can significantly reduce the cost of welding these items.
PLATE CRAWLER

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<td>(IPM)</td>
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<tr>
<td>(lb/hr)</td>
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<td>F.L.</td>
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Figure 1
Plate Crawler Electroslag Welding
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**MECHANICAL PROPERTIES ABS GRADE C (NORM)**

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<td>SATISFACTORY</td>
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**ABS GRADE AH-36**

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<td>F.L. 55</td>
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<td>HAZ 34 to 71</td>
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Figure 2
Single-Wire Consumable Guide Electroslag Welding
Figure 3
Block Diagram - Multiple Consumable Guide Electroslag Welding
Task

The original proposal for this project is presented in Appendix A. The task was divided into two distinct phases:

PHASE I

(a) Research of present information available on ESW techniques.
(b) Weld carbon steel castings in progressive thicknesses from 4" through 10".
(c) Weld mockup of a shaft strut arm
(d) Write Phase I report

PHASE II

(a) Weld castings from 10" through 24" using information from Phase I.
(b) Weld mockup of a rudder stock
(c) Write final report

Some of these objectives were redefined after the study began. The Phase I report was dropped in favor of further development work for production use on shaft struts. The rudder stock mockup was not specifically performed, but the ability to weld the larger thicknesses (16"+) covers the range needed for these stocks. An investigation into starting technique was added to Phase II. The corrected task is shown below:

PHASE I

(a) Research present information available on ESW techniques.
(b) Weld carbon steel castings in progressive thicknesses from 4" through 11".
(c) Development work for use of ESW for welding 11" thick shaft struts, including a mockup.
PHASE II

(a) Weld carbon steel castings in progressive thicknesses from 11" through 24".
(b) Compare Hobart PS-588 vs. Hobart H-25P ESW wires in the as-welded condition.
(c) Compare starting flux vs. running flux in the stress-relieved condition.
(d) Investigate starting techniques for larger guide tube spacings.
(e) Write final report to include assembly, fitup, welding, stress-relief, and NDT details.

Plan

The plan to accomplish the above task is shown below:

PHASE I

(a) Research present information: Develop a bibliography during the course of the project; also, run the DIALOG "Weldasearch" program and provide that information.

(b) Weld castings from 4" through 11" thick: Use 4", 6", 8", and 11" thick castings to establish techniques.

(c) Procedure development of shaft strut welds: Use 11" techniques and weld a 50" long mockup. Also, weld three consecutive radiographically (RT) acceptable 11" thick joints to prove technique consistency.
PHASE II

(a) Weld castings from 11” through 24”: Use 13”, 16”, 19” 22” and 24” thick castings to establish techniques.

(b) Compare PS-588 and H-25P electrodes: Weld 24” castings under the same conditions - one with each type of wire. Use destructive testing for comparison.

(c) Compare starting flux vs. running flux: Weld and stress-relieve 8” castings under the same conditions - one with each type of flux. Use Charpy V-notch curves for comparison.

(d) Investigate starting techniques: Use special “starting butts” that allow puddle visibility. Try different fluxes for starting. Use a specially designed guide tube rack to record simultaneous amperages in each guide tube below the bussed connection.

(e) Write final report.

**Equipment**

During this project, the HOBART "Porta-Slag" multiwire system was used. Figure 4 shows the equipment configuration used for the shaft strut mockup welding and is comparable to nearly all ESW welding done during this project. Figure 5 shows the HOBART RC-1000 power supplies used for all welding. All power and ground lines were composed of doubled 4/0 cables to withstand the high amperages and duty cycles. Specific equipment used for welding with up to 4 wires is listed below:

- Hobart RC-1000 Constant Voltage Power Supplies
- Hobart Multiwire Control Panel
  - 1 - oscillator box
  - 1 - dual control tray
  - 2 - single control trays
- Hobart Multiwire Oscillating Unit ES-5
- Gilliland Large Capacity Water Coolers with flow regulation
Figure 4
Equipment Configuration for Shaft Strut Mockup
Figure 5
Hobart RC-1000 Power Supplies
Water-cooled copper retaining shoes with hoses and in-line thermometers
Small magnetic base mirrors (for seeing into the joint)
Lincoln digital wire feed speed indicator
Weston 0-100 V calibrated voltmeter
Markal temperature crayons
Steel wool
Oxyfuel heating torch with large tip.
Stopwatch (for checking dwell time, start time)
-Arc time recorder
Heat-resistant putty (for sealing shoes) - Caution: Some compounds may contain asbestos!
Insulated container for dispensing flux - Must be able to hold 250°F heated flux without damage

Safety Items

The ESW-CG process can rapidly become dangerous when not properly operated. Large quantities of molten metal, near-boiling water, and the usual popping and spitting of molten flux can all cause severe injury. The following precautions should be taken:

(1) Head Cover - either a cap or hard hat (if overhead cranes are present) is needed.
(2) Ear Protection - full coverage ear muffs should be worn.
(3) Eye/Face Protection - Wear a protective full face shield during all work near the weld. Safety glasses should always be worn. Use burner's goggles (Shade 5 or 6) to look at the molten slag in a mirror only after the ESW mode has been attained.
(4) Heavy welding clothing should be worn by anyone near the weld (including observers!). Gloves should be worn at all times except when operating the control panel.
Method

Initially, a thorough search of recent literature concerning ESW-CG was performed and, along with later articles of interest, compiled into a bibliography. This search included use of the DIALOG "Weldasearch" program to investigate a larger, international database.

After completing the literature search, the first range of thicknesses was welded in the following increments: 4", 6", 8", and 11". The second range of thicknesses consisted of 13", 16", 19", 22" and 24" joints. For the purposes of this report, the joint dimensions shall be as shown in figure 6.

Joints of each of the aforementioned thicknesses were welded until at least one acceptable joint of each thickness was obtained. An acceptable joint is one that had no visible or RT (when the joint thickness was less than 20") indications. Macro sections were used in lieu of RT for some thicknesses. In the case of the 11" thickness, several joints, including a full scale mockup, were welded to refine parameters to be used on the production shaft struts.

Starting the welding operation is the most difficult and complex aspect of ESW-CG. Two operators are required (particularly for greater thicknesses) and must work closely together to get the process underway. One of the operators should be responsible for operating the control panel, checking parameters and adjusting coolant flow. The other operator should be stationed near the joint opening in order to give the starting commands, add flux, make necessary oscillation changes, and check the color of the joint sides and/or slag bath: Both operators should be watching for wire stoppages, slag leaks, excessive water temperature, excessive popping, etc.

There are many different starting variations, but each variation follows the same basic rules. Each arc must be initiated and covered with dry flux. This dry flux is melted by the heat of the open arc, and forms a puddle of molten slag. From this point on, that arc is said to be in "the electroslag mode" and the slag remains molten because of its resistance to the electrical current passing from the wire to the work. Once in this mode, the controls were adjusted and the "running" parameters were utilized. With more than one wire, the start becomes more difficult because the number of variables increases greatly. With larger guide tube spacings (usually during the greater thicknesses) it becomes harder to get the slag bath to traverse the entire joint thickness without wire stoppages. During the course of this project,
Figure 6
Typical Joint Dimensions
problems were encountered with starting techniques. As a result, an evaluation of the starting process was performed.

In order to evaluate the various starting variations, a special "starting butt" was designed to allow the operator to easily see what was taking place at all times. The "starting butt" configuration is shown in figure 7. After working with the short starting butt, a simple, reusable "blinder" was added to simulate actual joint conditions. This blinder had a small viewing port for an observer to assist the operator in learning to read the puddle. Some of the variables researched included: preplaced flux, oscillation during the start, guide tube cleaning methods, voltage, amperage/wire feed speed, flux type and guide tube spacing. For example, the arrangement shown in figure 8 was used to record simultaneous amperages below the last bussed connection - in this case the last row of spacers. It showed the differences in process stability with different fluxes, and also the actual mechanism of an "arc-out" weld stoppage. An "arc-out" can be encountered where more than one wire is not in the electroslag mode, and a wire actually welds itself to the inside diameter of the guide tube.

Nondestructive testing of welded joints included visual inspection, some magnetic particle (MT) testing and radiography (RT) when possible (NNS’ RT capability is limited to 20 inches). When RT was not possible macro sections were examined. Mechanical property testing included all-weld-metal tensiles (AWMT), tranverse tensiles (RST), side bends (SB) and Charpy V-notch impacts (CVN). Mechanicals were performed on both heat-treated and as-welded joints.

Results

The selected bibliography and output from the DIALOG "Weldasearch" program can be found in Appendix B. This appendix provides an excellent reference list for both the first-time ESW users who are just getting started, as well as the experienced ESW users who are either problem-solving or expanding their usage. Of these references the two most helpful documents were Cary’s Ports-Slag—Welding, and of course, the AWS English translation of Paton's Electroslag Welding which is still the most comprehensive treatment of the subject to date.

Figures C-1 thru C-25 in Appendix C show the sequence of operations developed for fitup of the test assembly, preparation and alignment of the
Figure 7
Special Starting Mockup
Figure 8
Guide Tube Arrangement for Recording Simultaneous Amperages
guide tube rack, and preparation for welding. By reading figures C-1 thru C-25 in order, preparation of nearly any butt joint should be possible. The only difficulty in depicting weldment preparation is the many different methods of supporting the weldment. For the cast test blocks used to develop these techniques, the methods in Appendix C were used. Larger full size weldments, such as shaft struts require special supports based on configuration and orientation. (Other ideas for preparation can be found in Hobart's book Porta-Slag welding). Included in each figure are "helpful hints" learned from experience that can reduce the total preparation time.

Appendix D contains the welding data sheets for joints welded during the evaluation as well as the visual and nondestructive test results for those joints. Mechanical testing results can be found in figures 9 through 14. Figure 15 is a comparison of CVN values from: a) the MIL-S-15083 Grade B base material, b) from a weld with Linde L-124 flux and c) a weld made with Hobart PF-203 starting flux. A comparison of simultaneous amperages for identical welds is shown in figure 16 using L-124 flux vs. PF-203 flux.

Appendix E contains information pertaining to the procedure qualification of ESW for use on production shaft struts, and includes the technical report which was submitted to and approved by NAVSEA.

Discussion

The first range of thicknesses - 4 through 11 inches - presented very little difficulty from a welding standpoint. M685-1 and -2, each 6" thick, were both welded successfully and had acceptable RT results. M685-1 was heat-treated at 1200°F for 6 hours, and compared to the as-welded M685-2 through standard mechanical testing (see figures 9 and 10). The heat-treated joint had lower (but acceptable) tensile and yield strength, higher impact strength, and satisfactory side bends. The joint tested without heat-treatment had unsatisfactory side bends, as expected, because of the typically large coarse grains.

Joints M685-3 and -4 were 4" thick and were welded with good results. M685-3 was cross-sectioned and macro-etched with no visible discontinuities. M685-4 was radiographed and rejected due to indications near the top of the weld, originating in the run-off tab. Since acceptable mechanical results were achieved with the 6" heat-treated joint, no mechanical testing was performed on
## Nondestructive Testing

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See Welding Data Sheet M685-1

## Destructive Testing

### Tensile Test

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<th>Tensile *</th>
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<td>in²</td>
<td>lbs</td>
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<td>100.500</td>
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\*L = location of failure; W - weld; F - fusion line; B - base metal

### Guided Bend Test

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</tr>
<tr>
<td>EB</td>
<td>S</td>
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S - side; F - face; R - root

### Impact Test

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<th>°F</th>
<th>ft</th>
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<th>% Shear</th>
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<td>1</td>
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<td>58</td>
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<td>0</td>
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### Deposit Analysis

Laboratory Services Number: 9704-W (M685-1)

Welding Engineer: P.D. Thomas

Figure 9
## NONDESTRUCTIVE TESTING

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<tr>
<th>Method</th>
<th>Technique</th>
<th>Acceptance</th>
<th>Date</th>
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</thead>
<tbody>
<tr>
<td>SEE WELDING DATA</td>
<td>SHEET M685-2</td>
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## DESTRUCTIVE TESTING

### TENSILE TEST

<table>
<thead>
<tr>
<th>#</th>
<th>Dimensions</th>
<th>Load</th>
<th>Tensile</th>
</tr>
</thead>
<tbody>
<tr>
<td>1A</td>
<td>1.000 in</td>
<td>1.750 in'</td>
<td>137100 lbs</td>
</tr>
<tr>
<td>1B</td>
<td>1.000 in</td>
<td>1.750 in'</td>
<td>138400 lbs</td>
</tr>
<tr>
<td>1C</td>
<td>1.000 in</td>
<td>1.750 in'</td>
<td>135800 lbs</td>
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<tr>
<td>2A</td>
<td>0.997 in</td>
<td>1.760 in'</td>
<td>134200 lbs</td>
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<tr>
<td>2B</td>
<td>1.000 in</td>
<td>1.750 in'</td>
<td>130300 lbs</td>
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<tr>
<td>2C</td>
<td>0.998 in</td>
<td>1.758 in'</td>
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<tr>
<td>AUM</td>
<td>0.995</td>
<td>38.0%</td>
<td>17.5%</td>
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**Notes:**
- *L* = location of failure; W = weld; F = fusion line; B = base metal

### GUIDED BEND TEST

<table>
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<tr>
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</tr>
<tr>
<td>1B</td>
<td>S</td>
</tr>
<tr>
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S = side; F = face; R = root

### IMPACT TEST

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<thead>
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<th>Loc.</th>
<th>Type</th>
<th>OF</th>
<th>ft lbs</th>
<th>Lateral Exp. %</th>
<th>Shear</th>
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<tbody>
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</tr>
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<td>H2</td>
<td></td>
<td></td>
<td>+72</td>
<td>8</td>
<td></td>
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<td>H3</td>
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<td>3</td>
<td></td>
<td></td>
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<tr>
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**Notes:**
- Laboratory Services Number: 6142-W
- Welding Engineer
## NONDESTRUCTIVE TESTING

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<th>Sat/Unsat</th>
<th>Date</th>
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<tbody>
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### DESTRUCTIVE TESTING

#### TENSILE TEST

<table>
<thead>
<tr>
<th>#</th>
<th>Dimensions</th>
<th>Load</th>
<th>Tensile *</th>
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<tbody>
<tr>
<td></td>
<td>in</td>
<td>in²</td>
<td>lbs</td>
</tr>
<tr>
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<td>1.793</td>
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<td>1.793</td>
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All Weld Metal Tensile

| R  | 0.505 | 35.8% | 17.5% | B6780 | 56.5% |

* - location of failure; W - weld; F - fusion line; B - base metal

#### IMPACT TEST (AVERAGE VALUES)

<table>
<thead>
<tr>
<th>#</th>
<th>Loc.</th>
<th>Type</th>
<th>OF</th>
<th>ft</th>
<th>lbs</th>
<th>Lateral Exp.</th>
<th>Shear</th>
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#### GUIDED BEND TEST

- R = 3/4"
- Dimensions: 3/8" x 1/16"

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<th>Unsat</th>
<th>#</th>
<th>Sat</th>
<th>Unsat</th>
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<tr>
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ALL SIDE BENDS UNSATISFACTORY

S - side; F - face; R - root

#### DEPOSIT ANALYSIS

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<th>Mn</th>
<th>Ni</th>
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<td>.37</td>
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<tr>
<td>.04</td>
<td>.27</td>
<td>.34</td>
<td>.006</td>
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S

Laboratory Services Number:

8692-Y

10/85-51

P.D. Thomas 1/1/86
Welding Engineer
## NONDESTRUCTIVE TESTING

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<tr>
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SEE WELDING DATA SHEET M685-32

## DESTRUCTIVE TESTING

### TENSILE TEST

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<td>in</td>
<td>lbs</td>
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*L = location of failure; W = weld; F = fusion line; B = base metal

### GUIDED BEND TEST

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<td>S</td>
</tr>
<tr>
<td>1B</td>
<td>S</td>
</tr>
<tr>
<td>1C</td>
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<td>2A</td>
<td>S</td>
</tr>
<tr>
<td>2B</td>
<td>S</td>
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</table>

S - side; F - face; R - root

### IMPACT TEST (AVERAGE VALUES)

<table>
<thead>
<tr>
<th>#</th>
<th>Loc.</th>
<th>Type of</th>
<th>ft</th>
<th>lbs</th>
<th>Lateral Exp. %</th>
<th>Shear</th>
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<tr>
<td>2</td>
<td>1-10</td>
<td></td>
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### ALL WELD METAL TENSILE

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<th>in.</th>
<th>RA</th>
<th>EL</th>
<th>VS</th>
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Laboratory Services Number: (7712-X)

M685-32

P.D. Thomas 11/24

Welding Engineer
## NONDESTRUCTIVE TESTING

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<th>Method</th>
<th>Technique</th>
<th>I</th>
<th>Acceptance</th>
<th>Sat\Unsat</th>
<th>Date</th>
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SEE WELDING DATA SHEET M685-33

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## DESTRUCTIVE TESTING

### TENSILE TEST

<table>
<thead>
<tr>
<th>#</th>
<th>Dimensions</th>
<th>Load</th>
<th>Tensile *</th>
</tr>
</thead>
<tbody>
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<td>in</td>
<td>in²</td>
<td>lbs</td>
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*L = location of failure; W - weld; F - fusion line; B - base metal

### GUIDED BEND TEST

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S - side; F - face; R - root

### IMPACT TEST

**Average Values**

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Laboratory Services Number:

7713-Y
(M685-33)

P. D. Thomas 1/7/54
Welding Engineer

---

**Figure 13**
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### DESTRUCTIVE TESTING

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*L = location of failure; W = weld; F = fusion line; B = base metal

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### DEPOSIT ANALYSIS

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Laboratory Services Number:
8691-Y
(MG03-38)

Welding Engineer

P.D. Thomas 1/1/86

**FIGURE 14**
Figure 15
Comparison of CVN Values: Base Metal, M685-32, M685-33
Figure 16
Comparison of Simultaneous Amperages: L-124 vs PF-203
4" thick joints. Later investigation (near the end of the project) showed these types of discontinuities to be slag-filled shrinkage voids which are typical of all ESW welds in the absence of an adequate run-off. "Paton's Electroslag weldin pages 160-162, states:

"Under all welding conditions, cracks and shrinkage cavities are observed at the extremity of the weld...it is essential to extend the weld 80-100mm beyond the end of the joint" . . . . . .

To avoid these types of defects, a run-off of at least 4" is necessary. This 4 inch dimension is the length of weld needed beyond the top of the casting to ensure that there are no shrinkage cracks or voids in the weldment. This was graphically illustrated during the project when the weld was extended only one inch into the run-off tabs. This resulted in the last three inches of weld in some of the weldments having shrinkage voids. Figure 17 is a classic example of these shrinkage voids in a 22" thick casting.

A total of four 8" thick joints were welded with acceptable results. The first joint, M685-5, was RT acceptable after repairing shallow LOF indications on one side. The next joint, M685-10, was welded essentially the same, except for a lower coolant flow rate which seemed to eliminate the previous LOF. No mechanical testing was performed on these two joints.

At the 11" thickness, several joints were welded to establish, develop, and check the parameters for the shaft strut weldment. See figure 18 for a graphic description of the production shaft strut setup, procedure and mechanical results. Figure 19 shows a comparison of the ESW joint design and welding time versus the old fabrication method. After the procedure qualification was performed and submitted for approval, a 50" long mockup of the strut was welded (figures 20 and 21). Three shorter joints (84-92-1,-2,-3) were also welded to prove technique consistency. All of these joints were visually and radiographically acceptable. Figures 22 through 24 are photographs of the fitup and preparation of the actual production shaft struts. As part of this project, six 11" joints were welded. Joints M685-6,-11,-12,-15 and -18 were all visually and radiographically acceptable. Figure 25 shows a microphotograph of M685-18 in the as welded condition. only M685-13 was visually unacceptable, with LOF on both sides for the full length of the joint, apparently due to low coolant flow.
STRUT ARM WELDMENT

WIDTH APPROX. 11”
LENGTH APPROX. 48”

BASE METAL — MIL-S-1 5083 GRADE B

THREE GUIDE TUBES WITH OSCILLATION

<table>
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MECHANICAL PROPERTIES

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Figure 18
Production Strut Setup, Procedure and Results
ESW VS SMAW

ESW
4 HOURS ARC TIME
50” JOINT LENGTH

SMAW
40 HOURS ARC TIME
50” JOINT LENGTH

Figure 19
Joint Volume and Welding Time: ESW vs SMAW
Figure 20
Shaft Strut Mockup Weldment
Figure 22
Fitup of Production Shaft Strut
Figure 23
Installation of Guide Tubes in Production Shaft Strut
Figure 24
Installation of Cooling Shoes on Production Shaft Strut
Figure 25
Macrophotograph of an 11" Thick Weld
The second range of thicknesses, 11 through 24 inches, was also successfully covered during the project, but not as easily as the first range. Two specific problems arose during this portion of the welding and will be addressed with the discussion of individual joints. One problem centered around the visual appearance of the weld reinforcement and the frequent occurrence of LOF discontinuities in this area. The second problem was related to the starting process for greater joint thicknesses and/or guide tube spacings. Specifically, the ability to get all of the electrodes into the electroslag mode became very difficult during the larger welds.

Many of the joints welded during the second range of thicknesses had visible lack of fusion along the weld reinforcement as shown in figure 26. Although the LOF rarely went more than 1/8” deep, the causes for the discontinuity were evaluated in order to try and eliminate any repair work. Several items were identified as potential causes. Among these were wire straightness, dwell time, cooling effect, cooling shoe location and ground location. Each of these was investigated and it became obvious that the cooling shoes were the common focal point. This caused the development of the method of locating the cooling shoes shown in Appendix C, to avoid the reinforcement depression of the shoes being off-center from the root opening. Thus, the only probable cause was the coolant effect. Initial attempts to regulate the coolant flow (measured in gallons per minute), in the hope of getting an acceptable cooling effect were difficult at best. This method still did not provide consistent visual results. During the time we were studying the cooling effect, larger capacity (15 gallon) water coolers were substituted for the standard (3-5 gallon) welding torch cooling units. Also, the coolant itself was changed from deionized (D.I.) water to a mixture of D.I. water and antifreeze (50% D.I. water, 50% Ethylene Glycol). These changes caused a drastic difference in the cooling effect for the same coolant flow rate, thus, the inconsistent visual results. The larger capacity coolers, and the water/antifreeze mixture were chosen as standards and another method of regulation was tried. Starting with the 19” thickness, thermometers in the return line (the line that takes the hot coolant from the shoe back to the reservoir) were observed and various temperature levels were tried until consistent visual results were achieved. This method does not depend on coolant type or reservoir capacity, and it can be regulated by slowly adjusting the flow of coolant through the system. Temperatures ranging from 155° - 175°F provided acceptable reinforcement appearance. The coolant temperatures should
Figure 26
Typical Lack of Fusion Discontinuity
not be allowed to exceed 200°F, if water is used as a coolant, since this can cause steam to form in the hoses and may exceed the temperature rating of the hose. This method of regulating the cooling effect of the shoes then became part of the standard weld procedure. The visual appearance of the reinforcement of a successful 24” thick joint welded with this procedure can be seen in figure 27. Note the smooth transition from the weld metal into the base metal at the fusion line.

As the project reached the 13” thickness, serious difficulties with the starting sequence began. Specifically, these difficulties appeared as wire stoppages during the starting process. Without one or more wires running, the possibility of completing a successful joint was lost. As mentioned earlier, an arc must be initiated under each electrode, and covered with dry flux. The heat of the open arc melts this flux, and at that point (when the open arc is extinguished and the slag remains molten) the electrode is in the ESW mode.

Initial attempts to determine the cause of the wire stoppages centered around the heavy spatter observed during the welding of M685-18, 19, and 19A. In order to find the starting parameters that caused the least amount of spatter, joint M685-19B was set up as shown in Appendix C. By using 2” thick base plate, standard jack clamp washers, and a single electrode, it was possible to witness (through a welding shield) the starting process. Various combinations of wire feed speed, voltage and flux addition were utilized. From these, it was concluded that using lower voltage (35-40) and preplaced flux around the steel wool under each wire would reduce the harmful spatter to almost none.

Joints M685-19B-1, -19C, and -19D, each 13” thick were successfully completed, but not without more starting problems. M685-19D was macro-etched and showed no discontinuities. At the 16” thickness, three joints (M685-20, -21, -22) were welded with satisfactory RT results. None of these joints had a smooth start or acceptable visual appearance at the reinforcement. Later, another 16” joint, M685-25 was welded (after determining the proper method of controlling the cooling effect). This joint had acceptable visual appearance, but was not RT’d due to the earlier RT success at this thickness. Three 19” thick joints, M685-22F, -23 and -24, were welded. M685-22F had satisfactory RT results, but none of these three joints had visually acceptable reinforcements; again due to the wrong cooling effect. The first 22” joint to be welded, M685-27 took 4 attempts to get started. After
Figure 27
Acceptable Weld Reinforcement
re-preparing the joint, the fourth attempt took 7-1/2 minutes to get all four wires into the ESW mode. After welding 14" of the 18" long joint, the #4 guide tube arced against the sidewall and the weld was stopped.

At this point, it was decided to further investigate starting parameters and technique. This investigation involved researching all available reference material, contacting vendors and other users of ESW and trying several different starting methods. During this period, 36 "starting mockups" (figure 7) were welded to optimize the technique before a decent consistency level was reached. Below is a summary of the findings during this part of the investigation.

"Using a single, unbussed guide tube and wire to determine starting parameters is not advisable, since this does not duplicate the problems encountered with a bussed system. The earlier findings are valid only for single wire systems.

"Wire stoppages (generally referred to as "arc outs") are, usually not a result of spatter clogging the ends of the guide tubes. Using a four channel strip chart recorder to monitor amperage below the last bussed connection, figure 8, it was possible to observe the mechanism that causes one wire to weld itself to the end of the guide tube (see figure 28). Because of the bussed connections, if more than one wire is allowed to go into the arc mode at the same time (even momentarily), one of the other wires may touch ground (the sump bottom) without enough amps or volts to burn off. When this occurs, the tube is positive and the wire negative, allowing the wire to weld itself to the tube at the end.

"These "arc outs" will occur occasionally during the starting routine, however, the other wires should still be able to go into the ESW model and then after a minute or so, the molten puddle should reach the small arc spot on the tube, melt it,
Figure 28
Mechanism of an "Arc-Out"
and allow the jammed wire to start. Also, the entire welding head can be lowered to try and melt the obstruction. All wires should be in the ESW mode within 7-10 minutes (maximum).

Use of a "running" flux for starting the ESW process will work, but only with small thickness per guide tube values (i.e., small guide tube spacings). Starting problems were minimal at 11" using three tubes, but at 22" using four tubes starting was nearly impossible. The flux being used (Linde L-124) is indeed a "running" flux. Hobart PF-203 starting flux was obtained, and with this flux better results were achieved. The PF-203 is more conductive and has a lower melting point. This allows the wire to go into the ESW mode more quickly and helps stabilize the process. Figure 16 shows the difference in amperage readings with L-124 VS. PF-203 on the four-channel strip recorder. Notice that the amperage trace with PF-203 is much smoother than with L-124.

As a result of this information, the use of PF-203 starting flux became part of the standard weld procedure. After all electrodes were in the electroslag mode, L-124 running flux was used to increase the slag bath to the proper depth.

After attaining what was deemed an acceptable number of consistently satisfactory starts, as well as achieving acceptable visual reinforcement results, work continued as planned.

Two 22" thick butts M685-28, and -37 were welded and both were visually acceptable. M685-28 was started in 5-1/2 minutes and the deposition rate was 72 pounds per hour. A total of three 24" thick joints were successfully welded. M685-29, used to establish parameters (see figure 29), was started in seven minutes and had good visual appearance with a deposition rate of 85 pounds per hour. Joint M685-31 was welded with Hobart PS-588 cored wire (the standard wire used during this project) and was compared to M685-38 which was welded using Hobart H-25P solid wire. Both joints had satisfactory visual results and the deposition rate of M685-31 was 79 pounds per hour. Due to the high cost of heat-treating joints of this thickness, both were tested in the
Figure 29
24" Thick Weldment
as-welded condition. Figures 11 and 14 show that neither joint passed side bends or CVN testing. The joint welded with PS-588 did have higher tensile and yield strength, and the weld deposit had higher chromium, manganese, nickel, and copper content. It is felt that either of these wires could be used to electroslag weld the low carbon steel castings used during this project, provided that suitable heat-treatment follows. Two more 8" thick joints were welded to compare two brands of ESW flux. M685-32 was welded with Hobart PF-203 and M685-33 was welded with Linde L-124 flux, under the same conditions. Both joints were normalized at 1600°F for 11 hours; then cross-sectioned and macro-etched with no visible discontinuities. Comparison of standard mechanical tests (figures 12, 13) show that the use of PF-203 resulted in lower CVN values at -20°F and 0°F, and slightly lower (although acceptable) tensile strength than the L-124 flux.

In order to complete the project, another 16" joint, M685-35, was welded using the information gathered. The joint took five minutes to start, had excellent visual results and a deposition rate of 74 pounds per hour. This was the last test needed to provide an acceptable joint at each of the specified thicknesses.

Conclusions

1. Multiple consumable guide electroslag welding is an efficient, high deposition process for joining 4 through 24 inch thick carbon steel castings that conform to MIL-s-15083 Grade B or equivalent. These weld joints will require postweld heat treatment to achieve acceptable mechanical properties. Deposition rates of up to 85 lbs/hr can be achieved.

2. Procedure qualification of multiple consumable guide electroslag welding to Navy requirements is possible using the information presented in this report.

3. The use of a "running" flux (such as Linde L-124) should be limited to guide tube spacings of less than 2-1/2 inches. A "starting" flux (such as Hobart PF-203) with a lower melting pint should be used with larger guide tube spacings to facilitate starting and then running flux added to complete the joint.
APPENDIX A

TASK PROPOSAL AND ACCEPTANCE
INTER-OFFICE COMMUNICATION
NEWPORT NEWS SHIPBUILDING AND DRY - COMPANY .
A Tanneco Company

To Manager of Welding Engineering

FOR: Information

FROM: SPC Program Manager


Reference:
(1) Newport News Shipbuilding (NNS) Contract With the Maritime Administration -- MA 80 SAC 01041.

The subject proposal has been reviewed and approved by the SNAME/SPC Welding Panel SP-7 and has subsequently been approved and funded in the Fiscal Year 1982 Modification to the referenced contract.

NNS Cost Engineering has assigned sub-division cost number 9 to our present Job Order 1026 M and, in so doing, authorizes work to begin and all incurred costs to be charged to 1026-M-9.

MIT/bmc-148

1 - File Copy
Proposal

Welding 4"-24" Thick Low Carbon Steel Castings Using the Electroslag (Multiple Consumable Guide) Welding Process

January 22, 1982

Prepared by:
Newport News Shipbuilding and Dry Dock Company
E.A. Stover, Senior Welding Engineer
Newport News, Virginia for:

Ship Production Committee Panel SP-7
B.C. Howser, Manager of Welding Engineering
Newport News Shipbuilding
Newport News, Virginia
I. **Purpose:**

This study will develop the multiple consumable guide electroslag welding process for joining 4" to 24" thick low carbon steel castings.

II. **Background:**

Cast steel hull structural components have always presented unique problems for welding fabrication and repair. With conventional multi-pass welding processes, the requirements for joint configuration and preparation, preheating and interpass control methods, weld sequencing for distortion control and in-process dimensional checks not only become fabrication bottlenecks, but also critical welding process controlling factors.

The multi-consumable guide electroslag welding process provides an alternative to the above problems. The electroslag process can be described as a welding technique which is based on the generation of heat by passing electrical current through molten slag. The advantages in using the process include: high deposition rate; high quality weld deposit, minimal joint preparation/fitup and minimal angular distortion.

Even though the shipbuilding industry has used this process, very little work in the D.S. has been done in the area of welding thick members. The intent of this project is to develop a technique for welding carbon steel castings 4"-24" in thickness. The application of the process would be directed toward the joining of rudder arms, shaft strut arms and other thick casting pieces. In some cases it has not been feasible to cast these items in one piece due to their size. The electroslag welding process would significantly reduce the cost of weld fabrication and repair of these items.

III. **Task Outline:**

The task will be broken down into two phases

**Phase One:**
- Initial technique development through 10" thickness

**Phase Two:**
- Continue technique development through 24" thickness

IV. **Task Schedule, Manning and Cost:** (See Figure 1)

**Phase One:**
- Research of present information available on techniques using electroslag
- Welding of carbon steel castings in progressive thicknesses from 4"s through 10"
- Field mockup of a shaft strut arm
- Write Phase I report
Phase Two:
- Weld castings from 10" through 24" using information derived from Phase One
- Weld a dockup Of a redder stock
- Write final report

Mining:
Mining for this task is for three Den working to various degrees for two years.

Cost:
Estimated cost of this project is not to exceed a budget of $1 10, 000.  see Figure 2 for a breakdown

v. **Progress Reports:**
progress reports will be provided at the end of each quarter with a detailed final report at the conclusion of the project.

v. **Task Management and Staff:**
The project will be under the direction of a Senior Welding Engineer who will be responsible for the development of welding techniques and writing technical reports.

All lab work will be performed by Senior Laboratory Technicians.
## Task Schedule

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Figure 1
## Project Cost Estimate

### (2 Year Period)

**Direct Labor**
- Project Engineers (502 time) $15,000
- Welding Technician (1002 time) $30,000

**Material**
- Cast test blocks and constables $28,000

**Testing**
- Nondestructive and destructive testing $14,000

**Overhead**
- $20,000

**Travel Cost**
- Estimated at two trips per year $3,000

**Total** $100,000
APPENDIX B

SELECTED BIBLIOGRAPHY & DIALOG "Weldasearch"


092921
Behaviour of the slag and the fusion zone in vertical electroslag welding of cast iron plates (Comportment du laitier et de la zone...).

MICHEL A

TWO types of unalloyed haematite iron plates were welded using either prismatic cast iron filler rods or fusible wire-guides (consumable guides) and for three different types of slag (slightly acid slightly basic, basic). The structures obtained in the different zones and problems related to inoculant in are studied. Results prove that vertical electroslag welding can be extended to cast iron, optimum conditions being obtained with the combination consumable guide/grey cast iron.

092726
Electroslag welding used to fabricate world’s largest crawler driven dragline.

NORUK, d S, ... pp. 15-19. 7 fig., 2 tab., Languages: English

Laboratory tests are reported on the use of consumable guide electroslag welding (ESW), in place of flux cored arc welding for full penetration welds in structural HSLA steel (to AWS standard D1.1) for construction of the carbody of large mining draglines. Advantages of ESW are discussed including increased welding speed, reduced angular distortion (and thus minimal machining time), improved weld integrity, improved weld shape and reduced exposure of men to fumes. Wire, flux and parameters were optimised to achieve adequate low temperature toughness, and AWS FES70-EWT-2 wire-flux combination was selected. Details are given of designing the solid copper water-cooled moulding spessers, and of establishing inspection standards. Some shop welding problems which had to be overcome were: erratic electrode dispensers; leakage of molten weld metal; gas buildup; monitoring flux depth.

092564
Application to cast irons of vertical welding under slag.

MICHEL A
Translation BISI 19373. Publ: London SWIY 5DB UK: Metals Society (BIDITIS); Mar. 1981. 28pp. 22 fig., 4 tab., Languages: English


091972
Special features of the pulsed melting of the guide in electroslag welding.

DUDKO D A; SIDORUK V S; GORBENKO N V; MISYURENKO M A
Automatic Welding Vol.32. no.11. Nov. 1979. PP.47-48. 3 fig., 1 tab., 3 ref., Languages: English

Expérients were conducted to examine the melting of the guide during the consumable guide electroslag welding of 50mm thick specimens of steel st3, to discover the effect of increasing the cross-section of the guide and to determine the break current (background current) at which the pulsed melting of the guide changes to continuous melting.

091637
Description of the BHP-MPL. Broken Hill Proprietary, Melbourne Research Laboratories. Wide plate facility and early data.

CHIPERFIELD C G
Paper presented at: Integrity of Welding Second joint , Wellington, NZ; New Zealand Institute of Welding; 1981. Publ: Wellington, NZ; New Zealand Institute of Welding; 1981. 4 pp. 5 fig., 2 tab., 7 ref., Languages: English

The wide plate testing machine at BHP-MRL, its development, capabilities and recent fracture data are described. Details are given of: specimen size restrictions; load range and accuracy; test plate preparation and insertions; features of the hydraulic and control systems; assessment of consumable guide welds in As 1204 grade 250 steel plate (0.22%C) of 50mm thickness and comparison with the CBD design curve and tolerable defect sizes.
Standards for welding practices.

Japanese Standards Association


Languages: English

English translations are given of Japanese Standards JIS Z 3601 to 3606, Z 3621 and Z 3700 covering welding equipment, consumables, joint design and process procedures for MMA welding of steel sheet; firecracker butt welding; submerged arc welding of mild steel sheet; TIG welding of aluminium and Al-alloys; CO2 welding with solid or flux cored wires; non-shielded flux cored wire welding; consumable nozzle electroslag welding; braze welding of carbon steels, copper and Cu-alloys plates and tubes; postweld heat treatment of carbon steel and low alloy steel.

The long-term strengths of electroslag welded joints in titanium alloys.

KOMPAN Ya Yu; PEREPECHKO N S


The effects of consumable guide electroslag welding conditions on the long term stress corrosion resistance of titanium alloys was investigated. A technology for the electroslag welding of components made of VT6 (Ti-6%Al-4%V) and VT22 alpha plus beta alloys was developed. The chemical and mechanical properties of different regions of the joints are tabulated. Results showing in detail the resistance of these alloys to salt corrosion under different conditions are given.

Weldability of carbon manganese steels and microalloyed steels (Soudabilite des aciers C-Nb et microallies).

BERNARD G; PAURE F

Report EUR 5866. Publ: Luxembourg; Commission of the European Communities; 1980. 170pp. 70 fig. 1 tab., 69 ref.

Languages: French

A report is given of results of a research programme at IRSID, France for the period 1 Jan. 1974 to 31 Dec. 1975, carried out for the European Coal and Steel Community (ECSC). Areas covered are the cold cracking due to low energy welding of c-Mn and microalloyed steels, and the fracture toughness of weld metal and HAZ microstructures from high energy welding (e.g., submerged arc or consumable guide welding) of these steels. Selection of welding conditions to avoid cold cracking is described, including use of hardness curves and IRSID thermal efficiency diagrams. Fracture toughness of HAZs was studied on Gleeble simulated specimens and the effects of microalloying elements were examined in relation to carbonitride precipitation during the weld cooling cycle and post weld heat treatment (PWHT). Metallurgical effects of PWHT on welded joints were studied. Overall weldability of the steels is discussed.

On the determination of the minimum cross-section of the consumable guide for the electroslag welding of reinforcing welds in steel columns and beams.

EVSTRATOY G I

Welding Production Vol.26, no.6. June 1979. PP.43-44. 1 fig., 3 ref., Languages: English

The minimum cross section of the tubular steel consumable guide required for electroslag reinforcing welds in steel is calculated. The heat generated by the welding current is equated to the temperature rise of the components and heat losses, putting the maximum temperature at 400 deg.C. The steel tube outer diameter is found to be 12mm when the internal diameter is 6mm. Welding conducted using a 1.2m long guide of these dimensions at 1000A welding current shows that the guide retains its properties. The temperature distribution in the guide resulting from dipping into the slag pool is also calculated, and it is found that temperature decreases markedly a small distance from the slag pool.

High productivity welding of thick plate.

VINES M J; CHIPPERFIELD C G; FANNER RB


Preventing an arc from forming between the weld edge and a consumable guide during electroslag welding.

DUOKO D A; Sidoruk V S
Automatic Welding Vol.32. no.6. June 1979. pp.43-46. 4 fig., 1 tab., 3 ref., Languages: English

To investigate the factors causing an arc to develop between the surfaces of a consumable guide and the edge of the work, welds were made with a PSG-500 converter or a VS2h-630 rectifier with a gently drooping external volt-ampere characteristic, the electrode positive. The AN-47, AN-8 or AN-348-A welding fluxes were used. The arc was struck as a result of the existence of a potential difference between the surfaces of a guide and a weld edge. Factors encouraging the development of an arc were overheating of the slag pool at the surface in the gap between guide and weld edge, or the formation of an arc between the electrode wire and the slag. Suggestions made to prevent an arc from forming included welding at the lowest possible voltage which ensures adequate penetration, and enlarging the gap between a consumable guide and a weld edge.

Fabricating steel safely using the electroslag welding process. Part 2.
SHACKLETON D N

Yield strength, Charpy impact energy and critical COD values (at 0 deg.C) are presented, and discussed, for electroslag weld metal and heat specimens in structural steels. Topics included are the variability of properties of repeat welds, the effects of stress relieving on properties (particularly toughness); properties of as-welded, stress-relieved and double-normalised weld metal in BS 4360 Grade 400 C-Mn-Si-Nb steel; IIAZ properties; and properties of consumable guide electroslag steels. Maximum allowable defect sizes in welds are calculated from COD data and their practical implications (detect detection, fracture mechanics aspects, quality assurance) are discussed.

Hydrogen in consumable guide electroslag welds - its sources and significance.
LOWE G; BALA S R; MALIK L
Welding Journal Vol.60. no.12 Dec1981 PP.258s-268s. 9 fig., 9 tab., 15 ref., Languages: English + English

The amount of diffusible hydrogen in consumable guide electroslag weld metal was measured using a mercury extraction technique for welds in 63.5mm thick A36 plate made using three commercial fluxes. The average hydrogen content was not influenced by slag cap height, current type or polarity, but was increased significantly by: applying wet asbestos; welding under an atmosphere with a high moisture content; and using water-soaked flux. Diffusible hydrogen was also higher close to the start of the weld. The incidence and causes of intergranular cracks (found particularly in the lower portions of the welds, and at higher hydrogen contents) and solidification cracks (found rarely) are discussed.
High productivity welding of thick plate.

VINES M J; FANNER R.


An investigation is reported on identifying high productivity welding procedures for 50mm thick plate AS 1204-250 steel (0.22%C, 0.74%Mn, 0.24%Si) using submerged arc (SAW) and electroslag processes. Processes studied were: single arc long electrode stickout SAW; twin arc SAW; hot wire SAW and consumable guide welding. Details are given of: welding sequences; weld metal and HAZ fracture toughness values; relative costs: deposition rates; power requirements: process parameters and joint preparations.

Long thick plate consumable guide electroslag welding.

WILSON A J

Australian Welding Journal vol.124, no.6. Nov. Dec, 1980. PP.33-34. 8 fig. In journal given wrongly as Vol.25, no.6., Languages: English + English

The advantages and disadvantages of consumable guide welding for long welds in thick plate are outlined. Aspects covered include: multiguide arrangements: adjustable wire feed drive systems; ways of attaching the shoes; different types of shoes: comparisons with MIG and submerged arc welding.

Vertical welding of aluminium.

MASUMOTO I; SHINODA T


A "half-submerged arc welding" process for welding vertical aluminium plate is described and compared with electroslag welding (ESW). The process uses a flux-coated consumable nozzle and graphite shoes. Reduced levels of lack of fusion can be achieved at lower currents than with ESW. Findings reported include: effect of welding parameters on lack of fusion and weld metal porosity: effect of flux ratio on lack of fusion; effects of different flux compositions. Additional shielding with argon was used in some cases.

Technological reliability of methods of electroslag welding of blanks of very large cross-section (Tekhnologicheskaya nadezhnost' sposobov...).

TUPITSYN L V; SEVRUK A N; SHEVCHENKO V S; ANDREEV V P

Problemy Spetsial'noi Elektrometal'llurgii no.11. 1979. pp.32-34. 5 ref., Languages: Russian + Russian

Investigations were conducted into problems associated with the technological reliability of the electroslag welding of blanks with very large cross-sections with consumable and nonconsumable guides using wire electrodes, and also with rigid strip electrodes, with a large cross-section. The limit to which the reliability of electroslag welding can be increased by doubling wire electrodes and drives is determined. The role of welders in the reliability of electroslag welding is outlined.

Electroslag welding of curvilinear unrotated joints (Elektroshlakovaya svarka kryjolineinykh...).

SEMENOV V M; RUDOMETKIN P P; GULIDA V V; SAPIRO V B


The mechanism of formation of non-fusion regions (non-uniform penetration) in electroslag welding of inclined and curvilinear joints was studied. Steel test pieces of 12KhM + 0kh18N10T clad steel, of shape simulating a spherical reactor vessel end, were electroslag-welded with a consumable tip in the welder A-645. A special design of the consumable tip for curvilinear joints of thickness 60-100mm is proposed.
Fabrication of pressed insulators of consumable nozzles used in electroslag welding is discussed. The best insulators are fabricated from powder flux by pressing or from fluorite in water glass solution. A heavy-duty pneumatic press developed for producing pressed insulators in various sizes is described. Drying and hardening of the insulators ensures high strength.

Application of electroslag welding to cast irons is reported. Two techniques were employed: welding with cast iron plate electrodes and welding with fusible wire guide. Unsatisfactory joints were obtained with the plate electrodes due to carbon activity in the slag. With the fusible wire guide, satisfactory joints were obtained after trying a variety of wire/guide combinations, and preheating was not required. Joint mechanical properties were better with flake graphite iron than with nodular iron.

A study is reported on consumable-guide electroslag welding with a non-vertical axis on AISI 501 stainless steel seamless tubes with Hobart HB-25P wire and PF-203 flux. Electrode feed rate, voltage and current were varied at different angles of inclination to find the acceptable ranges of parameters; data are presented on the effects on penetration, fusion zone, and HAZ widths and depths. The effect of welding parameter interaction on the tendency for centreline cracking is assessed. The inclination of the weld axis gave anisotropy of heat distribution in the weld zone leading to anisotropy of the HAZ width and penetration depth. The process was more sensitive to welding parameters at small angles of inclination than larger ones. Radiation heat transfer from the flux pool surface is shown to be a significant factor. Satisfactory penetration can be achieved at angles up to 60 deg.
Electroslag welded heavy fabrications replace large castings.

ANON
Languages: English + English
The replacement of cast manipulating levers for handling steel ingots at Australian Iron and Steel, Port Kembla, by welded heavy steel fabrications is described. A5 1204 grade 250 steel was used with consumable guide electroslag welding. Welding procedures and equipment are outlined.

Use of electroslag welding for cast irons (Application aux fontes du soudage vertical sous laitier.)

MICHEL A
Soudage et Techniques Connexes Vol.33. no. 11-12.
Languages: French + French (Paper presented to the Socite des Ingenieurs Soudeurs, Paris, 15 Nov. 1979.)
A study is reported on the welding of cast iron FT25 and FGS 50, 12, 20 and 50mm thick, by two processes: electroslag welding with prismatic cast iron or mild steel plate electrodes; and consumable guide electroslag welding with mild steel wire, covered wire which deposits a GS cast iron, graphite inoculation, refractory shoes and combinations of these. Macrographs and micrographs are presented to show the effect on weld metal and HAZ microstructure of the following: heat input; slag composition; carbon activity in the slag; use of composite electrodes; composition of welding shoes; composition of consumable guide; and inoculation during welding by silicon.

Consumable-guide electroslag welding of steel castings.

General data - plain carbon steels.
STEEL CASTINGS RESEARCH AND TRADE ASSOCIATION
Data Sheet. Publ: Sheffield S2 3pT:Steel Castings Research and Trade Association; 1977. 20pp. 22 fig. 17 tab.,
Languages: English + English
Data are given for the consumable guide welding of steel to BS 592: (A), (B) and (C) (now BS 3100: A1, A2 and A3). Operating conditions, mechanical properties (including impact strengths), microstructure and hardness data are given for testpieces in 75mm and 250mm steel welded using specified welding sequences and heat treatments.

Electroslag welding eliminates costly field machining on large mining shovel.

MYERS R D
The field erection of a 50 cu.yd. (38 cu.m) electrically operated, open pit mining shovel is described. Particular reference is made to the assembly of the 208 ton (189 t) revolving frame made from ASTM A-588 steel. The components were welded using consumable nozzle electroslag and flux cored arc welding processes. The development of the welding methods is described and details of all consumables and welding parameters are given together with weld metal analysis and as-welded mechanical properties.
Further toughness data on electroslag welds in C-Mn steels

Shackleton O N

Research International Vol. 9. no. 5. 1979. pp. 53-108. 2 fig., 15 tab., 34 ref.

Languages: English

Crack opening displacement and Charpy impact tests have been used to examine the toughness of electroslag welds. Mild, carbon manganese and microalloyed steels of thickness 40 or 51mm were welded using 5 solid and 1 tubular wire and three fluxes using both electroslag and consumable guide welding. With care in the selection of steels and welding consumables, acceptable values of toughness could be achieved in the as-welded and stress relieved conditions. Variations in toughness between nominally similar welds were attributed to changes in the heats and batches of steel plates and welding consumables and to small differences in the welding conditions used.

Fabrication of steel work for the CBA Commercial Bank of Australia building, Sydney.

Morrison N G; Sim R G


Languages: English

The design of the CBA building is described in general terms and the welding of the steel work is discussed with particular reference to the 84 Vierendeel girders used. Over 3000 tonnes of structural steel conforming to AS1204 grades 250 and 350 were used to make the three-plate beams, box columns and girders which were bolted and welded around a central concrete hub and three external concrete columns to give a flexible modern interior layout with the maximum area free from columns and other intrusions. As the Vierendeel girders were so important to the structure, much effort went into their design, fabrication and testing. Consumable guide electroslag welding and both manual and automatic gasless flux cored welding (with E70T-4 wires) were used. The beams and box sections were constructed using fully automatic submerged arc welding mainly. A variety of other welding techniques were employed as needs dictated.

Electroslag weldments - performance and needed research.

Culp J D

Welding Journal Vol. 58, no. 7 July 1979. PP. 27-41. 19 fig.

Languages: English

Details are given of the experience of the State of Michigan in constructing bridges in ASTM A36 and A588 steels using consumable guide electroslag welding, and research into the properties of such welds. Problems of weld microstructure and toughness are discussed with reference to the literature. Results are given of research into weld microstructures (with illustrations), and tensile, side bend and Charpy tests on welds - these tests (on weld metal and heat affected zone (HAZ)) were used as acceptance tests. Results are also given of energy transition temperature tests (Charpy tests on weld metal, HAZ and parent metal at -40 to +40deg.F (-40 to +4.4deg.C)), Charpy tests conducted to investigate anisotropy of weld impact toughness, and tests of fatigue notch sensitivity. Research still needed is outlined.

Causes of grain-boundary separations in electroslag weld metals.

Könköl, P J; Domis W F

Welding Journal Vol. 58, no. 5. May-June 1979. PP. 161S - 167S. 8 fig., 10 tab. 7 ref.

Languages: English

To determine the causes of grain-boundary separations (small crack-like discontinuities), a series of consumable-guide electroslag welds was made under conditions of relatively low external restraint in 1 and 2 in. thick (25 and 51mm) plates of A36 steel. Current and voltage were varied and some welds were made by using moistened flux. To determine the specific levels of moisture and/or restraint required to cause grain-boundary separations, additional electroslag welds were made under conditions of relatively high and low external restraint in 2 in. (51mm) thick plates of A588 grade A steel. The effects of cooling rate and postweld heat treatment were also investigated. The results of these studies indicate the grain-boundary separations occur at relatively low temperatures (below about 570 deg. F or 299 deg. C) and are caused by the presence of hydrogen and restraint stresses.
THE WELDING OF HEAVY CASTINGS IN CARBON STEEL IS DISCUSSED INCLUDING THE LIMITS OF BOTH CHEMICAL ANALYSIS AND DESIGN OF THE WELD JOINT. STRESSES CAUSED BY WELDING ARE EXPLAINED AND DETAILS OF NEW RESULTS RELATING TO WELD GAP AND APPLIED VOLTAGE ARE GIVEN. IT IS POSSIBLE TO WELD LARGE CASTINGS AND FORGINGS USING THE CONSUMABLE NOZZLE ELECTROSLAG WELDING PROCESS. THE MECHANICAL TEST RESULTS GIVE EXCELLENT TENSILE VALUES. THE CHARPY V-NOTCH TEST SHOW GOOD IMPACT VALUES DOWN TO 0°C. HARDNESS FIGURES ILLUSTRATE THAT THE WELD, HEAT AFFECTED ZONE AND PARENT MATERIAL HAVE VERY SIMILAR VALUES. THE DISCOVERY OF A NEW RELATIONSHIP BETWEEN VOLTAGE AND MATERIAL THICKNESS HAS SOLVED MANY OF THE PROBLEMS EXPERIENCED WHEN WELDING LARGE THICKNESSES OF MATERIAL.

OTHER ADVANTAGES INCLUDE A FINER CRYSTALLISATION IN THE WELD METAL AND A SMALLER COARSE-GRAIN ZONE IN THE TRANSITION REGION, EXHIBITING BETTER NOTCH IMPACT TOUGHNESS. BY FURTHER INCREASING THE WELDING SPEED, CURRENT AND WEIGHT SIZE OF THE CONSUMABLES GUIDE, THE PROCESS MAY BE FURTHER IMPROVED.

A METHOD IS DESCRIBED OF INTRODUCING A HARDENING AGENT IN CONSUMABLE GUIDE ELECTROSLAG WELDING IN WHICH MILD STEEL CONSUMABLE GUIDES ARE MELTED IN THE WELD POOL PRODUCING A WELD WHICH OTHERWISE HAS A LOWER HARDNESS VALUE THAN THE BASE METAL. THE HARDENING AGENT, SUCH AS FEMN (FERROMANHESE) ADDED BY ATTACHING CAPSULES CONTAINING THE HARDENING AGENTS 12 TO 15MM ABOVE THE TOP OF THE JOINT. AS WELDING PROGRESSES THE CAPSULES ARE MELTED AND THE HARDENING AGENT IS RELEASED GRADUALLY INTO THE WELD POOL. USED PRIMARILY IN WELDING RAILS, THE TECHNIQUE MAY REQUIRE FROM 10 TO 30 GRAMS FEMN, DEPENDING ON THE SIZE OF THE RAIL.
FRACTURE TOUGHNESS AND FATIGUE PROPERTIES OF STEEL PLATE BUTT JOINTS WELDED BY SUBMERGED ARC AND ELECTROSLAG WELDING PROCEDURES.

CULP J D

REPORT FIWA-R-1011. PUBLISHED: LANSING, MICH. 48904. MICHIGAN DEPARTMENT OF STATE HIGHWAYS AND TRANSPORTATION: TESTING AND RESEARCH DIVISION; MAY 1976. 132PP., 59 FIG., 22 TAB., 19 REF.

Languages: ENGLISH

THE FRACTURE TOUGHNESS AND FATIGUE CRACK INITIATION CHARACTERISTICS OF ELECTROSLAG (CONSUMABLE GUIDE) AND SUBMERGED ARC WELDED JOINTS, IN A36 AND A588 STEELS, WERE INVESTIGATED USING CHARPY V-NOTCH TESTS. ELECTROSLAG WELDED JOINTS APPEARED TO HAVE A NON-HOMOGENEOUS NATURE IN WELD METAL AND HEAT AFFECTED ZONE (HAZ) TESTS AT 0 DEG F (-18 DEG C), AND A HIGHLY ANISOTROPIC NATURE IN THE WELD METAL. CHARPY TESTS CARRIED OUT BETWEEN -40 DEG AND +40 DEG F (-40 TO 4 DEG C) REVEALED THE TEMPERATURE-DEPENDENT CHARACTERISTICS OF THE WELD ZONES. RESULTS INDICATED THAT SUBMERGED ARC WELDS HAD SIGNIFICANTLY LONGER CRACK INITIATION LIVES THAN ELECTROSLAG WELDS, WHICH WERE OFTEN INFERIOR TO THE PARENT METAL IN THIS RESPECT. WELD ZONE METALLURGY WAS ALSO INVESTIGATED. WELDING SPECIFICATIONS ARE RECOMMENDED.

(ELECTROSLAG WELDING OF) THE (ICE-BREAKING BULK CARRIER) ARCTIC.

HANNAH F J

CANADIAN WELDER AND FABRICATOR VOL.69, NO.5, MAY 1978. PP.6-8, 10, 13-17. 22 FIG., 1 TAB.

Languages: ENGLISH

THE MAJORITY OF WELDS MADE WERE COMPLETED USING AUTOMATIC SUBMERGED-ARC WELDING, CONSUMABLE GUIDE ELECTROSLAG WELDING BEING USED TO WELD VERTICAL BUTT JOINTS IN DECK PLATES. BRIEF DETAILS ARE GIVEN OF WELDING OPERATIONS, EQUIPMENT (ALL OF WHICH HAD TO BE PORTABLE) AND PROBLEMS SUCH AS HEAT TREATMENT.

ELECTROSLAG WELDING OF SUPER TANKER RUDDER-STOCKS.

KONKOL P J

WELDING JOURNAL VOL. 56 NO. 12 DECEMBER 1977 PP. 3715-3795.

Languages: ENGLISH

A SERIES OF EIGHT WELDS WERE MADE IN 241N. (0.61M) WIDE A588 GRADE A STEEL PLATES, OF 1IN. (25.4MM) AND 4 IN. (102MM) THICKNESS, USING A CONSUMABLE GUIDE ELECTROSLAG WELDING PROCESS. THE VARIABLES STUDIED WERE SHOE TYPE (WATER COOLED COPPER SHOE/SOLID COPPER), GUIDE TYPE (SINGLE OSCILLATING/TWO FIXED), PLATE THICKNESS AND WELD LENGTH. TEMPERATURES WERE MONITORED DURING AND AFTER WELDING BY MEANS OF THERMOCOUPLES EMBEDDED AT VARIOUS DISTANCES FROM THE GROOVE FACE.
062894
(CONSUMABLE GUIDE) ELECTROSLAG WELDING METHOD.
BABBACO AND MILCOX COMPANY
BRITISH PATENT 1 495 855. FILED: 25 FEB. 1975. (USA 491 447, 24 JULY 1974). PUBLISHED: 21 DEC. 1977. 5 FIG., 1 TAB., 6 CLAIMS.
Languages: ENGLISH

THE PROCESS DESCRIBED INVOLVES USE OF FLUXES IN FIBROUS FORM MADE BY POURING MOLTEN FLUX THROUGH A JET OF AIR. THE FLUX INCLUDES AT LEAST 25 PER CENT SiO2 (UP TO 40 PER CENT) AND: 10-25 PER CENT CaO, 13-14 PER CENT Al2O3, 7-8 PER CENT MOO, 7-65 PER CENT CAF2, AND 7-25 PER CENT MnO2. A REFRACTORY FIBRE IS USED TO SEAL THE COOLING SHOE/WORKPIECE INTERFACE. VARIOUS COMPOSITIONS OF FLUXES ARE GIVEN AND THE DIMENSIONS OF GUIDE PLATES, CAVITY WIDTHS AND BLANKET THICKNESS ARE GIVEN.

062657
WIDE PLATE TESTS ON HIGH HEAT INPUT WELDMENTS IN C-MN STEELS.
HARRISON J D; SAUNDERS G G
WELDING RESEARCH INTERNATIONAL VOL. 7, NO. 4. 1977. PP. 277-297. 11 FIG., 7 TAB., 6 REF., Languages: ENGLISH

AN INVESTIGATION INTO FRACTURE TOUGHNESS OF 3 STEELS (DOMEX 3600, DOMEX 450D, 0X602D) INCLUDED STUDIES OF 5 WELDING PROCESSES. THESE INCLUDED 2- AND 1-SIDED SUBMERGED ARC, 1-SIDED SUBMERGED ARC WITH TUBULAR ELECTRODES, CONSUMABLE NOZZLE ELECTROSLAG AND ELECTROGAS WELDING. TESTS INCLUDED CHARPY V, PELLENI DROP WEIGHT, DYNAMIC TEAR AND COD. THE RESULTS MAY BE USED TO PREDICT FLAWED STRUCTURES.

062185
ELECTROSLAG WELDING.
KELLY P F
AUSTRALIAN WELDING JOURNAL VOL. 21, NO. 4. JULY/AUG. 1977. PP. 15-19. 9 FIG., 4 TAB., 6 REF., Languages: ENGLISH

ENGLISH PAPER PRESENTED AT: SEMINAR ON HIGH PRODICTIVITY CONTINUOUS WIRE WELDING PROCESSES.

THE BASIC PRINCIPLES OF ELECTROSLAG WELDING ARE OUTLINED, AND THE BASIC TECHNIQUES DESCRIBED. EQUIPMENT, JOINT PREPARATION AND CONSUMABLES ARE DISCUSSED. MECHANICAL PROPERTIES AND THE KIND OF PERFORMANCE THAT CAN BE ACHIEVED ARE REVIEWED WITH EXAMPLES FROM THE LITERATURE. FOUR SETS OF WELDING CONDITIONS ARE COMPARED AND APPLICATIONS SUGGESTED.

061428
MECHANICAL PROPERTIES OF CONSUMABLE GUIDE ELECTROSLAG WELD METALS IN GRAIN-REFINED C-MN STEELS.
VEDIA L A DE; PATCHETT B M
WELDING AND METAL FABRICATION VOL. 45, NO: 6, JULY/AUG. 1977. PP. 365-373, 11 FIG., 5 TAB., 19 REF., Languages: ENGLISH

THE EFFECT OF MANGANESE AND SILICON LEVELS ON THE TOUGHNESS AND TENSILE PROPERTIES OF C-MN MICROALLOYED WELD METALS PRODUCED WITH THE CONSUMABLE GUIDE ELECTROSLAG PROCESS HAS BEEN INVESTIGATED. THE AIM WAS TO DEVELOP GOOD WELD METAL MECHANICAL PROPERTIES IN AL AND NB GRAIN-REFINED STEELS WITHOUT RESORTING TO NORMALIZING. A HIGH-SPEED LOW-HEAT-INPUT TECHNIQUE WITH A BASIC FLUX WAS USED, AND THE WELD METALS WERE TESTED IN THE AS-WELDED AND STRESS-RELIEVED CONDITIONS. THE RESULTS SHOW THAT NO 4360 GRADE 40E (AL ADDITION) AND GRADE 50D (NB ADDITION) STEELS REQUIRE DIFFERENT LEVELS OF Mn AND Si IN THEIR RESPECTIVE WELD METALS TO DEVELOP OPTIMUM PROPERTIES.

061386
ELECTROSLAG WELDING OF LARGE CASTINGS FOR SHIP CONSTRUCTION.
BROSHOLLEN A; SKAUG E; VESSER J J
WELDING JOURNAL VOL. 56, NO. 5, AUG. 1977. PP. 26-30. 11 FIG., 4 TAB., Languages: ENGLISH


060391
MANUFACTURE OF FORKS FOR FORK LIFT TRUCKS,
LANCER BOSS LTD

L-SHAPED FORK MEMBERS CAN BE WELDED FROM TWO ROLLED-STEEL-STRIPS HELD PERPENDICULAR TO ONE ANOTHER, THE STRIPS BEING CLAMPED IN POSITION AND A WATER-COOLED JACKET ENCLOSING THE JOINT AREA. WELDING IS CARRIED OUT BY FILLING THE SPACE BETWEEN THE STRIPS WITH MOLTEN METAL PROVIDED BY A CONSUMABLE ELECTRODE AND GUIDE WIRE OF EN 24 STEEL. DATA IS GIVEN FOR THE PERFORMANCES OF VARIOUS METAL COMPOSITIONS (INCLUDING MECHANICAL TESTS AND HARDNESS) HEAT-TREATMENT CONDITIONS AND WELDING PARAMETERS (ELECTROSLAG).

0611428
MECHANICAL PROPERTIES OF CONSUMABLE GUIDE ELECTROSLAG WELD METALS IN GRAIN-REFINED C-MN STEELS.
VEDIA L A DE; PATCHETT B M
WELDING AND METAL FABRICATION VOL. 45, NO: 6, JULY/AUG. 1977. PP. 365-373, 11 FIG., 5 TAB., 19 REF., Languages: ENGLISH

THE EFFECT OF MANGANESE AND SILICON LEVELS ON THE TOUGHNESS AND TENSILE PROPERTIES OF C-MN MICROALLOYED WELD METALS PRODUCED WITH THE CONSUMABLE GUIDE ELECTROSLAG PROCESS HAS BEEN INVESTIGATED. THE AIM WAS TO DEVELOP GOOD WELD METAL MECHANICAL PROPERTIES IN AL AND NB GRAIN-REFINED STEELS WITHOUT RESORTING TO NORMALIZING. A HIGH-SPEED LOW-HEAT-INPUT TECHNIQUE WITH A BASIC FLUX WAS USED, AND THE WELD METALS WERE TESTED IN THE AS-WELDED AND STRESS-RELIEVED CONDITIONS. THE RESULTS SHOW THAT NO 4360 GRADE 40E (AL ADDITION) AND GRADE 50D (NB ADDITION) STEELS REQUIRE DIFFERENT LEVELS OF Mn AND Si IN THEIR RESPECTIVE WELD METALS TO DEVELOP OPTIMUM PROPERTIES.
THE APPLICATION OF ELECTRICALLY INSULATING COATINGS TO TITANIUM ELECTRODES.

GUDEVICH S M

AUTOMATIC WELDING VOL.28, NO.9. SEPT. 1975. P. 61. 1 FIG.,

TRANSLATION OF AVTOMATICHESKAYA SVARKA

A METHOD IS DESCRIBED OF PRODUCING A HALIDE COATING ON TITANIUM ELECTRODES USED IN CONSUMABLE GUIDE ELECTROSLAG WELDING OF TITANIUM ALLOYS. AS A RESULT, THE JOINT GAP CAN BE REDUCED, THERE IS NO NEED TO FEED IN FLUX DURING WELDING, WELDING SPEED CAN BE RAISED AND WELD QUALITY IS IMPROVED.

GUIDE FOR STEEL HULL WELDING.

AMERICAN WELDING SOCIETY

THE FIRST SECTION DEALS WITH STEEL MANUFACTURE NOTCH TOUGHNESS AND SPECIFICATIONS FOR STEEL AND WELDING CONSUMABLES. THE SECOND SECTION DEALS WITH WELDING PROCESSES USED IN HULL CONSTRUCTION, NAMELY MMA, SUBMERGED ARC, GMA, FCA, ELECTROSLAG, ELECTROGAS, CONSUMABLE GUIDE, STUD AND THERMIT WELDING. OTHER SECTIONS COVER DESIGN, HULL CONSTRUCTION (INCLUDING DISTORTION CONTROL DURING WELDING) AND INSPECTION.

ELECTROSLAG WELDING OF HEAVY SECTIONS.

SCAGNETTI H J: VEDIA L DE: SOLARI M: BILONI H

PAPER PRESENTED AT 29TH"ABM ANNUAL CONGRESS PORTO ALEGRE, R.G. DO SUL, BRAZIL. PUBL. SAO PAULO, BRAZIL, ASSOCIACAO BRASILEIRA DE METALIS, 1974. 36 PP. 10 REF.,

ELECTROSLAG WELDS WERE MADE WITH CONSUMABLE GUIDES ON STEEL PLATES IN THICKNESSES OF 40 AND 65 MM AND ON 150 MM SQUARE BILLETS. THE EFFECTS OF VARIATIONS IN WELDING VOLTAGE, CURRENT INTENSITY AND OSCILLATION OF THE FILLER METAL ON THE SOLIDIFICATION OF THE BEAD, ITS MICRO- AND MACROSTRUCTURES (INCLUDING PENETRATION), THE ANGLE OF INTERSECTION OF THE COLUMNAR GRAINS IN THE WELD METAL AND SEGREGATION SUBSTRUCTURES WERE STUDIED. THE MECHANISM OF METAL TRANSFER FROM THE EDGES OF THE PARENT METAL TO THE POOL OF MOLTEN METAL AND THE INFLUENCE OF PREHEATING OF THE EDGES ON GRAIN GROWTH IN THE PARENT METAL WERE INVESTIGATED. EXPITAXIAL NUCLEATION OF GRAINS SOLIDIFYING IN THE BEAD. NAD OTHER STRUCTURAL CHARACTERISTICS TYPICALLY PRODUCED BY WELDING PROCESSES WERE OBSERVED.

VERTICAL WELDING EFFICIENTLY WITH THE CONSUMABLE GUIDE ELECTROSLAG PROCESS.

PATCHETT B M

SME TECHNICAL PAPER AD74-407 DEARBORN, MICH. 48128:

SOCIETY OF MANUFACTURING ENGINEERS: 1974. 14 PP. 9 REF.,

ELECTRO-SLAG WELDING OF LARGE CAPACITY MIXED FLOW HYDRAULIC TURBINE RUNNER.

WELDING INSTITUTE OF THE CHINESE MECHANICAL ENGINEERING SOCIETY PEOPLE'S REPUBLIC OF CHINA, 1975. 12 PP. 11 FIG., 3 TABLES, 1 REF.

Languages: ENGLISH

In order to improve productivity, joint quality and working conditions, MMA WELDING OF TURBINE COMPONENTS was replaced by ELECTROSLAG WELDING. A special fixture was designed for the purpose. By using consumable nozzles and regulating heat distribution by careful positioning of the electrode wires in the slag bath, penetration depth was controlled throughout the weld. The material was 20MNSI cast steel (0.2 per cent C, 1.1 per cent Mn, 0.7 per cent Si). Also in: PROCEEDINGS, ADVANCED WELDING TECHNOLOGY 2ND INTERNATIONAL SYMPOSIUM OF THE JAPAN WELDING SOCIETY, OSAKA, 25-27 AUGUST 1975. PUBL. TOKYO, JAPAN WELDING SOCIETY, 1975. PP. 651-656.

WELDING PROCESSES MOVE TOWARD AUTOMATIC CONTROL.

MULLIN S P J

Languages: ENGLISH

Recent progress in the various classical welding processes and towards the solution of metallurgical problems posed by welding is described. Topics include: development of automatic submerged arc welding, use of numerical control for the positioning of the electrode, supply of electrical energy, wire feed, use of cored electrodes for mig welding, and development of consumable guide welding. Use of high strength low alloy steels and high cooling rates in the heat affected zone have encouraged investigation of heat treatment before and after welding.

FABRICATED STEEL STRUCTURE OF LARGE-CAPACITY WELDED HYDRAULIC TURBINE RUNNER.


Languages: ENGLISH

Consumable nozzle welding was used to construct turbine runners. The runner is a rotating body which will operate at low temperatures so it was subjected to post-weld heat treatment. Various types of cracking were encountered where electroslag welding was used. Ways of preventing cracks are outlined. The steels used were S-4IC(C-MN) and SC-46(C-MN-NI-C-R-CU).

PROBLEMS AND IMPROVEMENT OF LARGE HEAT INPUT ELECTROSLAG WELDING.


Languages: ENGLISH

The most effective methods for decreasing heat input in electroslag welding are to reduce the weld gap and the volume of metal deposited. Experiments were carried out on narrow gap electroslag welding using a 0.8 MM X 20 MM strip electrode and a consumable guide. The gap could be reduced to about 12 MM with a corresponding reduction in heat input. Mechanical properties, particularly resistance to hot cracking and brittleness, improved.

APPLICATION OF ELECTROSLAG WELDING TO HEAVY COMPONENTS.
NARROW GAP ELECTROSLAG WELDING PROCESS.
ITO Y IKEDA M YAMAUCHI N: FURUICHI J
Languages: ENGLISH

AUTOMATIC WELDING APPARATUS OF SIDE LONGITUDINALS OF SUPERTANKER HULL AT ERECTION STAGE.
ONISHI T; FURUTA S; OZAKI A
Languages: ENGLISH
THE LONGITUDINAL ASSEMBLIES CONSIST OF WEB AND FACE PLATES. ONE-SIDED AUTOMATIC CO2 WELDING WITH AN OSCILLATING ELECTRODE IS USED FOR THE WEB L-JOINTS. CONSUMABLE GUIDE WELDING IS USED FOR THE FACE JOINTS. A SPECIAL MOBILE UNIT HAS BEEN CONSTRUCTED FOR FITTING UP AND WELDING THE JOINTS. THE UNIT TRAVELS UP AND DOWN THE LONGITUDINAL AND INCLUDES A JIG FOR JOINT MISALIGNMENT CORRECTION.

ELECTROSLAG WELDING OF T JOINTS WITH SINGLE V EDGE PREPARATION USING A TUBULAR CONSUMABLE GUIDE.
SUSHCHUK-SLYUSARENKO I
AUTOMATIC WELDING VOL. 28, NO. 1. JAN. 1975. P. 53. 3 FIG., 1 REF.
Languages: ENGLISH
DETAILS ARE GIVEN OF THE SIMPLIFICATION OF THE PROCESS OF ELECTROSLAG WELDING WITH A CONSUMABLE TUBULAR GUIDE OF PRESS COMPONENTS OF THICKNESS 80 MM, LENGTH 2.5 M. A THICK-WALLED GUIDE TUBE OF EXTERNAL DIAMETER 14 MM WITH A WELDED-ON LONGITUDINAL RIB, AND A WATER-COOLED COPPER BACKING PLATE WERE USED. AN EXAMPLE IS GIVEN OF THE MACROSTRUCTURE OF A FILLET WELD WITH V-SHAPE EDGE PREPARATION. STEEL PLATES CAN ALSO BE USED FOR WELD SHAPING, IN ADDITION TO THE COPPER PLATE.
051706
ELECTROSLAG WELDING WITH A CONSUMABLE GUIDE PLATE AND FIBERISED FLUX.

STARK L E
DVS BERICHTE NO.32. PROCEEDINGS, 2ND INTERNATIONAL COLLOQUIUM ON WELDING IN NUCLEAR ENGINEERING, DUSSELDORF, 23-24 OCT. 1974. PUBL.DUSSELDORF, OVS, T974.PP.155-159. 9 FIG., 3 TABLES.
Languages: ENGLISH

A NEWLY DEVELOPED PROCESS IS DESCRIBED WITH DETAILS OF THE APPARATUS USED. THE DEVELOPMENT INCLUDED WELDING TESTS USING BARE CONSUMABLE GUIDE PLATES, PREPARATION OF THE FIBERISED FLUX AND TESTS CARRIED OUT WITH THE FLUX. THESE TESTS CONSISTED OF TENSILE AND IMPACT STRENGTH DETERMINATIONS AFTER STRESS RELIEVING. IT WAS FOUND THAT FOR THICKNESSES OVER 100 MM THE NEW PROCESS IS MANY TIMES FASTER THAN SUBMERGED ARC OR CONVENTIONAL ELECTROSLAG WELDING. RECOMMENDATIONS FOR FUTURE DEVELOPMENT ARE PRESENTED BRIEFLY.

051554
APPARATUS FOR WELDING VERTICAL JOINTS.

ESAB LTD
Languages: ENGLISH

THIS EQUIPMENT FOR CONSUMABLE GUIDE WELDING CONSISTS OF A CONSUMABLE TUBULAR GUIDE MEMBER WITH AN EXTERNAL SCREW THREAD; A UNIT FOR FEEDING THE ELECTRODE THROUGH THE CONSUMABLE GUIDE; MEANS FOR SUPPORTING AND POSITIONING THE CONSUMABLE GUIDE WITHIN THE WELDING GAP CONSISTING OF AN ANNULAR MEMBER MOUNTED FOR ROTATION IN A UNIT: WELD POOL RETAINING MEANS.

051485
CRACK OPENING DISPLACEMENT TESTING OF WELD METAL AND THE INFLUENCE OF THE ROTATION AXIS ON THE TEST RESULTS.

RIETJENS P H A
DELT UNIVERSITY OF TECHNOLOGY DEPARTMENT OF WELDING TECHNOLOGY REPORT 09-2/26. AUG. 1973. 33 PP.15 FIG., 3 TABLES, 11 REF.,
Languages: ENGLISH

A DESCRIPTION IS GIVEN OF THE POSSIBILITY OF DEFINING CODS BY SO-CALLED DOUBLE MEASUREMENT CARRIED OUT ON COMPACT KIC AND BEND SPECIMENS OF WELDED JOINTS. THIS METHOD SHOWS THAT OVER A VERY IMPORTANT RANGE OF CRACK OPENING DISPLACEMENT (COD) VALUES CONSIDERABLE ERRORS ARE MADE BY ASSUMING THE SPECIMEN TO HAVE A FIXED CENTRE OF ROTATION AS IS USUAL IN THE PROPOSED STANDARD COD TEST PROCEDURE. COMPARISON OF TEST RESULTS OF BOTH SPECIMENS (CK AND BEND) SUGGESTS THAT THE USE OF BEND SPECIMENS GIVES MORE CERTAINTY ABOUT THE PRECISION OF THE TEST RESULTS. FINALLY, THE RESULTS OF COO TESTS OF STATIC-LOADED BEND AND COMPACT KIC SPECIMENS, J1JUBLINK

DROP-WEIGHT TESTS AND CHARPY-V IMPACT TESTS APPLIED TO THE DEPOSITED METAL OF ELECTROSLAG WELDED PLATES (THICKNESS 50MM.ST52NB) ARE PRESENTED.

051383
RECENT EXPERIENCES IN AUTOMATIC ARC WELDING.

HORSFIELD A M
SVETSAREN NO. 1.1975.PP. t-9. 12 FIG., 3 REF.,
Languages: ENGLISH

DEVELOPMENTS ARE CONSIDERED IN THE FOLLOWING FIELDS: GRAVITY WELDING WITH COATED ELECTRODES: CO2 WELDING WITH FLUX CORED ELECTRODES: SUBMERGED ARC WELDING: ELECTROSLAG AND CONSUMABLE GUIDE WELDING.

051228
METHOD OF HARDFACING METAL WORKPIECE.

GREAT CANADIAN OIL SANDS LTD
Languages: ENGLISH

THIS IS A METHOD OF HARDFACING BY ELECTROSLAG WELDING USING AT LEAST TWO SEPARATE CONSUMABLE GUIDE NOZZLES OF A DIFFERENT METALLURGICAL COMPOSITION. THE WORKPIECE CAN BE A BUCKET WHEEL OR EXCAVATOR TOOTH. ONE GUIDE MEMBER MAY CONTAIN 60 PER CENT TUNGSTEN CARBIDE, 30 PER CENT FERROCHROME, 5 PER CENT FERROMOLYBDENUM AND 5 PER CENT FERROVANADIUM, AND THE OTHER MAY CONTAIN 49 PER CENT FERROCHROME, 49 PER CENT SILICON CARBIDE AND 2 PER CENT COBALT.

051187
CONSUMABLE GUIDE ELECTROSLAG WELDING OFFERS DESIGN FLEXIBILITY.

WELDING NEWS NO. 157. NOV. 1974. PP. 9-11. 6 FIG., 1 TABLE.
Languages: ENGLISH

THE COMPLEX WELDING OF TWO SECTIONS OF A RAILWAY STATION USING AS A186 MILD AND C-MN STEELS IS DESCRIBED. OVER 100 WELDS WERE MADE AND ULTRASONICALLY EXAMINED. DETAILS ARE GIVEN OF THE EQUIPMENT AND CONSUMABLES (NOZZLE GUIDES, SHOES ETC.), AND THE WELDING CONDITIONS AND TIMES ARE TABULATED.
CONSUMABLE NOZZLE ELECTROSLAG WELDING.

MOZOS A DE LOS

ROTACION VOL. 7, NO. 78. 1975. PP. 9-18. 15 FIG.,
Languages: SPANISH

A DESCRIPTION IS GIVEN OF TESTS CARRIED OUT FOR THE APPLICATION IN PRODUCTION OF CONSUMABLE-NOZZLE ELECTROSLAG WELDING EQUIPMENT DESIGNED TO WELD LONGITUDINAL BUTTS FOR BOTTOMS AND DECKS OF TANKERS. DATA ON THE EQUIPMENT USED TOGETHER WITH NOZZLE AND FLUX COMPOSITIONS AND TESTS UNDERTAKEN FOR APPROVAL BY THE CLASSIFYING BODIES ARE INCLUDED. BUTTS OF 600 X 35 AND 660 X 24 MM AND LENGTHS OF 575 X 36 MM ARE CURRENTLY WELDED. THE FLOW DIAGRAM AND OPERATIONAL TECHNIQUES ARE SHOWN.

MICROCRAKCS IN CONSUMABLE GUIDE WELDS AND THEIR POSSIBLE CONSEQUENCES ON WELD PERFORMANCE.

BANKS E E; RITCHIE J

AUSTRALIAN WELDING JOURNAL VOL. 19, NO. 1. JAN./FEB. 1975.
PP. 7-10. 5 FIG., 3 TABLES, 5 REF.,
Languages: ENGLISH

FACTORS CAUSING MICROCRACKING IN CONSUMABLE GUIDE WELDING 'ARE MOISTURE IN THE WELD POOL, FLUX DEPTH, VOLTAGE AND RESTRAINT LEVEL. TESTS WERE CARRIED OUT ON WELDS IN ASA 186 GRADE 250 PLATE (C 0.17 PER CENT, Mn 0.8 PER CENT, S 0.015 PER CENT, P 0.014 PER CENT). PRESENCE OR ABSENCE OF MICROCRACKS WAS JUDGED BY SIDE-BEND TESTS. IT IS CONCLUDED THAT IN PRACTICE MICROCRACKS ARE DIFFICULT TO DETECT BY NON METHODS, BUT THE CONSEQUENCES OF MICROCRACKING ARE NOT SERIOUS.

POWER SOURCES FOR GAS AND SLAG SHIELDED ARC WELDING PROCESSES.

PINFOLD B E; JUBB J E M

MAY 1975. PP. 274-276. 7 FIG.,
Languages: ENGLISH

ELECTRICAL CHARACTERISTICS OF POWER SOURCES FOR MIG AND ELECTROSLAG/CONSUMABLE GUIDE WELDING SYSTEMS ARE DISCUSSED.
045360
MICRO-CRACKING IN CONSUMABLE-NOZZLE ELECTROSLAG WELD METAL.
KUNIHIRO T; NAKAJIMA H
MICROCRACKS PRODUCED IN SPECIAL CONDITIONS IN CONSUMABLE GUIDE WELD METAL IN HT50 STEEL ARE HYDROGEN INDUCED CRACKS WHICH CAN BE PREVENTED BY INCREASING THE DEPTH OF THE SLAG POOL AND DECREASING THE COOLING RATE OF THE WELD METAL. THE EFFECT OF THESE MICROCRACKS ON THE FATIGUE STRENGTH OF WELDED JOINTS WAS INVESTIGATED. IF THE WELD REINFORCEMENT IS LEFT ON THE FATIGUE STRENGTH DEPENDS ON THE STRESS CONCENTRATION AT THE WELD TOES WITH OR WITHOUT MICROCRACKS. IF THE WELDS ARE GROUND FLUSH MICROCRACKS REDUCE FATIGUE STRENGTH.

045767
SOME ASPECTS OF THE USE OF HIGH STRENGTH STEELS IN OIL TANKERS.
AZPIROZ J J
REVISTA DE SOLDADURA VOL.4,No. 1.JAN-MAR. 1974. PP.3-15.14 FIG.,2 TABLES,7 REF., Languages: SPANISH
DESIGN CONSIDERATIONS ARE OUTLINED, AND DETAILS ARE GIVEN OF MANUAL METAL ARC WELDING USING LOW HYDROGEN ELECTRODES, SEMIAUTOMATIC FLUX-CORED CO2 WELDING, SUBMERGED ARC WELDING, CONSUMABLE GUIDE ELECTROSLAG WELDING, CORROSION TESTS AND ECONOMIC ANALYSIS. COVERAGE IS LIMITED TO STEELS OF 360 MPa UIS, MICROALLOYED WITH Nb AND NORMALISED.

046925
CALCULATION OF THE PARAMETERS OF THE SHAPE OF Penetration IN ELECTROSLAG WELDING WITH A CONSUMABLE GUIDE.
EREGIN, L P
WELDING PRODUCTION VOL. 21, NO. 4. APRIL 1974. PP. 45-48. 4 FIG., 1 TABLE, 2 REF., Languages: ENGLISH
TRANSLATION OF SVAROCHNOE PROIZVODSTVO.

044772
DEVELOPMENT AND APPLICATION OF AUTOMATIC PROCESSES.
WILSON A
AUSTRALIAN WELDING JOURNAL VOL. 18, NO. 2. MAR.-APR. 1974. PP. 8-15, 10 FIG., 1 TABLE, 11 REF., Languages: ENGLISH
THE ADVANTAGES AND DISADVANTAGES OF AUTOMATIC WELDING PROCESSES ARE OUTLINED. GAS METAL ARC WELDING IS REVIEWED, PARTICULARLY THE GAS MIXTURES THAT ARE CURRENTLY IN USE, AUTOMATIC PROCESSES FOR PIPELINE AND RAIL WELDING ARE DISCUSSED, AND RECENT DEVELOPMENTS IN CONSUMABLE GUIDE AND ELECTROSLAG WELDING DESCRIBED.
THE STRUCTURE AND PROPERTIES OF WELD METALS FOR HY 80 QUENCHED AND TEMPERED STEELS.

APPS R L; SMITH E


The mechanical properties of low dilution deposits were evaluated using hardness, tensile, and notch-impact tests, and the results have been related to weld metal composition and micro-structure. The influence of post-weld heat treatment on the weld deposits was also studied. The mechanical properties of the weld deposits are adequate for applications down to -20 deg.C but notch toughness is not equivalent to that of parent material. There is a possibility that attention to weld microstructure and inclusion content could improve this situation.

CONSUMABLE NOZZLE TYPE ELECTROSLAG WELDING PROCESS USING FLUX CORED WIRE (SES PROCESS USING FLUX-CORED WIRE).

NIPPON STEEL CORPORATION

NEW WELDING PROCESS.PUBL.SAGAMIHARA JAPAN. NIPPON STEEL CORP. NIPPON STEEL WELDING PRODUCTS AND ENGINEERING CO.LTD.PAPER NO. 12.PP. 105-108. 1 FIG.,2 TABLES. , Languages: ENGLISH

The process is identical with the SES process with covered consumable guide (Electroslag 4-4349) except that a covered filler wire is used. Similar equipment is used with a different wire feed roller. Standard welding conditions are given for plate between 12 and 50 mm thick. Weld metal tensile and impact properties are given for a range of steels used in shipbuilding. See also:NIPPON STEEL TECHNICAL REPORT (OVERSEAS), NO.6.1974 PP. 40-48. (IN ENGLISH).

ELECTRIC SLAG WELDING PROCESS WITH COVERED CONSUMABLE NOZZLE ('SES WELDING PROCESS').

NIPPON STEEL CORPORATION

‘NEW WELDING PROCESS’. PUBL.SAGAMIHARA JAPAN,NIPPON STEEL CORP.NIPPON STEEL WELDING PRODUCTS AND ENGINEERING CO LTD.PAPER NO 12.PP.99-104. 4 FIG.,3 TABLES,
Languages: ENGLISH

This slightly modified consumable guide process uses a flux-covered steel tube as a consumable nozzle. Details are given of equipment, control devices, types of guide for steels of different strength and thickness. Standard welding conditions are given for plate from 14-60 mm thickness.
CROSS COUNTRY TRIP FOR ELECTROSLAG WELDING.
4 in. (100 mm) thick, 16 ft. (4.8 m) long plates of Cor-Ten B for a U.S. West Coast Nuclear Installation were shipped to Pittsburgh, Pa., for the execution by a specialised fabricator using consumable nozzle electroslag welding of 24 in. (0.61 m) blind welds along a 10 ft. (3 m) height and 48 in. (1.22 m) blind welds along a 4 ft. (1.22 m) height. Satisfactory welds were produced in a quarter of the time required for conventional processes.

WELDING IN JAPANESE SHIPYARDS.
NORTH TH
WELDING AND METAL FABRICATION VOL. 42, NO. 4. APRIL 1974. pp. 118-124. 11 Fig., 1 Table, 5 REF., Languages: English
New assembly methods have been developed and working conditions improved to attract more welders. The trend towards machine-intensive welding is described in relation to submerged arc welding of flat panels, using flux-backing consumables, and of stiffeners by gravity welding methods, CO₂ welding, GMA mechanised welding of block assemblies, and electrogas, electroslag and consumable nozzle electroslag welding.

THE ELECTROSLAG WELDING OF HEAVY SECTION 25KHN3MF STEEL.
CHERNYKH V V
A brief description is given of the electroslag welding of a full scale model for low alloy steel turbogenerator rotors. The weld cross-section was 2000 x 2650 mm. Consumable guide welding was used, with a preheat of 450 deg. C. The completed item, weighing 160 tonnes, was normalised and tempered after welding. A bar was removed from the centre of the weld, and tensile and impact tests and metallographic examination were carried out. The results obtained being considered satisfactory.

ARC WELDING IN SPANISH SHIPYARDS.
PENCHE C
A brief description is given of manual MIG submerged arc, miniature electroslag and consumable guide welding in Spanish shipyards is described. Spanish ship production expanded four times faster than the average during the late 1960s and a marked trend towards mechanisation of welding accompanied this growth.

STRUCTURAL STEELWORK FOR (THE SYDNEY, AUSTRALIA) KINGS CROSS AND MARTIN PLACE RAILWAY STATIONS.
BILSTON K J M
AUSTRALIAN WELDING JOURNAL Vol. 17. No. 5. SEPT.-OCT. 1973. pp. 31-33. 4 FIG., 4 REF., Languages: English
Paper No. 2 Presented to 21st National Welding Conference, Australian Welding Institute, Sydney, N.S.W., 8-12 OCT. 1973. Large continuous beams supported on columns were required for permanent support in two underground railway stations in Sydney's eastern suburbs railway. The design, fabrication, welding and erection of the steel work are discussed. The consumable guide electroslag, flux-cored CO₂ and submerged arc welding processes were used.

NEW TECHNOLOGY FOR MANUFACTURING THE BEARING UNIT OF A ROTARY KILN.
KOZULIN M G
WELDING PRODUCTION Vol. 20, No. 5. MAY 1973. pp. 77-78. 2 FIG., 1 TABLE, 2 REF., Languages: English
Translation of Svarochnoe Proizvodstvo.
The bearings consist of shells and hoops, hitherto secured using gaskets and side stops. Two halves, each of 35L steel 35L (0.37 per cent C: 0.69 per cent Mn: 0.25 per cent Cr), were joined by consumable tip electroslag welding. Methods for compensating for strain to achieve dimensional accuracy are reported. After local stress relieving and ultrasonic testing of the welds, the bearing units were completed by circumferential submerged arc welding, with preheating, stress relieving and ultrasonic inspection. The units have proved entirely satisfactory over two years' service.
042602
WELDED FABRICATION OF HEAVY COMPLEX STRUCTURAL UNITS.
AMBROSE S A; PENNIE J. AUSTRALIAN WELDING JOURNAL VOL. 17, NO. 4. JULY-AUG. 1973. PP. 11-14. 9 FIG., 1 TABLE., Languages: ENGLISH
THE FABRICATION OF COMPLEX STRUCTURAL UNITS IN AS A186 GRADE 250 MILD STEEL OF UP TO 7 IN (180 MM) THICKNESS IS DESCRIBED. INVERTED TRIANGULAR UNITS OF BOX GIRDER WERE REQUIRED FOR THE BASE SECTIONS OF A 20 STOREY BUILDING TO BE BUILT OVER A RAILWAY STATION. THESE UNITS WERE FABRICATED USING MANUAL METAL ARC, FLUX CORED GASLESS, SUBMERGED ARC AND CONSUMABLE GUIDE ELECTROSLAG WELDING PROCESSES. DETAILS OF THE WELDING PARAMETERS AND TECHNIQUES ARE GIVEN.

042579
USE OF A TUBULAR CONSUMABLE GUIDE FOR ELECTROSLAG WELDING METAL, UP TO 50MM THICK.
SUSHCHUK SLYUSARENKO I I AUTOMATIC WELDING VOL.26.NO.5.MAY 1973.PP.73-74.2 FIG.,3 REF., Languages: ENGLISH
(TRANSLATION OF AVTOMATICHESKAYA SVARKA)
IT HAS BEEN FOUND POSSIBLE TO USE CONSUMABLE GUIDE ELECTROSLAG WELDING FOR MATERIALS AS THIN AS 25-50MM. THE SPECIAL NARROW GUIDE TUBE DEVELOPED, AND USE OF THE PROCESS FOR FABRICATION OF A 125 T PRESS FRAME ARE DESCRIBED.

042481
UNUSUAL ELECTROSLAG WELDING APPLICATIONS.
DORSCHU K E; NORCROSS J E; GAGE,C J WELDING JOURNAL VOL.52,NO.11.NOV.1973.PP .710-716.16 FIG.,8 TABLES., Languages: ENGLISH
THE ADVANTAGES OF ELECTROSLAG WELDING (OF BOTH THE MOVING SHOE AND CONSUMABLE NOZZLE VARIETIES) INCLUDE HIGH DEPOSITION RATE, EFFICIENCY AND WELD METAL SOUNDNESS, COST SAVINGS WHEN JOINING THICK PLATE OR ASSEMBLING MASSIVE COMPONENTS, AND LOW DISTORTION IN SUITABLE CASES. PREDICTABLE USE OF THE PROCESS IS ILLUSTRATED BY APPLICATIONS INCLUDING: THE WELDING OF SIDE GRAMES IN 1020 STEEL FOR A 5000-TON HYDRAULIC PRESS; THE FABRICATION OF GAINT HOOPS USED IN PRESSES THAT FORM SYNTHETIC DIAMONDS; THE WELDING OF NUCLEAR TIE DOWNS; THE REPAIR OF A CRACKED CEMENT KILN RING AND A BROKEN STEEL MILL ROLL; THE OVERLAYING OF 1060 STEEL ON LOCOMOTIVE DRIVE WHEELS; THE ELECTROSLAG CASTING OF A 2 1/4 CR-MO STEEL PRESSURE VESSEL; AND THE SURFACING OF HIGH-ALLOY AND TOOL STEEL BILLETS WITH MILD STEEL ON THE ENDS FOR SMOOTHER HOT ROLLING.

SVEISSTEMNIK VOL.28.NO.4.SEPT. 1973.PP. 61-67.70-72.18 FIG.,2 TABLES,10 REF., Languages: DANISH
(TRANSLATION OF SVÆRDEKONSTRUKTION)
THE PRINCIPLES MACHINES USED, APPLICATIONS AND PROSPECTS ARE DESCRIBED FOR THE MECHANISED VERTICAL WELDING PROCESSES-ELECTROSLAG, CONSUMABLE GUIDE ELECTROSLAG, AND ELECTROGAS WELDING. THE PROCESSES ARE COMPARED. A SHORT SURVEY IS GIVEN OF WELD STRUCTURE, MECHANICAL PROPERTIES AND DEFECTS, AND THE ECONOMICS OF THE PROCESSES.

042394
NON-DESTRUCTIVE EXAMINATION OF WELDS AS APPLIED IN HEAVY STEEL FABRICATION AT AUSTRALIAN IRON AND STEEL PTY. LTD., PORT KEMBLA.
THE FABRICATION OF A STEEL SHOP INVOLVED THE ULTRASONIC INSPECTION OF THICK-SECTION WELDS IN STRUCTURAL STEEL PRODUCED BY AUTOMATIC PROCESSES, INCLUDING CONSUMABLE GUIDE ELECTROSLAG WELDING. THIS INSPECTION METHOD WAS USED BECAUSE IT GAVE GREATER COVERAGE INSPECTION, AND HAS THE REQUIRED SENSITIVITY. WELD DEFECTS ARE DESCRIBED, WHICH OCCURRED IN T JOINTS, BUTTWELDS WITH VARIOUS JOINT SHAPES, INCLUDING LAMELLER TEARING AND LACK OF FUSION. THE EXAMINATION OF HOT METAL AND TEEMING LADLES, MADE OF STEEL PLATE, HOT METAL AND TEEMING LADLE TRANSFER CARS, AND OVERHEAD CRANES AND RUNWAY GIRDER S ARE DESCRIBED IN WHICH CRACKING AND OTHER DEFECTS WERE FOUND.

042355
THE ELECTROSLAG WELDING OF BANDS FOR A 7 X 230 M ROTARY CEMENT KILN.
KOZULIN M G; MAKAROV G N; SUSHCHUK SLYUSARENKO I I AUTOMATIC WELDING VOL. 26, NO. 4. APR. 1973. PP. 7D7I. 2 FIG., 1 TABLE, 2 REF., Languages: ENGLISH
TRANSLATION OF AVTOMATICHESKAYA SVARKA.
THE WELDING CROSS SECTION OF THE 130 T FURNACE, OF TYPE 30 STEEL, " 0.5 X 1.35 M. HALF-RINGS MADE FROM TWO PARTS WERE CONSUMABLE GUIDE ELECTROSLAG WELDED TOGETHER ON SITE. ACCURACY OF SHAPE OF THE COMPLETED FURNACE BANDS WAS SATISFACTORY.

042409
ELEGTROSLAG AND ELECTROGAS WELDING,
ANDERSEN C B
042142
CONFERENCE - WELDING LOW-TEMPERATURE CONTAINMENT PLANT.
METAL CONSTRUCTION AND BRITISH WELDING JOURNAL VOL. 6, NO. 1.
JAN. 1974. PP. 18-21.,
Languages: ENGLISH
A REPORT ON THE AUTUMN CONFERENCE OF THE WELDING INSTITUTE,
HELD IN LONDON, IN NOVEMBER, 1973. THE PAPERS PRESENTED ARE
BRIEFLY DESCRIBED UNDER THE FIVE CONFERENCE SESSION HEADINGS:
CONSUMABLES FOR NICKEL STEELS, INCLUDING WELD-METAL STRENGTH
AND FERRITIC CONSUMABLES: FRACTURE TOUGHNESS OF NICKEL STEELS;
OTHER CRYOGENIC MATERIALS FOR SUBMERGED-ARC AND
CONSUMABLE-GUIDE WELDING, FATIGUE, ELECTROSLAG WELDING OF
ALUMINIUM, INVAR ALLOYS: DESIGN AND CONSTRUCTION RELATING TO
WELDED TUBE, SPHERICAL TANKS, PIPELINES AND TANK ROOFS, WITH
REFERENCE TO QUALITY CONTROL: CODES OF PRACTICE FOR STORAGE
TANKS.

041858
METHOD FOR VERTICAL WELDING OF ALUMINIUM.
UNION CARBIDE CORPORATION
BRITISH PATENT 1 343 499. FILED 20 MAY 1971. (UNITED STATES
FIG. 8 CLAIMS.,
Languages: ENGLISH
THE INVENTION PROVIDES A METHOD FOR VERTICAL WELDING
ALUMINIUM OR ALUMINIUM ALLOY WORKPIECES HAVING A THICKNESS OF
AT LEAST 1IN. (25MM) TO OVERCOME THE DIFFICULTIES ENCOUNTERED
WITH THE USUAL TYPE OF ELECTROSLAG PROCESS. AN ALUMINIUM OR
ALUMINIUM ALLOY WIRE ELECTRODE IS PASSED THROUGH A
CURRENT-CARRYING GUIDE TUBE INTO A CAVITY BETWEEN THE
WORKPIECE SURFACES, AND A PAIR OF OPPOSITELY DISPOSED WELD
PUDDLE RETAINERS MADE OF GRAPHITE, OR FACED WITH GRAPHITE,
ARE POSITIONED SO THAT THE WIRE ELECTRODE IS PROGRESSIVELY FUSED
WITHIN THE CAVITY UNDER A LAYER OF HALOGEN BASE FLUX WHICH IS
MAINTAINED MOLTEN BY THE PASSAGE OF A WELDING CURRENT OF FROM
1300 TO 400 AMPERES AT 40 TO 75 VOLTS. WHEN WELDING PLATES
OF THICKNESS GREATER THAN 2IN. (5CM) SEVERAL GUIDE TUBES MUST BE
USED, EACH SUPPLIED WITH WIRE PASSED THROUGH A ROTATING
SKEWER.

041660
APPLICATION OF ELECTRO-SLAG AND CONSUMABLE GUIDE WELDING,
PART 6.
ELLIS D J; GIFFORD A F
WELDING AND METAL FABRICATION VOL. 41, NO. 11.
NOVEMBER 1973. PP. 387-390, 9 FIG.,
Languages: ENGLISH
PARTS 1-5: IBID., NOS. 4, 5, 6, 8, 10, APR., MAY, JUNE, AUG.
OCT. 1973., PP. 112-119, 116-166, 198-203, 284-287 AND
326-364, RESPECTIVELY.
IN THIS, THE CONCLUDING ARTICLE OF A SERIES, THE
APPLICATIONS OF ELECTRO-SLAG AND CONSUMABLE GUIDE WELDING
DESCRIBED ARE THE WELDING OF SHIPS STERN FRAMES, THE WELDING
OF OIL DRILLING RIG LEGS, MINE SHAFT LININGS AND FLANGES FOR
WIND TUNNELS.

041728
HIGH SPEED CONSUMABLE GUIDE WELDING OF C-MN STEELS FOR LOW
TEMPERATURE CONTAINER APPLICATIONS.
PATCHETT B M; COLLINS F W; APPS R L
PREPRINTS CONFERENCE ON WELDING LOW TEMPERATURE CONTAINMENT
PLANT, LONDON, 20-22 NOVEMBER 1973, PUBL. ABINGTON, CAMBRIDGE,
FIG. 3 TABLES, 14 REF.,
Languages: ENGLISH
WELDING SPEEDS OF 10M/HR AND HEAT INPUTS OF LESS THAN
15KJ/MM IN 19MM THICK PLATE HAVE BEEN PRODUCED USING A NARROW
GAP CONSUMABLE GUIDE TECHNIQUE. SATISFACTORY PROPERTIES HAVE
BEEN ACHIEVED IN SEVERAL BS 4360 WELD METALS IN THE AS-WELDED
CONDITION. PEARLITE-REDUCED AND PEARLITE FREE STEELS GIVE GOOD
WELD METAL PROPERTIES WITH ADEQUATE PARENT PLATE AND HAZ
PROPERTIES, MAKING THESE STEELS SUITABLE FOR SUBZERO
APPLICATIONS. WELDS WERE MADE IN A MODIFIED X-65 STEEL USING A
VARIETY OF FILLER WIRES TO DETERMINE OPTIMUM PROCESS
CONDITIONS AND WELD METAL COMPOSITION.
041358
CONSUMABLE GUIDE ELECTROSLAG WELDING OF VERTICAL BEAM JOINTS.
ANDERSEN N, SVETSAREN NO. 1. 1973. PP. 9-12. 5 FIG., 1 TABLE.
Languages: ENGLISH
NEW EQUIPMENT FOR CONSUMABLE GUIDE WELDING IS DESCRIBED. THE PRINCIPLES OF THE PROCESS ARE COMPARED WITH THOSE OF NORMAL ELECTROSLAG AND THE IMPORTANCE OF CORRECT FLUX COMPOSITION IS STRESSED. ALSO BRIEFLY DESCRIBED ARE THE MECHANICAL PROPERTIES ATTAINED IN TYPICAL WELDMENTS.

041252
WELDING OF CASTINGS.
FWP JOURNAL VOL. 13, NO. 7. JULY 1973. P.11. 1 FIG.,
Languages: ENGLISH
A DEMONSTRATION OF A SIX WIRE CONSUMABLE GUIDE APPARATUS FOR WELDING VERY LARGE CASTINGS IS DESCRIBED. THE APPARATUS HAS SUCCESSFULLY JOINED TWO CASTINGS TO PRODUCE A ROLLING MILL STAND WEIGHING 94TONS. ULTRASONIC TESTING SHOWED A DEFECT-FREE JOINT.

041108
ELECTROSLAG WELDING WITH A CONSUMABLE GUIDE.
KELLY P F
AUSTRALIAN WELDING JOURNAL VOL. 16, NO. 7. NOV-DEC. 1972. PP. 13-17, 11 FIG., 2 TABLES, 3 REF.
Languages: ENGLISH

040577
ELECTROSLAG WELDING.
GUYOT F
PP. 17-26. 9 FIG.
Languages: FRENCH

040503
THE USE OF CONSUMABLE NOZZLE ELECTROSLAG WELDING IN THE SHIPBUILDING INDUSTRY.
KALAGO M, PIOTROWSKI F, KOBIEROSKI A
PRZEGALD SPAWALNICTWA VOL. 25, NO. 5. MAY 1973. PP. 104-106. 5 FIG., 1 TABLE, 4 REF.
Languages: POLISH
POLISH THE METHOD AND THE EQUIPMENT AND MATERIALS USED ARE DESCRIBED. THE EQUIPMENT IS SIMPLE, OF LOW WEIGHT. TECHNOLOGY OF THE WELDED JOINTS. CONSUMABLE NOZZLE ELECTROSLAG WELDING IS TO BE USED ABOVE ALL IN FABRICATION OF STRUCTURES. IN PARTICULAR WHEN A LARGE NUMBER OF JOINTS OF UP TO 1M LENGTH IS MADE IN THE VERTICAL POSITION. POSSIBLE APPLICATIONS OF THE PROCESS.

040355
APPLICATION OF ELECTRO-SLAG AND CONSUMABLE GUIDE WELDING.
ELLIS D J, GIFFORD A F
PART 4. WELDING AND METAL FABRICATION VOL. 41, NO. 8. AUG. 1973. PP. 284-287. 11 FIG.
Languages: ENGLISH
HEAVY STEEL MILL ROLLING EQUIPMENT, PRESSES AND STEEL CONVERTERS ARE THE COMPONENTS COVERED IN THIS PART OF THE REVIEW ON ELECTRO-SLAG AND CONSUMABLE GUIDE WELDING. DETAILS ARE GIVEN OF THE TECHNIQUES USED AND THE DEGREES OF DISTORTION TO BE EXPECTED.
The effect of welding gap dimension and metal deposition rate on welding speeds and heat inputs has been investigated. Welding speeds of up to 15 m/h with heat inputs of less than 20 kJ/mm were made in 32-38 mm thick mild steel plates using welding gaps between 10 mm and 19 mm with insulated consumable guides. The high speed low heat input conditions were applied to welding BS 4360 steels using acid and basic commercial fluxes, and the mechanical properties of the welded joints were examined. In the as-welded condition, the tensile properties of the weld metals were above specification, but the impact properties of the weld metals met the plate specification only when basic fluxes were used. The chemical composition of the steel was the dominant factor affecting impact properties in the heat-affected zone. In the Al grain refined grade 40E steel, impact values in low heat input welds were satisfactory, as they were in the semi-killed grade 40D steel. The fully-killed Nb grain refined grade 50D steel yielded impact values well below specification even with low heat inputs.

Further applications of the processes in the construction of power generation equipment are described. In particular, consideration is given to the design of machines and shoes and to the welding procedures for making T butt joints. Shrinkage, bowing and angular distortion can occur in T butt joints; preventive measures are outlined.


Languages: English

The author briefly describes the principles and application of manual metal arc, CO2, flux cored gasless, MIG, tungsten arc, submerged arc and electroslag welding to mild, low alloy and stainless steels. Types of consumables and operating characteristics are outlined for each process. An example is given on process selection, NDT, and subsequent heat treatment when welding a thick walled pressure vessel.
037286
RECENT DEVELOPMENTS IN WELDING STEEL CASTINGS.
RIDL E J, JACKSON W J
Languages: ENGLISH
PART 1 PUBLISHED IN METAL CONSTRUCTION AND BRITISH WELDING JOURNAL, VOL.4, NO.11. NOV. 1972. PP.413-417.
THIS PAPER HAS THREE DISTINCT SECTIONS. THE FIRST DESCRIBES AN INVESTIGATION INTO THE EFFECTS OF SULPHUR CONTENT (FROM 0.004 PER CENT - 0.039 PER CENT), OF LOW HYDROGEN AND RUTILE ELECTRODES, OF CARBON EQUIVALENT FROM 0.2 TO 0.46, AND OF RESIDUAL ELEMENTS (NI MAX. OF 0.16 PER CENT, CR MAX. OF 0.20 PER CENT AND MO MAX. OF 0.09 PER CENT) ON THE WELDABILITY OF CAST C:MN STEELS. CTS TESTS AT T.S.N.S OF 15,10,7 AND 5 WITH NO PREHEATING WERE USED. SUCCESSFUL WELDS WITH NO HAZ CRACKING RESULTED; RESIDUAL ELEMENTS DID NOT IMPAIR THE WELDABILITY WHICH WAS SUPERIOR TO THAT REPORTED PREVIOUSLY FOR WROUGHT C:MN STEEL. IN THE SECOND PART, THE ADVANTAGES OF CAST-WELD FABRICATION ARE DELINEATED; SEVERAL EXAMPLES ARE ILLUSTRATED, IN THE FINAL PART, SOME OF THE NEWER SEMIAUTOMATIC CONSUMABLE WIRE WELDING PROCESSES APPLICABLE TO STEEL CASTINGS ARE DISCUSSED. THESE ARE CO2 WELDING WITH SOLID AND FLUX CORED WIRE, SELF SHIELDED WELDING AND CONSUMABLE GUIDE WELDING.

036873
MARTIN PLACE RAILWAY STATION - PART IV,
WELDING NEWS NO. 148, APRIL 1972. PP. 8-9. 4 FIG., 1 TABLE.
Languages: ENGLISH
PARTS 1-3 APPEARED IN WELDING NEWS, NOS. 144, 146 AND 147 RESPECTIVELY.
THE ARTICLE DESCRIBES THE SITE WELDING OF STEEL BEAM WEBS INVOLVING BUTT WELDS IN 100 MM (4 IN.) THICK MATERIAL USING THE CONSUMABLE GUIDE ELECTROSLAG PROCESS. WELDING CONDITIONS ARE TABULATED, NO PREHEAT BEING USED, AND 1450 MM (47 IN.) LENGTHS BEING WELDED IN 6-1/2 HRS WELD TIME. FINAL 100 PER CENT ULTRASONIC EXAMINATION BEFORE AND AFTER HEAT TREATMENT. SUBSEQUENT MACHINING REMOVED ABOUT 4 TONES OF METAL, THE TABLE FINALLY BEING OF ABOUT 49 TONES (48 TONS).

036662
IMPROVEMENTS IN ELECTROSLAG WELDING.
BRITISH STEEL CORPORATION
Languages: ENGLISH
IN CONSUMABLE GUIDE WELDING, A TROUGH ISLOCATED BENEATH THE WORKPIECES AND BRIDGES THE WHOLE WIDTH AND LENGTH OF THE BOTTOM OF THE WELD GAP, SLAG IS PLACED IN THE TROUGH AND HEATED BY INDUCTION OR RESISTANCE HEATING TO FACILITATE WELD STARTING. SLAG MAY BE INTRODUCED EITHER MOLTEN OR AS A DRY POWDER. AND THE WORKPIECES ARE PREFERABLY PREHEATED. BOTH RESISTANCE AND INDUCTION HEATED TROUGHS ARE DESCRIBED. FOR NON-RECTANGULAR WORKPIECES, ADAPTOR CHECKS ARE WELDED OVER THE WORKPIECES ENDS AND THE TROUGH PLACED BENEATH THE CHECKS.

036318
INVESTIGATION OF A DEFECT IN A CONSUMABLE-GUIDE WELD.
MUSGRAVE M P; ELLIS D J
METAL CONSTRUCTION AND BRITISH WELDING JOURNAL VOL. 5, NO. 1. JAN. 1973. PP. 26-27. 3 FIG.,
Languages: ENGLISH
PIPING THROUGH THE WELD METAL WAS DISCOVERED WHEN A CRUCIFORM JOINT BETWEEN FOUR PLATES, THOUGHT TO BE OF BS 1501-224-GR. 32 MATERIAL, WAS SECTIONED. INVESTIGATION SHOWED THAT TWO OF THE PLATES WERE OF A... TYPE OF NO PARTICULAR SPECIFICATION. THESE PLATES, BEING UNKILLED, RELEASED GAS INTO THE MOLTEN POOL, THUS CAUSING PIPING.

036872
WELDED 52 TON GIRDER TABLE.
WELDING NEWS NO. 148. APRIL 1972. PP. 2-8. 8 FIG.,
Languages: ENGLISH
THE DESIGN AND PERFORMANCE OF A HIGH-SPEED CONSUMABLE-GUIDE ELECTROSLAG WELDING MACHINE.

PATTERTON B M; COLLINS F W; TIMPSON D
CRANFIELD MEMO No. 72. JUNE 1972. 22 PP.
16 FIG., 1 TABLE, 5 REF. CRANFIELD INSTITUTE OF TECHNOLOGY.

The purpose of the design of this machine was to lower the heat input associated with electroslag welding by providing methods of achieving high welding speeds in mild and low alloy steel plates to thicknesses between 25 mm and 150 mm and lengths of up to 1000 mm. Welding speeds of up to 15 m/h have been achieved primarily through the use of narrow gaps and high electrode wire feed rates. Heat inputs have been reduced by a factor of 3 in comparison with conventional electroslag methods. As a result, some grades of steel are suitable for use in the as-welded condition.

IMPROVED METHODS REDUCE COSTS, INCREASE CAPACITY.

WELDING ENGINEER VOL.57, NO.8. AUG. 1972. PP. 25-29. 5 FIG., Languages: ENGLISH
Techniques used in the NASSCO (SAN DIEGO) SHIPYARD ARE DESCRIBED. USE OF MECHANISED HANDLING WITH GREAT EMPHASIS ON CONVEYOR BELT SYSTEMS SPEEDS UP ENTRY AND EXIT TO THE PROFILE CUTTING AND EDGE PREPARATION UNITS. USE OF SUBMERGED ARC AND CONSUMABLE GUIDE ELECTROSLAG WELDING FOR STEEL DECK PANELS AND MECHANISED OR SEMI-AUTOMATIC MIG WELDING, FOR PIPEWORK AND ALUMINIUM SUPERSTRUCTURES HAS ACHIEVED GREAT SAVINGS IN MANPOWER AND TIME.

ELECTRIC WELDING.

BRITISH OXYGEN CO LTD THE

Languages: ENGLISH
To improve the impact properties of the heat affected zone of electroslag or electrogas welds the rate of heat input to the weld zone is varied with distance along the welding path to produce a heat affected zone with non-linear boundaries. The thermal cycling may be produced by varying the welding voltage while keeping the wire feed speed and welding current constant, or by adjusting the wire feed speed and voltage simultaneously in a chosen relationship.

ELECTROSLAG WELDING IN JAPAN.

MASUMOTO I; TERAI K
TRANSACTIONS OF THE JAPAN WELDING SOCIETY VOL. 2, NO. 1. APRIL 1971. PP. 42-51. 21 FIG., 7 TABLES.
ELECTROSLAG PROCESS SAVES MONEY BUT IT STILL HAS TO BE FULLY EXPLOITED.

APP S R L; PATCHETT B M

PROCESS ENGINEERING. JANUARY 1972. PP. 58-60. 7 FIG., Languages: ENGLISH

THE EFFECTS OF REDUCING THE ENERGY INPUT, BY USING HIGHER WELDING SPEEDS AND CURRENT AT LOWER VOLTAGES AND OF EMPLOYING BASIC RATHER THAN ACIDIC FLUXES ON THE QUALITY OF CONSUMABLE GUIDE WELDS HAVE BEEN STUDIED. THE TENSILE AND IMPACT PROPERTIES OF WELDED JOINTS IN THICK PLATES OF MILD STEEL, QUENCHED AND TEMPERED LOW ALLOY STEELS QT35 AND HY80 AND 2-1/4 PER CENT CR-1 PER CENT MO STEEL ARE RECORDED. IT IS CONCLUDED THAT MORE RESEARCH IS REQUIRED INTO BASIC FLUXES SPECIFICALLY FOR THE PROCESS AND INTO THE USE OF HIGHER SPEEDS BEFORE THE PROCESS WILL BE ADOPTED FOR PRODUCTION.

THE ELECTROSLAG WELDING OF BENDING ROLLS,
KOZULIN M G

AUTOMATIC WELDING VOL. 24, NO. 7. JULY 1971. P. 70, 2 FIG., 1 REF., Languages: ENGLISH

A LARGE DIAMETER ROLL IN GRADE 60 STEEL, WHICH HAD FAILED BY BRITTLE FRACTURE WAS REPAIRED BY ELECTROSLAG WELDING WITH TWO CONSUMABLE GUIDES SIMULTANEOUSLY ENTERING A COMMON WELD POOL. DETAILS OF THE PRE-HEAT TEMPERATURES TOGETHER WITH WELDING PARAMETERS ARE GIVEN. NO DEFECTS WERE FOUND AFTER 100 PER CENT ULTRASONIC INSPECTION.

FRACTURE INITIATION IN WELD METALS: EFFECTS OF GEOMETRY AND STRAIN RATE.
Dawe S M G

WELDING INTERNATIONAL RESEARCH AND DEVELOPMENT VOL. 1, NO. 4. 1971. (13 PAGES) 8 FIG., 6 TABLES. 6 REF., Languages: ENGLISH

W.I. MEMBERS REPORT NO. E/33/70 JANUARY 1970.

THE EFFECTS OF SPECIMEN SIZE, LOADING RATE AND NOTCH ACUITY ON THE RESISTANCE TO FRACTURE INITIATION OF A RANGE OF COMMERCially AVAILABLE MEDIUM AND HIGH TENSILE WELD METALS DEPOSITED BY THE MMA, ELECTROSLAG, CONSUMABLE GUDE, SUBMERGED ARC AND CO2 (BOTH BARE WIRE AND FLUX CORED WIRE) PROCESSES HAVE BEEN INVESTIGATED. THE RESULTS OBTAINED FROM COO TESTS WERE COMPARED WITH THOSE FROM CHARPY IMPACT TESTS: THE LATTER WERE SHOWN TO BE LESS SENSITIVE UNDER SLOWLY APPLIED LOAD CONDITIONS.

AUTOMATION OF ARC WELDING.
VERBREE M

PHILIPS WELDING REPORTER NO. 71/3, 1971. PP. 3-11. 11 FIGS.,
The use of narrow weld gaps and high welding currents has allowed consumable guide welds in 25, 32 and 38 mm thick steel to be made at high welding speeds (up to 121 mm/min) and low heat inputs (about 20 KJ/mm). The narrow gap welding technique offers increased productivity from welding equipment and the possibility of lower weld coats. The lower heat input results in a smaller grain size in the weld metal and heat affected zone. The limited results obtained indicate that, compared with conventional consumable guide welds, the notch toughness of narrow gap welds, as measured by Charpy V-notch impact tests, is improved for the weld heat affected zone and fusion boundary, but the weld metal is unaffected.

WELD PLATE THE ELECTROSLAG WAY.
IRVING R R
IRON AGE APRIL 15, 1971, 207(15), 59-61.,
Languages: ENGLISH
ELECTROSLAG, ELECTROGAS, AND CONSUMABLE NOZZLE WELDING PROCESSES ARE COMPARED.

WELDING - A KEY FACTOR IN SHIPBUILDING.
BOCKHOLT R
SHIPBUILDING INTERNATIONAL. SEPTEMBER 1971. PP. 2 3, 6, 10, 8 FIGS.,
Languages: ENGLISH
EXTENSIVE LABOUR COST SAVINGS HAVE BEEN ACHIEVED IN THE SHIPYARDS OF EUROPE AND JAPAN BY ADOPTING MECHANISED WELDING PROCEDURES. THE INVESTMENT POLICIES OF A NUMBER OF YARDS AND THE DIFFICULTIES OF MAINTAINING A SKILLED LABOUR FORCE FOR THE STILL NECESSARY MANUAL WELDING ARE DISCUSSED.

PROCESS SELECTION BY ECONOMIC ANALYSIS.
NOLAN M V
METAL CONSTRUCTION AND BRITISH WELDING JOURNAL JULY 1971, VOL. 3, NO. 7, 281-284, 8 FIGS., 1 TABLE, 6 REFS.,
Languages: ENGLISH
THE AUTHOR SHOWS THAT, FOR THE WELDING PROCESSES CONSIDERED, UNIT PROCESS COSTS INITIALLY DECREASE WITH INCREASING UTILISATION AND THEN TEND TO A LIMITING VALUE WHICH CAN BE CONSIDERED A PROCESS CONSTANT. THESE CURVES ARE USED TO PREDICT THE WELDING RATE ABOVE WHICH ANY PROCESS IS NOT ECONOMICAL. TO SELECT THE CHEAPEST WELDING PROCESS FOR A FIXED

PRODUCTION RATE OR AS A GUIDE FOR COST ESTIMATION.

A BALLING PRESS RECONDITIONED BY ELECTROSLAG WELDING.
SHEKHTER S YA; REZNITSKII A M
AVT. SVARKA VOL. 23, NO. 3, MARCH 1970, PP. 60-61, 2 FIG.
1 TABL., 1 REF.,
Languages: ENGLISH
TECHNOLOGY FOR THE REPAIR OF THE HOUSING OF A 1500 T PRESS: ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE, USING THREE 4 MM DIAMETER ELECTRODE WIRES. THE HOUSING WAS MADE OF 170 MM THICK STEEL.

FIVE TIMES AS FAST WITH ULTRA HIGH SPEED WELDING.
BERKOVITCH I
THE ENGINEER 29 JULY 1971, VOL.233,NO.6021 ,36-37, 3 DIGS.,
Table.
Languages: ENGLISH
THE PRINCIPLES AND ADVANTAGES OF CONSUMABLE GUIDE WELDING ARE DESCRIBED. INDUSTRIAL DEVELOPMENT OF THE NEW PROCESS WILL DEPEND UPON ECONOMIC FACTORS AND ACCEPTANCE BY THE INSURANCE COMPANIES.

WELDING BY FUSION.
SMIT NIJMEGEN ELECTROTECHCE FABRIEKEN N V
Languages: ENGLISH
TETRAS 'TURN-ON' TOSHIBA-II-II PAVILION AT EXPO'70.

NEW IDEAS IN SKYSCRAPERS,

MINIATURIZATION OF ELECTROSLAG WELDING: A NEW METHOD FOR WELDING RELATIVELY THIN PLATES.

ELECTROSLAG WELDING OR FULLY-CORED ARC WELDING. PRINCIPLES OF OPERATION; HISTORY. NUMBER OF WELDING MACHINES IN SERVICE AROUND THE WORLD. FIELDS OF APPLICATION. MODIFICATIONS CARRIED OUT TO IMPROVE THE WELDING HEADS FOR THE USE OF THESE TWO PROCESSES. SHIPBUILDING. THEIR VARIANTS: ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE, ELECTROGAS WELDING WITH SOLID FLUX-CORED WIRE. WELDING EQUIPMENT. INSPECTION OF WELDS.

WHERE TO CONSIDER ELECTROSLAG WELDING.

ELECTROSLAG WELDING OF CAST IRON.

A NEW ELECTROSLAG WELDING OF CAST IRON PLATES USING CONSUMABLE ELECTROSLAG WELDER IS DISCUSSED. USES OF A MILD STEEL WIRE, A SILICON-CONTAINING WIRE, A CORED WIRE CONTAINING A CAST IRON OR GREY CAST IRON POWDER AND A CAST IRON ROD ARE COMPARED. MAJOR RESULTS OBTAINED ARE AS FOLLOWS: 1) USE OF A MILD STEEL WIRE IS EASY TO EXECUTE BUT RESULTS IN AN EXTREMELY HARD WELD METAL WHICH IS DIFFICULT TO MACHINE; 2) USE OF A HIGH SILICON WIRE PRODUCES A CONSIDERABLY HARDER WELD METAL THAN THAT OF A MILD STEEL WIRE, BUT THE RESULTS ARE NOT FULLY SATISFACTORY. 3) USE OF A CORED WIRE WITH A GRAPHITE NOZZLE GIVES THE BEST RESULTS WITH HARDNESS, TENSILE STRENGTH, COLOUR TONE AND DAMPING FACTOR OF THE WELD METAL ABOUT THE SAME AS THOSE OF BASE METAL. 4) USE OF CAST IRON ROD IS USEFUL IN WELDING A SHORT LENGTH JOB. ABOUT FLUXES EXPERIMENTALLY PREPARED WITH THE AIM TO OBTAIN LOWER TEMPERATURE FUSIBLE FLUX, THE BEHAVIOUR DURING WELDING AND THE PROPERTIES OF WELD METAL AND PHYSICAL PROPERTIES OF MOLT SLAG HAVE BEEN CHECKED.
026182
WELDING IN JAPAN
TICHELAAAR G W
LASTECHN. VOL 36, NO 5, MAY 1970, PP. 94-97. 8 REF.,
Languages: DUTCH
DUTCH STATE IN 1969, OF THE FOLLOWING PROCESSES: AUTOMATIC ARC WELDING WITH STICK ELECTRODES (BY GRAVITY, BY THE FIRECRACKER PROCESS, ETC), SUBMERGED ARC, ONE SIDE MANUAL ARC WELDING, GAS SHIELDED, ELECTROSLAG, EXPLOSIVE, ELECTRON BEAM AND PLASMA WELDING, STUD WELDING. BRIEF SURVEY OF THE EDUCATION OF WELDING ENGINEERS.

026044
REPAIR BY ENCLOSED WELDING, OF THE RAM OF A DROP HAMMER.
JARAUSCH R HUTTENES K; BECKEN O
PRAKT/SCHW.SCHN.VOL 22 NOS 7 AND 8, JULY AND AUG 1970, PP. 150-53 AND 181-83, 20 FIG.,
Languages: GERMAN
GERMAN REPAIR OF A 38 TON RAM IN C 45 STEEL (0.36 C-0.22SI-0.62 MN-0.015 P-0.024 S) BROKEN IN TWO PARTS IN AN APPROXIMATELY HORIZONTAL PLANE. AFTER MANY WELDING TESTS, 20 ENCLOSED WELDS 2.4 M LONG WERE MADE USING CONSUMABLE GUIDES, 2.2 M IN LENGTH IN 37/3 STEEL. WELDING PARAMETERS A STRESS-FREE ANNEALING WAS THEN APPLIED AT 600 DEG.C, FOLLOWING BY CONTROLLED COOLING: ULTRASONIC, MAGNETIC PARTICLE AND DYE-PENETRANT TESTING. RECOMMENDATIONS FOR THE REPAIR OF OTHER LARGE PARTS.

026009
NEW IDEAS IN BUILDING CONSTRUCTION.
WOG.DES.FABR. VOL 43, NO 6, JUNE 1970, PP. 68-70, 3 FIG.,
Languages: ENGLISH
ENGLISH CONSTRUCTION OF A 64 STORY OFFICE BUILDING IN PITTSBURG, USA: THE GIRDERS AND COLUMNS ARE VISIBLE. THE COLUMNS ARE FILLED WITH WATER TO FIREPROOF. USE OF COR-TEN, ASTM A-36, EX-TEN 42, 50 AND 60, T-I STEELS. MANUAL ARC WELDING, MIG WELDING WITH SOLID AND FLUX CORED WIRE, SUBMERGED ARC AND ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE.

025918
METHOD FOR SAVING WORKING HOURS IN ELECTROSLAG WELDING WITH CONSUMABLE WIRE-GUIDE.
ARIKAWA M; KANO M; WATANABE T; TANIGUCHI M
WDG. TECH. VOL. 17, NO. 10, OCT. 1969, PP. 34-40, 13 FIG., 2 TABL.,
Languages: ENGLISH
ENGLISH DEVELOPMENT OF A DEVICE WHICH AUTOMATICALLY SUPPLIES THE FLUX AND THE OPERATING OF WHICH IS BASED ON THE FLUCTUATION OF THE WELDING VOLTAGE WHEN THE THICKNESS OF THE MOLTEN SLAG IS TOO SMALL. THIS METHOD (OS-KOB) WHICH IS APPLICABLE TO ALL ELECTROSLAG WELDING METHODS, IS PARTICULARLY EFFICIENT IN ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE. APPLICATION OF THIS METHOD IN JAPANESE SHIPYARDS.

025186
ONE-SIDE WELDING IS STRONG IN JAPAN.
BISKUP J T
Languages: ENGLISH
ENGLISH SOME OF THE IMPROVED PROCESS APPLICATIONS RESPONSIBLE FOR THE HIGH RATE OF WELDED PRODUCTIVITY IN STEEL, FABRICATION IN JAPAN ARE: ONE-SIDE WELDING BY THE GAS-METAL-ARC, FLUX-CORED-ARC, MANUAL-SHIELDED-ARC AND SHIELDED-ARC WELDING PROCESSES; GRAVITY-ARC WELDING FOR HORIZONTAL FILLETS, A PROCESS IN WHICH THE ELECTRODE HOLDER SLIDES DOWN AUTOMATICALLY UNDER ITS OWN WEIGHT, TO FEED THE ELECTRODE FOR WELDING; INCINRATION OR CONTACT WELDING, A PROCESS FOR WELDING IN SMALL, CONFINED SPACES IN WHICH THE ELECTRODES IS UNDER SPRING PRESSURE AND IS SET AT A VERY LOW ANGLE; AND ELECTROSLAG WELDING WITH A CONSUMABLE NOZZLE, PARTICULARLY A NOZZLE COATED WITH ADDITIONAL RINGS OF SOLID AND INTERMITTENT FLUX.

025990
ELECTROSLAG WELDING OF CAST IRON (REPORT 1).
ISHII Y; TAMURA H; KATO N; TESSUKA Y; MURASE K
J. JAP. WDG. SOC. VOL. 39, NO. 3, MARCH 1970, PP. 79-90, 21 FIG., 7 TABL., 2 REF.,
Languages: JAPANESE
JAPANESE DEVELOPMENT OF A METHOD FOR JOINING CAST IRON BY ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE. TESTS WERE CARRIED OUT WITH FOUR FILLER METALS: A MILD STEEL WIRE, A SILICON WIRE, A FLUX CORED WIRE CONTAINING WHITE OR GREY CAST IRON POWDER AND A MEEHANITE CAST IRON ROD. RECOMMENDATION FOR THIS OPERATION OF THE FLUX CORED WIRE OR OF THE CAST IRON ROD CONTAINING 3.05 TO 3.38 PERCENT C AND 1.73 TO 2.58 PERCENT S1 WHICH GIVE EXCELLENT RESULTS REGARDING HARDNESS STRENGTH AND COLOUR OF THE JOINT.
024619
FILLING BLIND HOLES BY ELECTROSLAG WELDING WITH A MOVING CONSUMABLE NOZZLE.
POSTOVALOV YU I; VOLOSHKEVICH G Z
SVAR. PROIZV. VOL 16. NO 6, JUNE 1969, PP. 17-18, 5 FIG., 2 TABL.
Languages: ENGLISH

024360
REPORT ON VISITS TO JAPANESE SHIPYARDS.
TURNER M J
METAL CONSTRUCTION AND BRITISH WELDING JOURNAL JUNE 1970, 2, 6, 219-226. 9 FIGS., 4 TABLES, 3 REFS.,
Languages: ENGLISH
IN THIS REPORT ON VISITS TO TWELVE JAPANESE SHIPYARDS THE AUTHOR DESCRIBES THEIR ORGANISATION AND SUPERVISION STRUCTURE; PAY SCALES AND FRINGE BENEFITS FOR WELDERS; STOCKYARD MARKING AND CUTTING OPERATIONS; WELDER TRAINING; RESEARCH IN PROGRESS; WELDING PRACTICES, INCLUDING ONE SIDE WELDING, AUTOMATIC WELDING OF BUTTS AND SEAMS ON THE BERTH, AND CONSUMABLE GUIDE WELDING OF STIFFENERS. WHERE APPROPRIATE, THE AUTHOR MAKES COMPARISONS WITH UK PRACTICE.

024253
ELECTROSLAG WELDING EQUIPMENT.
DE CONINCK VAN NOYEN P
REV. SOUD. VDL. 26, NO. 1, QST QUARTER 1970, PP. 30-39, 21 FIG., 1 TABL.
Languages: FRENCH
GENERAL ON ELECTROSLAG WELDING EQUIPMENT: SPECIALISEO SEMI-AUTOMATIC AND AUTOMATIC MACHINES (WITH CONSUMABLE WIRE-GUIDE, FOR HEAVY THICKNESSES, FOR WELDING WITH ADDITION OF METAL POWDER): JIGS: POWER SOURCES.

023836
DESIGNING FOR THE NEWER WELDING PROCESSES.
HICKS J G
ENGINEERING DESIGN ’70 PP. 4-10. 14 FIGS., 3 TABLES.,
Languages: ENGLISH
A REVIEW OF FIVE OF THE NEWER WELDING PROCESSES - PULSED ARC, ELECTRON BEAM, PLASMA ARC, CONSUMABLE GUIDE, FRICTION WELDING. AFTER AN INTRODUCTORY EXPLANATION OF THE MODE OF OPERATION OF EACH PROCESS, THEIR SCOPE AND LIMITATIONS ARE CONSIDERED FROM THE DESIGNER’S POINT OF VIEW.

022658
VERTICAL POSITION WELDING.
SNIEGON K
PRZEGL. SPAW. VOL 20, NO 9, SEPT 1968. PP. 213-22, 16 FIG, 9 TABL, 4 REFS.,
Languages: POLISH
TECHNOLOGY OF AUTOMATIC VERTICAL POSITION CO2 AND ELECTROSLAG WELDING WITH CONSUABLE WIRE GUIDE. WELDING VARIABLES FOR THICKNESSES FROM 12 TO 400 MM. COMPARISON OF THE WELDING TIMES FOR VARIOUS METHODS. THE SELECTION OF THE FILLER METAL DEPENDS ON THE QUALITY OF THE PARENT METAL, ON ITS THICKNESS AND ITS LENGTH AS WELL AS ON THE WELDING METHOD CHOOSEN AND ON THE TYPE OF WELDING MACHINE. MECHANICAL PROPERTIES OF THE VERTICALLY WELDED JOINTS MADE BY THE GAS SHIELDED AND ELECTROSLAG PROCESSES.

021977
INVESTIGATIONS IN CONSUMABLE GUIDE WELDING.
NOLAN M V; APPS R L
WELDING AND METAL FABRICATION NOVEMBER 1969, 37, 11, 464-470, 10 FIGS, 6 TABLES, 14 REFS.,
Languages: ENGLISH
THE SUSCEPTIBILITY TO BRITTLE FRACTURE OF CONSUMABLE GUIDE WELDS (BOTH CONVENTIONAL AND NARROW GAP) MADE IN 1 1/2 IN. SILICON-KILLED MILD STEEL PLATE WAS INVESTIGATE AND COMPARED WITH THAT OF THE PARENT METAL AND OF SUBMERGED ARC WELDS BY MEANS OF THE PELLINI DROP WEIGHT TEST. THE EFFECT OF VARIATION OF WELDING PARAMETERS UPON THE DIMENSIONS AND PROPERTIES OF WELDS WAS EXAMINED. THE WELD METAL WAS SHOWN TO GIVE NIL-DUCTILITY TEMPERATURES SUBSTANTIALLY SUPERIOR TO THAT OF THE PARENT PLATE, BUT INFERIOR TO THAT OF SUMERGED ARC WELD METAL. IT WAS FOUND THAT USING NARROW GAP JOINTS CONSIDERABLE INCREASES IN WELDING SPEED (OVER 20 FT/HR) COULD BE ACHIEVED, THIS REDUCING HEAT INPUT AND, THEREFORE, BOTH WELD AND HEAT AFFECTED ZONE GRAIN SIZE.

022895
ELECTROSLAG MELTED TRANSITION-PIECE UNITS AS AN ALTERNATIVE TO DIRECT WELDING.
BENNETT A P; EATON N F
METAL CONSTRUCTION AND BRITISH WELDING JOURNAL VOL. 1, NO. 125, DECEMBER 1969, 59-65. 10 FIGS., 16 REFS.,
Languages: ENGLISH
ELECTROSLAG WELDING WITH COATED CONSUMABLE NOZZLES.
MATSUOKA T; ABARI M; SUZUKI H; MURAI K
BR.WOG J VOL 14, NO 6, JUNE 1967, PP.287-98. 16 FIG, 8 TABL, 3 REF.
Languages: ENGLISH
DEVELOPMENT AND APPLICATIONS OF A NEW AND SIMPLIFIED ELECTROSLAG WELDING (SES) PROCESS. MAIN CHARACTERISTICS OF THIS PROCESS, EQUIPMENT USED, WELDING PROCEDURE AND TYPICAL OPERATING CONDITIONS. POSSIBILITY OF WELDING MILD OR HIGH STRENGTH STEEL PLATES 12 TO 60 MM THICK WITH A SINGLE COATED CONSUMABLE WIRE GUIDE, 150 MM THICK WITH 2 WIRE GUIDES AND 250 MM THICK WITH 4 WIRE GUIDES. MECHANICAL PROPERTIES OF THE WELDS.

ELECTROSLAG FOR KWINARA POWER STATION STRUCTURAL.
WOG NEWS NO 133, APRIL 1968, PP.5-6, 4 FIG, 2 TABL.
Languages: ENGLISH
QUALIFICATION OF THE PROCESS (ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE): PRODUCTION IN SHOP OF BUTT WELDS FOR (JOINING COLUMN ELEMENTS MADE OF 2 IN. THICK PLATES AND COLUMNS TO BASEPLATES OF VARIOUS THICKNESSES.

THE CONSUMABLE NOZZLE ELECTROSLAG WELDING PROCESS WITH MOVABLE CURRENT TERMINAL.
NAKAZUMA M; ISHIKAWA Y; SHIMAMOTO T
MITSUBISHI TECH. REV. JAN. 1969, 6, 1-9.,
Languages: ENGLISH
THIS IS AN AUTOMATIC, SINGLE-PATH VERTICAL WELDING METHOD SIMILAR TO THE ORDINARY TYPE OF CONSUMABLE NOZZLE WELDING. THE APPARATUS AND ITS OPERATION IS DESCRIBED IN DETAIL. THE QUALITY OF 1-HE WELDS PRODUCED BY THE NEW METHOD HAS BEEN INVESTIGATED AS A FUNCTION OF WELDING VARIABLES; THE PROPERTIES OF THE WELD ARE DISCUSSED. THE PROCESS IS MUCH CHEAPER THAN CURRENT WELDING METHODS.

WELDING THE HEAVY ONES.
LEA O
AMER. MACH. 7 APR. 1969, 113, (7), 92-94.,
Languages: ENGLISH
LARGE WELD JOINTS IN RAILS NEEDED FOR GANTRY-TYPE. NUMERICALLY CONTROLLED MACHINING CENTERS ARE PRODUCED BY ELECTROSLAG WELDING WITH A CONSUMABLE GUIDE SYSTEM. THE SYSTEM USED DIFFERS FROM OTHER CONSUMABLE GUIDE SYSTEMS IN THAT TWO OF THE THREE AVAILABLE WELDING HEADS HAVE OSCILLATION MECHANISMS THAT MOVE THE ELECTRODE FROM SIDE TO SIDE IN THE JOINT, ALLOWING THE SYSTEM TO WELD THICKER MATERIALS WITH MORE UNIFORM PENETRATION AND FEWER ELECTRODES. WELDS IN PLATES, 11 X 56 X 204 IN. HAVE BEEN PRODUCED WITH ONLY 4-HR CRANE TIME AND A SAVINGS OF 65 MANHOURS IN WELDING TIME.
**020658**

**ELECTROSLAG WELDING WITH CONSUMABLE GUIDE ON THE BANK OF AMERICA WORLD HEADQUARTERS BUILDING.**

AGIC T; HAMPTON J A

WELD.J. EC. 1968. 47, (12), 939-946., Languages: ENGLISH

INTERNAL FULL PENETRATION PLATE WELDS IN A-441 AND A-36 STEEL BOX COLUMNS UP TO 47 FT LONG ARE MADE BY ELECTROSLAG WELDING WITH A CONSUMABLE GUIDE TUBE. A FLUX COATING ON THE OUTSIDE OF THE TUBE PROVIDES ELECTRICAL INSULATION AND AUTOMATIC FLUX ADDITION DURING WELDING. COPPER MOLDS, WITH OR WITHOUT WATER COOLING, ARE ATTACHED TO THE WELD JOINT TO SERVE AS DAMS FOR THE MOLTEN METAL. A 2 PER CENT Mn WIRE IS USED TO OBTAIN THE REQUIRED 50,000 PSI YIELD STRENGTH, 70,000-90,000 PSI ULTIMATE STRENGTH, 22 PER CENT ELONGATION AND 40 PER CENT REDUCTION OF AREA. TYPICAL WELD CONDITIONS ARE TABULATED FOR VARIOUS PLATE THICKNESSES. ILLUSTRATIONS SHOW THE L WELD SEQUENCE USED TO JOIN CONTINUITY PLATES TO FLANGE MEMBERS AND THE U WELD SEQUENCE USED TO JOIN THE PLATES TO WEB MEMBERS. A COVER PLATE FLANGE IS ALSO WELDED BY THIS METHOD. LONGITUDINAL PARTIAL PENETRATION WELDS ON THE COLUMNS ARE PERFORMED BY A CONVENTIONAL SUBMERGED-ARC PROCESS WITH THE DUAL ELECTRODE DIRECT CURRENT-ALTERNATING CURRENT SYSTEM.

**020634**

**WELDING IN EUROPEAN SHIPYARDS.**

NORCROSS J E

METAL PROGR. JAN. 1969, 95, (1), 88-92., Languages: ENGLISH

RECENT DEVELOPMENTS USED IN EUROPEAN SHIPYARDS INCLUDE: A ONE-SIDE WELDING PROCESS USING BLENDED POWDERS AND AUTOMATIC WELDING WITH EITHER THE GAS METAL ARC PROCESS OR SUBMERGED ARC PROCESS TO L-JOIN DECK PLATES; A VARIATION OF THE ELECTROSLAG PROCESS USING A CONSUMABLE-NOZZLE WELDING WIRE IS USED TO MAKE VERTICAL JOINTS AS IN THE WELDING OF DECK STIFFENERS IN PLACE; AN ELECTROGAS WELDING HEAD MOUNTED IN AN ENCLOSED TOWER AND EASILY MOVED BY CRANE FROM JOINT TO JOINT IN THE WELDING OF VERTICAL JOINTS IN HULL PLATES; GRAVITY FED ELECTRODES WHICH INCREASE OUTPUT AND REDUCE OPERATOR FATIGUE; SEMIAUTOMATIC GAS METAL ARC WELDING USING SOLID ELECTRODES AND CO2 SHIELDING TO ELIMINATE FLUX REMOVAL OPERATIONS DURING MULTIPASS WELDS; SUBMERGED ARC WELDING WITH MULTIPLE ELECTRODES FOR MAKING BUTT WELDS IN PLATES; AND FILLET WELDING OF STIFFENERS TO SIDE AND DECK PLATES.

**014938**

**HEAT CONDITIONS OF ELECTROSLAG SURFACING OF STEEL G13 ON TO LOW-CARBON STEEL.**

SHVARTSER A YA; ZOLOTAREVSKY D B

AVTOMAT. SVARKA APR. 1968, (4). 16-19., Languages: ENGLISH

ELECTROSLAG SURFACING EXPERIMENTS OF STEEL G13 ON ST. 3 WERE CARRIED OUT USING A CERAMIC CONSUMABLE TIP. DISTRIBUTIONS OF TEMP. IN THE TRANSVERSE AND LONGITUDINAL SECTION OF THE SPECIMEN WERE DETERMINED. EFFECTS OF COOLING RATE ON THE SURFACED METAL STRUCTURE AND RELATIONSHIP BETWEEN THE STRENGTH OF THE WELD SEAM AT VARIOUS MO-CONTENTS IN THE SURFACED METAL AND AT VARIOUS RATES OF COOLING WERE INVESTIGATE.
PRESENT STATE AND FUTURE PROSPECTS OF ELECTROSLAG WELDING.

Makara A M; Bel, For M G

SVAR. PROIZV VOL 13, NO 11, NOV 1967, PP. 27-30, 6 FIG, 14 REF.

Languages: ENGLISH

Use of this process for joining components with a thickness ranging between 12 and 2000 mm and for surfacing. Use of welding wires 5-6 mm in diameter. New techniques of the process: Electroslag welding with a coated consumable wire guide. Welding and surfacing with strip electrodes. Future of the semi-automatic electroslag process for welding operations on site. Equipment used for these various techniques. Researches in progress for improving the welding techniques and rates, for avoiding welding distortions and for eliminating the requirement of a high temperature heat treatment after welding.

ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE. ECONOMY AND FIELD OF APPLICATION

Gutormsen K

SVEISETERNIKK VOL 22, NO 5/6 DEC 1967, PP. 89-92, 94-97 AND 108, 20 FIG, 5 REF.

Languages: NORWEGIAN

APPLICATION OF ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE TO STEEL CONSTRUCTIONS

Omezu S; Takaoa S; Sakurai R

SVEISS. SCIENCE VOL 20, NO 3, MARCH 1968, P. 135, 1 FIG.

Languages: GERMAN

German from Doc. IIS/IW-XII-I-2-67

Various applications of electroslag welding with bare or coated consumable wire guide. Results obtained with each method. The main advantage of this process is its economy.

APPLICATION OF ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE TO BUTT JOINTS IN T-SECTION COMPONENTS.

Trephpov P V

AVT. SVARKA VOL 20, NO 6, JUNE 1967, PP. 53-54, 5 FIG, 2 REF.

Languages: ENGLISH

Welding of these sections with a device allowing the contained formation of the weld pool, consisting of a three electrode automatic welding head, two side ones and a central one with consumable wire guide. Welding starts with the three electrodes simultaneously. Description of the procedure.

ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE. ECONOMY AND FIELD OF APPLICATION

Gutormsen K

SVEISETERNIKK VOL 22, NO 5/6 DEC 1967, PP. 89-92, 94-97 AND 108, 20 FIG, 5 REF.

Languages: NORWEGIAN

APPLICATION OF ELECTROSLAG WELDING WITH CONSUMABLE WIRE GUIDE TO BUTT JOINTS IN T-SECTION COMPONENTS.

Trephpov P V

AVT. SVARKA VOL 20, NO 6, JUNE 1967, PP. 53-54, 5 FIG, 2 REF.

Languages: ENGLISH

Welding of these sections with a device allowing the contained formation of the weld pool, consisting of a three electrode automatic welding head, two side ones and a central one with consumable wire guide. Welding starts with the three electrodes simultaneously. Description of the procedure.

THE ELECTROSLAG WELDING OF TITANIUM WITH A CONSUMABLE GUIDE.

Gurevich S M; Kompanya YU

AVT. SVARKA VOL 20, NO 1, JAN 1967, PP. 65-8, 4 FIG, 2 TABL.

Languages: ENGLISH

Possibility of welding large components in titanium alloys by the electroslag process. Use of argon for shielding the liquid metal from the surrounding air.
ELECTROSLAG WELDING WITH COATED CONSUMABLE NOZZLES.
MATSUOKA T; ARAKI M; SUZUKI H; MURAI K
BR. WDG J. VOL 14. NO 6, JUNE 1967, PP 287-98. 16 FIG, 8 TABL, 3 REF., Languages: ENGLISH
DEVELOPMENT AND APPLICATIONS OF A NEW AND SIMPLIFIED ELECTROSLAG WELDING (SES) PROCESS. MAIN CHARACTERISTICS OF THIS PROCESS, EQUIPMENT USED. WELDING PROCEDURE AND TYPICAL OPERATING CONDITIONS. POSSIBILITY OF WELDING MILD OR HIGH STRENGTH STEEL PLATES 12 TO 60 MM THICK WITH A SINGLE COATED CONSUMABLE WIRE GUIDE, 150 MM THICK WITH 2 WIRE GUIDES AND 250 MM THICK WITH 4 WIRE GUIDES. MECHANICAL PROPERTIES OF THE WELDS.

CONSUMABLE NOZZLE ELECTROSLAG WELDING OF MILD STEEL.
COPLESTON P W
SEC. COMMONWEALTH WDG CONF. LONDON 1965, PP. 55-62, 9 FIG, 3 TABL, 6 REF. DISC. P. 79., Languages: ENGLISH
WELDING TECHNIQUE USING A SINGLE OR SEVERAL WIRES. THICKNESSES OF PLATE AND LENGTH OF WELD WHICH MAY BE WELDED. SPECIAL TECHNIQUES FOR WELDING IRREGULAR SHAPES ENCOUNTERED IN SHIPBUILDING AND IN THE INDUSTRY. COMPARISON OF THE METALLURGICAL AND ECONOMICAL ASPECTS OF THIS PROCESS WITH THOSE OF CONVENTIONAL ELECTROSLAG WELDING.
APPENDIX C

GENERAL GUIDELINES FOR FITUP OF TEST ASSEMBLIES
Run-On/Run-Off Block Locations - Typical Top and Bottom

Note:
Shaded Areas Need To Be Cleaned

Strongback Locations - Typical Both Sides

Figure C-1
Prepare Castings
Figure C-2
Add Run-On/Run-Off Blocks
(Apply To Both Castings)

Straight Edge

Keep these faces aligned * 1/1 6". Use Long Straight Edge And Grind As Needed.

PT2S.1
Typ Top
And Bottom 3/8

Sim
EIV.1
Typ 3 Sides
Top And Bottom
Add Spacer Plate (One Casting)

Spacer Plate Thickness Should Equal R.O.b.

Dimension "A" Should Be
1-1/2" Min. 2-1/2" Max.

Figure C-3
Add Spacer Plate (One Casting)
Figure C-4
Fabricate 4 Or 6 Strongbacks

Note: Shaded Areas Need To Be Cleaned.

Dimension “A” Should Equal The Shoe Width Plus 1”.

Dimension “B” Should Equal The Shoe Thickness Plus 1/2”.
Place the casting with separation plate on an assembly platen. Insert a pipe or round bar as shown. This also should be equal to R.O.B. Land the top casting onto the separation plate with a crane. Lower the end until it rests on the pipe. Align the castings, keeping the faces in the proper orientation. Use wedges to achieve R.O.T. Remove pipe.
To determine guide tube spacing, \( S \), in inches from tube edge to tube edge:

\[
S = \frac{T - N(D) - O}{N-1}
\]

Where:

- \( T \) = Thickness of joint in inches
- \( N \) = Number of guide tubes
- \( D \) = Outside diameter of guide tubes in inches
- \( O \) = Oscillation amplitude in inches

For Example:

To weld a 12 3/4" thick joint using four 5/8" diameter guide tubes, and a 1-3/4" oscillation amplitude

\[
S = \frac{12.75 - 4 (.625) - 1.75}{3}
\]

\[2.8, \text{ use 2-13/16"}\]

Figure C-8
Figure C-9
Establishing Guide Tube Spacing
Figure C-10
Initial Fitup Of Guide Tubes
Figure C-11
Welder Tanking Spacers To Guide Tubes
Figure C-12
Completed Guide Tube Rack
FIGURE C-13
Installing Test Assembly

- Place Welding Head On This Side
- Use This Area As A Workbench
- Place Test Assembly In Stand. Do Not Tack!
- Attach Ground Cables.
- Feed Approximately 1" Of Wire Into Guide Tube.
- Install Guide Tube Rack Into Welding Torches.
- Tighten All Torch Bolts.
- Use Vertical Travel To Set Stickout.

Figure C-14
Guide Tube Rack Installation
Guide Tube Rack Must Be Made Parallel To Joint Faces, Centered, And Aligned Vertically. Use Fine Adjustments On Welding Head To Control Rack Location. After Alignment Is Complete, Tighten The Welding Head Completely And Tack The Casting To The Stand. Check To Assure Rack Is Still Centered Between The Two Faces.

Figure C-15
Guide Tube Rack Alignment
Figure C-16
Guide Tube Rack Installed In Joint — Side View
Move Rack To An Extreme Using The Oscillation Control Switch.
Using A Straight Edge (Away From An Insulator)
Line Up The Guide Tube And Joint Sides.
Adjust The Limit Switch Stop As Needed.
Straight Edge Should Touch The Tube At Top And Bottom.
Measure And Record The Oscillation Amplitude.
Move Rack To Opposite Extreme.
Use The Straight Edge To Check That Side.
Adjust Limit Switch Stops As Needed.
Use Stopwatch To Set End Dwell.
Then Use The Oscillation Speed Control To Achieve The Proper Cycle Time.
(Cycle Time = 2 Dwell + 1 Traverse)

Figure C-17
Set Oscillation & Dwell
- Measure Dimensions A & B, from edge of shoe to center of bevel.
- Scribe dimensions in circles shown, on top of shoe. The disconnect fittings must be at the top.
- Inspect shoes for damage, leaks, etc.
- Insert Shoes From The Top And Align With Scribed Lines.
- Turn On Shoes At Max. Pressure And Check Operation. If Satisfactory, Shut Down And Remove Shoes.

Figure C-19
Install Cooling Shoes
To determine wire needs for a certain joint

(1) Width x Length x Thickness = Joint volume (in$^3$)

NOTE: Include run-on/run-off tabs in length

(2) Joint volume x .283 #/in$^3$ = number of pounds of wire needed for the joint.

(3) Add 3 to 5 pounds as a safety factor.

(4) Divide the number of pounds required by the number of guide tubes.

For Example:

To weld a 10-3/4" thick, 26" long joint, with a nominal root opening of 1.25 using 3 guide tubes

$10.75 \times 26 \times 1.25 = 350 \text{ in}^3$

$350 \text{ in}^3 \times .283 \#/\text{in}^3 = 99 \text{ lbs.}$

$99 \text{ lbs} + 5 = 104 \text{ lbs}$

$104/3 = 35 \text{ pounds per roll}$
- Center The Guide Tube Rack From Side-To-Side.
- Determine Wire Needs For Joint, From Figure C-20. Put Wire On Stand.
- Lower One Of The Center Wires Down, Into A 1" Ball Of Steel Wool. Lower All Other Wires Until They Are Recessed 1/8".
- Again Insert And Align The Cooling Shoes. Wedge Them Tightly Against Strongbacks. Use As Many Shoes As Necessary To Make Sure The Joint Is Enclosed At Least To The Middle Of The Run-Off Block.
- Seal The Bottom Of The Shoes, And Any Gaps Between The Shoes And Casting Greater Than 3/32" With Heat Resistant Putty.

Figure C-21
Preparation For Welding

- Attach Welding Mirrors To Torch Rack To Increase Puddle Visibility.
- Preheat Sump If Necessary.
- Attach Voltmeter And Arc Time Recorder.
- Secure Area, Have Fire Extinguisher On Hand.
APPENDIX D

WELDING DATA SHEETS
NOTE  The use of various preheat temperatures during the project was for assuring moisture removal prior to welding, not for achieving certain heating/cooling rates.
ELECTROSLAG DATA SHEET

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>WIRE CONSUMABLE GUIDE</th>
<th>POSITION</th>
<th>VERTICAL UP</th>
<th>Preheat (min)</th>
<th>Preheat Sump Area Only</th>
</tr>
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<tbody>
<tr>
<td>ELECTROSLAG WELDING</td>
<td>Hobart RC-1000</td>
<td>Hobart</td>
<td>casting</td>
<td>125°F</td>
<td>Torch Tempstick</td>
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<tr>
<td>CONTROLS:</td>
<td>Hobart Multi-Torch Control Box</td>
<td>Hobart Multi-Wire Oscillator</td>
<td></td>
<td>measured by</td>
<td></td>
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</tr>
<tr>
<td>EQUIPMENT</td>
<td>Power Supply</td>
<td>Hobart</td>
<td></td>
<td>1/4&quot; Dia. Round Bar</td>
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<tr>
<td></td>
<td>Polarity</td>
<td>DCEP</td>
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<td>Commercial</td>
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<td>Wire Feeder</td>
<td>Hobart</td>
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<td>ASTM A108 Gr. 1018</td>
<td>ASTM A108 Gr. 1018</td>
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<tr>
<td>FILLER MATERIAL</td>
<td>Size/Type</td>
<td>3/32&quot; Dia./Cored Wire</td>
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<td>Brand/Type</td>
<td>Linde 124/F74</td>
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<td></td>
<td>Brand</td>
<td>Hobart PS-588</td>
<td></td>
<td>Storage Flux oven @ 250°F,</td>
<td></td>
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<td></td>
<td>Specification</td>
<td>EWT2 (AWS 5.25-78)</td>
<td></td>
<td>Remained warm to touch</td>
<td></td>
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<tr>
<td>BASE MATERIAL</td>
<td>Dimensions</td>
<td>16&quot;L x 12&quot;W x 6&quot;T</td>
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<td>PO/Heat/Lot</td>
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<td>COOLING SHOES</td>
<td>Size/Type</td>
<td>24&quot; Long/Copper</td>
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<td>Flow</td>
<td>N/R</td>
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</tr>
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<td>Max Temp</td>
<td>190 °F</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Satisfactory</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Visual Defects</td>
<td>X</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Final Visual</td>
<td>Unsatisfactory</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Description</td>
<td>Procedure 0900-003-9000 CL 1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Good Appearance</td>
<td></td>
</tr>
</tbody>
</table>

Joint Design & Details

\[ R.O.t = 1-1/8" + 0/16" \]
\[ R.O.b = 1-1/8" + 0/16" \]

GUIDE TUBE SPACING 3 1/8"

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 ipm</td>
<td>50 V</td>
<td>1-1/2 in.</td>
<td>450 A</td>
<td>3 sec.</td>
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</table>

Technicians/SSN
Spence

Charge
1026M-9

Date
7/1/83

Joint No.
M865-1
ELECTROSLAG DATA SHEET

PROCESS

<table>
<thead>
<tr>
<th>WIRE CONSUMABLE GUIDE</th>
</tr>
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<tbody>
<tr>
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<table>
<thead>
<tr>
<th>ELECTROSLAG WELDING</th>
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<table>
<thead>
<tr>
<th>VERTICAL UP</th>
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<tbody>
<tr>
<td>X casting</td>
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<table>
<thead>
<tr>
<th>Plate</th>
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</thead>
<tbody>
<tr>
<td>Preheat (min) 175°F</td>
</tr>
<tr>
<td>Torch</td>
</tr>
<tr>
<td>Tempstick</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>CONTROLS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hobart Multi-Torch Control Box</td>
</tr>
<tr>
<td>Hobart Multi-Wire Oscillator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SIZE/TYPE</th>
<th>MAT'L</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/32&quot; Dia./Solid Wire</td>
<td></td>
</tr>
<tr>
<td>Hobart 25-P</td>
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<tr>
<td>5/8&quot; Dia. Guide Tubes</td>
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</tr>
<tr>
<td>Hobart Type No. 58</td>
<td></td>
</tr>
<tr>
<td>ASTM A108 Gr. 1018</td>
<td></td>
</tr>
<tr>
<td>1/4&quot; Dia. Round Bar</td>
<td></td>
</tr>
<tr>
<td>Commercial</td>
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<tr>
<td>ASTM A108 Gr. 1018</td>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PO/Heat/Lot</th>
</tr>
</thead>
<tbody>
<tr>
<td>N/R</td>
</tr>
<tr>
<td>MIL-S-15083 Gr. B</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FLUX</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand/Type Linde 124 &amp; PP-2</td>
</tr>
<tr>
<td>Storage Flux oven @ 250°F</td>
</tr>
<tr>
<td>Remained warm to touch</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>TOOLS</th>
</tr>
</thead>
<tbody>
<tr>
<td>SHOES</td>
</tr>
<tr>
<td>24&quot; Long/Copper</td>
</tr>
<tr>
<td>Flow</td>
</tr>
<tr>
<td>N/R</td>
</tr>
<tr>
<td>Max Temp</td>
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<tr>
<td>180°F</td>
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<table>
<thead>
<tr>
<th>INSULATION</th>
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<tr>
<td>Satisfactory</td>
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<tr>
<td>Visual Defects</td>
</tr>
<tr>
<td>Description</td>
</tr>
</tbody>
</table>

<table>
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<tr>
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</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>16&quot;L x 12&quot;W x 6&quot;H</td>
</tr>
<tr>
<td>Hobart Type No. 59</td>
</tr>
<tr>
<td>5/8&quot; Inside Diameter</td>
</tr>
</tbody>
</table>

<table>
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<tr>
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<tbody>
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<td>Storage Flux oven @ 250°F</td>
</tr>
<tr>
<td>Remained warm to touch</td>
</tr>
</tbody>
</table>

R.O.ₐ = 1-1/4" + 0/16"

R.O.ₜ = 1-1/16" + 0/16"

GUIDE TUBE SPACING 3-1/8"
# Electroslag Data Sheet

**Process:** Electroslag Welding

<table>
<thead>
<tr>
<th>Equipment</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>Hobart RC-1000</td>
</tr>
<tr>
<td>Polarity</td>
<td>DCEP</td>
</tr>
<tr>
<td>Wire Feeder</td>
<td>Hobart Multi-Torch Control Box</td>
</tr>
<tr>
<td>Controlling</td>
<td>Hobart Multi-Wire Oscillator</td>
</tr>
</tbody>
</table>

**Filler Matl:**
- Size/Type: 3/32" Dia./Cored Wire
- Brand: Hobart PS-588
- Specification: E6T2 (AWS 5.25-78)

**Base Matl:**
- Dimensions: 24"L x 12"W x 4"T
- PO/Heat/Lot: MIL-S-15083 Gr. B
- Insulator: Hobart Type No. 59
- Inside Diameter: 5/8" Inside Diameter

**Cooling Shoes:**
- Size/Type: 24" Long/Copper
- Flow: N/R
- Max Temp: 85/100 °F

**Dimensions:**
- Joint Design & Details: \( R.O._t = 1-1/2'' + 1/16'' \)
- \( R.O._b = 1-1/4'' + 1/16'' \)

<table>
<thead>
<tr>
<th>Wire Feed Speed</th>
<th>Volts</th>
<th>Electrode Extension</th>
<th>Amperage Per Wire</th>
<th>Oscillation</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 ipm</td>
<td>49</td>
<td>1-1/2 in.</td>
<td>420 A</td>
<td>Dwell 3 sec. Cycle Time 11 sec. Frequency 5 cpm Amplitude 1 in.</td>
</tr>
</tbody>
</table>

**Start:**
- 175 ipm
- 47 V
- 420 A

**Running:**
- Charge: 1026M-9
- Date: 11/9/83
- Joint No: M685-3

**Process Preheat:**
- Tempstick
- Tempstick
- Preheat Sump Area Only
- Interpass: N/A

**Preheat (min):** 125°F

---

**Technical Specifications:**

- **Guide Tube Spacing:** N/R
ELECTROSLAG DATA SHEET

PROCESS: 2 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING

EQUIPMENT:
- Power Supply: Hobart RC-1000
- Polarity: DCEP
- Wire Feeder: Hobart
- CONTROLS:
  - Hobart Multi-Torch Control Box
  - Hobart Multi-Wire Oscillator

FILLER METAL:
- Size/Type: 3/32" Dia./Cored Wire
- Brand: Hobart PS-588
- Specification: EWT2 (AWS 5.25-78)

BASE METAL:
- Dimensions: 24"L x 12"W x 4"T
- PO/Heat/Lot: MIL-S-15083 Gr. B
- Specification: Hobart Type No. 59
- Insulator: 5/8" Inside Diameter

COOLING SHOE:
- Size/Type: 24" Long/Copper
- Flow: N/R
- Max Temp: 125/100°F

WOOD IS 1-3/8" ± 1/16"

R.O.b = 1-1/4" ± 1/16"

WIRE FEED SPEED: 155 ipm VOLTS: 50 ELECTRODE EXTENSION: 1-1/2 in.
AMPERAGE PER WIRE: 425 A OSCILLATION:
- Dwell: 3 sec.
- Cycle Time: 11 sec.
- Frequency: 5 cpm
- Amplitude: 1 in.

START:
- 170-175 ipm
- 45 A

RUNNING:

Technicians/SSID:
Byrd

Charge:
1026M-9

Date:
11/16/83

Joint No.:
M895-4

PREHEAT (min) 125°F
Torch method measured by Tempsick

PREHEAT SUMP AREA ONLY
Interpass N/A

1/4" Dia. Round Bar
Commercial
ASTM A108 Gr. 1018

Flux:
Brand/Type: Linde 124/F/4
Storage Flux oven @ 250°F
Remained warm to touch

Satisfactory

Unsatisfactory

Procedure: 0900-003-9000 CL 1

GUIDE TUBE SPACING: N/R
ELECTROSLAG DATA SHEET

WIRE CONSUMABLE GUIDE
ELECTROSLAG WELDING

PROCESS

3

POSITION

VERTICAL UP

X

plate casting

POWER SUPPLY
Hobart RC-1000
DCEP
WIRE FEEDER
Hobart

CONTROLS:
Hobart Multi-Torch Control Box
Hobart Multi-Wire Oscillator

POWER SUPPLY POLARITY Wired
WIRE FEEDER PROBLEM, N/A

FILLER METAL

Size/Type 3/32" Dia./Cored Wire
Brand Hobart PS-588
Specification EMT2 (AWS 5.25-78)

5/8" Dia. Guide Tubes
Hobart Type No. 58
ASTM A108 Gr. 1018

1/4" Dia. Round Bar
Commercial
ASTM A108 Gr. 1018

BASE MATERIAL

Dimensions 13"L x 8"W x 8"T
PO/Heat/Lot MIL-S-15083 Gr. B
Specification Hobart Type No. 59
5/8" Inside Diameter

FLUX
Brand/Type Linde 124/F74
Storage Flux oven @ 250°F,
Remained warm to touch

COOLING SHOES

Size/Type 24" Long/Copper
Flow N/R
Max Temp 105/90 °F

Satisfactory X Visual Defects
Description LOE on Side 2
was repaired

FINAL RT

X Satisfactory

PROCEDURE
0900-003-9000 CL 1

Joint Design & Details

R.O_t = 1-1/4" + 1/16"

R.O_b = 1-1/8" + 1/16"

WIRE FEED SPEED 155 ipm
VOLTS 50 V
EXTENSION 1-1/2 in.
AMPERAGE 400 A

OSCILLATION

Dwell 3 sec.
Cycle Time 11 sec.
Frequency 5 cpm
Amplitude 5/8 in.

START

RUNNING

175-200 ipm
40 V
400 A

GUIDE TUBE SPACING N/R

Technicians/SSN
Byrd

Charge 1026M-9

Date 1/31/84

Joint No. M685-5
ELECTROSLAG DATA SHEET

PROCESS
3 WIRE CONSUMABLE GUIDE
ELECTROSLAG WELDING

POSITION
VERTICAL UP
plate casting

EQUIPMENT

Power Supply
Hobart RC-1000

Polarity
DCEP

Wire Feeder
Hobart

CONTROLS:
Hobart Multi-Torch Control Box
Hobart Multi-Wire Oscillator

PREHEAT SUMP AREA ONLY

INERT
N/A

FILLER METAL

Size/Type
3/32" Dia./Cored Wire

Brand
Hobart PS-588

Specification
ERT2 (AWS 5.25-78)

Dimensions
14"Lx8"Wx10-3/4"T

PO/Heat/Lot
MIL-S-15083 Gr. B

BASE METAL

Size/Type 24"

Brand/Type Linde 124/F74

Flow
Long/Copper

Max Temp
115/90 °F

Satisfactory X Visual Defects
Description 4" LONG LOF on Side 2 was repaired

FLUX

1/4" Dia. Round Bar

Commercial
ASTM A108 Gr. 1018

Remained warm to touch

COOLING SHOES

WIRE FEED SPEED

START
160 ipm

55 V

1-1/2

1-1/2

425 A

ELECTRODE EXTENSION

AMPERAGE PER WIRE

OCCLUSION

Dwell
3 sec.

CYCLE TIME
11 sec.

FREQUENCY
5 cpm

AMPLITUDE
2 in.

WIRE FEED SPEED

STORAGE
145- 150 ipm

47 V

385- 400 A

GUIDE TUBE SPACING

N/R

No spacers were used between the guide tubes.

Final Flux

Depth = 1-1/2"
Electroslag Data Sheet

- **Wire Consumable Guide**: Electroslag Welding
- **Process**: #4
- **Position**: Vertical Up
- **Vertical Up**: X
- **Preheat (min)**: 125°F
- **Torch Method**: Tempstick
- **Preheat Sump Area Only**: Interpass
- **N/A**

**Equipment**
- **Power Supply**: Hobart RC-1000
- **Polarity**: DCER
- **Wire Feeder**: Hobart
- **Controls**: Hobart Multi-Torch Control Box, Hobart Multi-Wire Oscillator

**Filler Material**
- **3/32" Dia./Cored Wire**: Hobart FS-588
- **EWT2 (AWS 5.25-78)**
- **5/8" Dia. Guide Tubes**: Hobart Type No. 58
- **ASTM A108 Gr. 1018**
- **1/4" Dia. Round Bar**: Commercial
- **ASTM A108 Gr. 1018**

**Base Material**
- **Dimensions**: 16"L x 9"W x 13"T
- **PO/Heat/Lot**: MIL-S-15083 Gr. B
- **Insulator**: Hobart Type No. 59
- **5/8" Inside Diameter**
- **FLUX**: Brand/Type Linde 124/774
- **Storage Flux oven @ 250°F**, Remained warm to touch

**Cooling Shoes**
- **Size/Type**: 24" Long/Copper
- **Flow**: N/R
- **Max Temp**: 170°F
- **Satisfactory**: X
- **Visual Defects**: LOF Both Sides Apparent
- **3/8" Deep, Full Length**
- **Procedure**: Unsatisfactory N/A

**Joint Design & Details**

![Joint Design Diagram]

\[ R.0_t = 1-1/4" + 1/16" \]

\[ R.0_b = 1-1/8" + 1/16" \]

**Guide Tube Spacing**: N/R

**WIRE FEED SPEED** | VOLTS | ELECTRODE EXTENSION | AMPERAGE PER WIRE | OSCILLATION | Dwell | Cycle Time | Frequency | Amplitude |oscillation|
<table>
<thead>
<tr>
<th></th>
<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td>START 155 V</td>
<td>55 1-1/2 in.</td>
<td>385-450 A</td>
<td>3 sec. 11 sec. 5 cpm 2 in.</td>
<td>Used one water cooler</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUNNING 155 V</td>
<td>50</td>
<td>400-425 A</td>
<td>400-425 A</td>
<td>400-425 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>165 V</td>
<td>48</td>
<td>400-425 A</td>
<td>400-425 A</td>
<td>400-425 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Technicians/SSN**
- **Byrd**
- **Charge**: 1026M-9
- **Date**: 3/23/84
- **Joint No.**: H685-7
**ELECTROSLAG DATA SHEET**

**WIRE CONSUMABLE GUIDE**
**ELECTROSLAG WELDING**

**PROCESS**
- Power Supply: Hobart RC-1000
- Polarity: DCEP
- Wire Feeder: Hobart

**CONTROLS:**
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

**POSITION**
- Vertical Up
- Plate
- Y Casting
- Interpass: N/A

**FILLER MATERIAL**
- Size/Type: 3/32" Dia./Cored Wire
- Brand: Hobart PG-500
- Specification: E71T-11 (AWS 5.25-78)

**BASE MATERIAL**
- Size/Type: 5/8" Dia. Guide Tubes
- Brand: Hobart Type No. 59
- Specification: ASTM A108 Gr. 1018

**PREHEAT SUMP AREA ONLY**
- 1/4" Dia. Round Bar
- Commercial
- ASTM A108 Gr. 1018

**COOLING SHOES**
- Size/Type: 12" long/Copper
- Flow: N/R
- Max Temp: 115°F

**Joint Design & Details**
- Description: LOF on both sides Full Length
- Procedure: Satisfactory

**WIRE FEED SPEED**
- Start: 140 ipm
- Running: 150 ipm

**ELECTRODE EXTENSION**
- Start: 55 V 1-1/2 in.
- Running: 53 V

**AMPERE PER WIRE**
- Start: 385 A
- Running: 385 A

**OSCILLATION**
- Start: Dwell 4 sec, Cycle Time 13 sec, Frequency 4 cpm, Amplitude 2 1/8 in.

- Running: Used one water cooler

**GUIDE TUBE SPACING**
- N/R

**Technicians/SSN**
- Byrd

**Charge**
- 1026M-9

**Date**
- 4/4/84

**Joint No.**
- MB85-8
**ELECTROSLAG DATA SHEET**

### Process
- **Wire Consumable Guide**: Electroslag Welding
- **Position**: Vertical Up
- **Preheat (min)**: 125°F
- **Torch Method**: Tempstick
- **Preheat Sump Area Only**: Interpass N/A

### Equipment
- **Power Supply**: Hobart RC-1000
- **Polarity**: DCEP
- **Wire Feeder**: Hobart
- **Controller**: Hobart Multi-Torch Control Box
- **Multi-Wire Oscillator**: Hobart

### Filler Mat-L
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart WS-588
- **Specification**: E1T (AWS 5.25-78)
- **Dia. Guide Tubes**: 5/8" Dia.
- **Type**: Hobart Type No. 58
- **Material**: ASTM A108 Gr. 1018
- **1/4" Dia. Round Bar**: Commercial
- **ASTM A108 Gr. 1018**: Brand/Type Linde 124/F74
- **Storage Flux oven @ 250°F**: Remained warm to touch

### Base Mat-L
- **Dimensions**: 10"L x 12"W x 3-3/4"T
- **PO/Heat/Lot**: MIL-S-15083 Gr. B
- **Hobart Type No. 59**: 5/8" Inside Diameter

### Cooling Shoes
- **Flow**: N/R
- **Max Temp**: 130°F

### Joint Design & Details

### Wire Feed Speed

- **Volts**: 150
- **Electrode Extension**: 1-1/2 in.
- **Amperage Per Wire**: 385 A
- **Dwell**: 4 sec.
- **Cycle Time**: 13 sec.
- **Frequency**: 4 cpm
- **Amplitude**: 1-5/8 in.

- **Start**: Used one water cooler
- **Running**: After weld was complete, flow was checked—greater than 3 GPM

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
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<td>V</td>
<td>1-1/2 in.</td>
<td>385 A</td>
<td>4 sec.</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>13 sec.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>4 cpm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>1-5/8 in.</td>
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<tr>
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<td></td>
<td></td>
<td></td>
<td>Used one water cooler</td>
</tr>
<tr>
<td>155 ipm</td>
<td>V</td>
<td>390 A</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>After weld was complete, flow was checked—greater than 3 GPM</td>
</tr>
</tbody>
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**Technician/SSN**
- **Byrd**: Charge
- **1026M-9**: Date
- **4/6/84**: Joint No.
- **M685-9**
**ELECTROSLAG DATA SHEET**

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>WIRE CONSUMABLE GUIDE</th>
<th>POSITION</th>
<th>VERTICAL UP</th>
<th>X</th>
<th>Casting</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>Hobart RC-1000</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<td></td>
</tr>
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<td>Hobart</td>
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</tr>
<tr>
<td>CONTROLS</td>
<td>Hobart Multi-Torch Control Box</td>
<td></td>
<td></td>
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<td></td>
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<thead>
<tr>
<th>FILLER METAL</th>
<th>SIZE/TYPE</th>
<th>BRAND</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>3/32&quot; Dia./Cored Wire</td>
<td>Hobart FS-588</td>
<td>EWT2 (AWS 5.25-78)</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BASE METAL</th>
<th>DIMENSIONS</th>
<th>PO/HEAT/LOT</th>
<th>SPECIFICATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>13&quot;L x 12&quot;W x 8&quot;T</td>
<td></td>
<td>MIL-S-15083 Gr. B</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COOLING SHOES</th>
<th>SIZE/TYPE</th>
<th>FLOW</th>
<th>MAX TEMP</th>
<th>X</th>
<th>SATISFACTORY</th>
<th>VISUAL DEFECTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>24&quot; Long/Copper</td>
<td>N/R</td>
<td>125 °F</td>
<td></td>
<td></td>
<td>Good Appearance</td>
<td></td>
</tr>
</tbody>
</table>

**Joint Design & Details**

\[
R_{O_t} = 1 - 1/4" + 0/16" \\
R_{O_b} = 1 - 1/8" + 0/16" \\
\]

**GUIDE TUBE SPACING**: N/R

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>160 ipm</td>
<td>55 V</td>
<td>1-1/2 in.</td>
<td>395-400 A</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUNNING</td>
<td>160 ipm</td>
<td>55 V</td>
<td>A</td>
<td></td>
</tr>
<tr>
<td></td>
<td>160 ipm</td>
<td>50 V</td>
<td>390-395 A</td>
<td></td>
</tr>
</tbody>
</table>

**Technicians/SSN**

Byrd

**Charge**

1026M-9

**Date**

4/20/84

**Joint No.**

M685-10
ELECTROSLAG DATA SHEET

WIRE CONSUMABLE GUIDE
Electroslag Welding

Process
3

Power Supply
Hobart RC-1000

Polarity
DCEP

Wire Feeder
Hobart

Controls:
Hobart Multi-Torch Control Box
Hobart Multi-Wire Oscillator

Position
Vertical Up

Preheat (min)
125°F

Torch method
Tempstick

Interpass
N/A

Base Matl.

Size/Type
3/32" Dia./Cored Wire

Brand
Hobart PS-588

Specification
EWT2 (AWS 5.25-78)

Dimensions
13"Lx9"Wx10-3/4"T

PO/Heat/Lot
MIL-S-15083 Gr. B

Hobart Type No. 59

5/8" Inside Diameter

1/4" Dia. Round Bar

Commercial

ASTM A108 Gr. 1018

Filler Matl.

Size/Type
5/8" Dia. Guide Tubes

58

ASTM A108 Gr. 1018

Brand/Type
Linde 124/F74

Storage
Flux oven @ 250°F

Remained warm to touch

Cooling Shoes

Size/Type
24" Long/Copper

Flow
N/R

Max Temp
130°F

X Satisfactory

Visual Defects

<1/16" Undercut

Approx. 1" Long

Joint Design & Details

W.O. = 1-1/4" + 1/16"

W.O. B = 1-1/8" + 1/16"

Guide Tube Spacing
N/R

Wire Feed Speed

Volts
160

155

Electrode Extension
55 V

1-1/2 in.

50 V

A

A

\text{Used one water}

Amperage per Wire
400

380-390

Oscillation

Dwell
390-4

13 sec.

1 5/8 in.

Cycle Time
4 sec.

Frequency
4 cpm

Amplitude


Technicians/SSN
Byrd

Charge
1026M-9

Date
5/23/84

Joint No.
M685-11
ELECTROSLAG DATA SHEET

<table>
<thead>
<tr>
<th>WIRE CONSUMABLE GUIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td>ELECTROSLAG WELDING</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>EQUIPMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>Hobart RC-1000</td>
</tr>
<tr>
<td>Polarity</td>
<td>DCEP</td>
</tr>
<tr>
<td>Wire Feeder</td>
<td>Hobart</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>CONTROLS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hobart Multi-Torch Control Box</td>
</tr>
<tr>
<td>Hobart Multi-Wire Oscillator</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>POSITION</th>
<th>VERTICAL UP</th>
</tr>
</thead>
<tbody>
<tr>
<td>plate</td>
<td>X casting</td>
</tr>
</tbody>
</table>

| Preheat (min) | 125°F |
| Torch method | Tempstick |
| measured by   | N/A   |

<table>
<thead>
<tr>
<th>FILLER MATERIAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size/Type</td>
</tr>
<tr>
<td>Brand</td>
</tr>
<tr>
<td>Specification</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>5/8&quot; Dia. Guide Tubes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand</td>
</tr>
<tr>
<td>Specification</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>1/4&quot; Dia. Round Bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand</td>
</tr>
<tr>
<td>Storage</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BASE METAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
</tr>
<tr>
<td>PO/Heat/Lot</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSULATOR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hobart Type No. 59</td>
</tr>
<tr>
<td>5/8&quot; Inside Diameter</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COOLING</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Shackes</td>
<td>24&quot; Long/Copper</td>
</tr>
<tr>
<td>Flow</td>
<td>N/R</td>
</tr>
<tr>
<td>Max Temp</td>
<td>125°F</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FINAL VISUAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>Description</td>
</tr>
<tr>
<td>X Visual Defects</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>INSULATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>FINAL RT</td>
</tr>
<tr>
<td>Procedure</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 ipm</td>
<td>55 V</td>
<td>1-1/2 in.</td>
<td>390-400 A</td>
<td>Dwell</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cycle Time</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Frequency</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Amplitude</td>
</tr>
<tr>
<td>155 ipm</td>
<td>53 V</td>
<td></td>
<td>390-400 A</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R.O. = 1-1/4" + 1/16"  
R.O. = 1-1/8" + 1/16"

GUIDE TUBE SPACING | N/R

Technicians:  
Syrd  
Chase  
1026M-9  
Date  
6/3/84  
Joint No.  
M85-13
**ELECTROSLAG DATA SHEET**

**EQUIPMENT**
- Power Supply: Hobart RC-1000
- Polarity: DCEP
- Wire Feeder: Hobart

**FILLER METAL**
- Size/Type: 3/32" Dia./Cored Wire
- Brand: Hobart PS-588
- Specification: E7T2 (AWS 5.25-78)

**BASE METAL**
- Dimensions: 18"L x 12"W x 13"T
- Brand/Type: Linde 124/74
- Storage Flux oven @ 250°F, remained warm to touch

**COOLING SHOES**
- Size/Type: 24" Long/Copper
- Flow: 1.7 GPM
- Max Temp: 140°F

**WIRE FEED SPEED**
- Volts
- Electrode Extension
- Amperage Per Wire
- Oscillation

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 ipm V</td>
<td>55</td>
<td>1-1/2 in.</td>
<td>390-400 A</td>
<td>4 sec.</td>
</tr>
<tr>
<td>155 ipm V</td>
<td>50</td>
<td>-</td>
<td>385-390 A</td>
<td>-</td>
</tr>
<tr>
<td>155 ipm V</td>
<td>45</td>
<td>-</td>
<td>360-385 A</td>
<td>-</td>
</tr>
</tbody>
</table>

**Process Details**
- Preheat (min) 125°F
- Torch method: Tempstick
- Preheat Sump Area Only
- Interpass: N/A
- Guide Tube Spacing: 2 1/2" 

**Visual Defects**
- LOF on Side 1, 6" Long, 3/16" deep repaired

**Joint Design & Details**
- R.O.t = 1-1/4" + 0/16"
- R.O.b = 1-1/8" + 0/16"
**ELECTROSLAG DATA SHEET**

**PROCESS**
- Wire Consumable Guide
- Electroslag Welding

**EQUIPMENT**
- Power Supply: Hobart RC-1000
- Polarity: DCEN
- Wire Feeder: Hobart

**CONTROLS:**
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

**FILLER METAL**
- Size/Type: 3/32" Dia./Cored Wire
- Brand: Hobart PS-588
- Specification: E62 (AWS 5.25-78)

**BASE METAL**
- Dimensions: 26" x 18" x 10 - 3/4" x 7/8" Inside Diameter
- Brand/Type: Linde 124/74
- Commercial ASTM A108 Gr. 1018

**COOLING SHOES**
- Size/Type: 24" Long/Copper
- Flow: 17 GPM
- Max Temp: 135 °F

**WIRE FEED SPEED**
- 135 ipm
- Volts: 49
- Electrode Extension: 1-1/2 in.
- Amperage: 300-350 A

**OSCILLATION**
- Dwell: 4 sec.
- Cycle Time: 13 sec.
- Frequency: 4 cpm
- Amplitude: 1 3/4 in.

**FINAL VISUAL**
- Satisfactory
- Good Appearance

**PROCEDURE**
- Procedure: 0900-003-9000 CL 1

**GUIDE TUBE SPACING**
- N/R

**Joint Design & Details**

\[
R.O. = 1-1/4" + 1/16" - 0"
\]

\[
R.O. = 1-1/8" + 1/16" - 0"
\]

**Technicians/SSN**
- Byrd
- Charge: 1026M-9
- Date: 9/25/94
- Joint No: M685-15
### ELECTROSLAG DATA SHEET

- **WIRE FEED SPEED**: 135 ipm
- **VOLTS**: 49
- **EXTENSION**: 1-1/2 in.
- **AMPERAGE**: 390 A
- **Dwell**: 4 sec.
- **Cycle Time**: 13 sec.
- **Frequency**: 4 cpm
- **Amplitude**: 1 3/4 in.

#### Process
- **Power Supply**: Hobart RC-1000
- **Polarity**: DCERP
- **Wire Feeder**: Hobart

#### Controls
- **Hobart Multi-Torch Control Box**
- **Hobart Multi-Wire Oscillator**

#### Filler Material
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EWT7 (AWS 5.25-78)
- **Diama. Guide Tubes**: 5/8" Dia.
- **Brand**: Hobart Type No. 58
- **Commercial**: ASTM A108 Gr. 1018

- **Dimensions**: 30"lx8"wx12 3/4"T
- **PO/Heat/Lot**: MIL-S-15083 Gr. B
- **Type**: Hobart Type No. 59
- **Inside Diameter**: 5/8" Inside Diameter

#### Base Material
- **Brand/Type**: Linde 124/F74
- **Storage**: Flux oven @ 250°F,
- **Remained warm to touch**

#### Coolant Information
- **Type**: Long/Copper
- **Flow**: 1.7 GPM
- **Max Temp**: 100/125°F

#### Visual Inspection
- **Satisfactory**: X Satisfactory
- **Visual Defects**: Completed area of weld had good appearance

#### Welding Procedure
- **Preheat (min)**: 125°F Torch Tempstick
- **method**:
- **measured by**:
- **PREHEAT SUMP AREA ONLY**
- **Interpass**
- **N/A**

#### Joint Design & Details

- **R.O.**:
  - **R.O.**: 1-1/4" + 1/16" - 0
  - **R.O.**: 1-1/8" + 1/16" - 0

#### Oscillation
- **Weld was stopped 1" from run-off due to power supply failure**

#### Joint No.
- **M895-16**

#### Charge
- **1026M-9**

#### Date
- **10/12/84**

#### Joint No.
- **M895-16**

#### Procedure
- **0900-003-9000 CL 1**

---

**Completed by**

- **Technicians/SSN**: Byrd
- **Charge**: 1026M-9
- **Date**: 10/12/84
- **Joint No.**: M895-16

---

**GUIDE TUBE SPACING**

- **N/R**
**ELECTROSLAG DATA SHEET**

- **PROCESS:** 4 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING
- **POSITION:** VERTICAL UP X casting
- **Preheat (min):** 125°F
- **Torch method:** Tempstick
- **Measured by:** N/A
- **PREHEAT SUMP AREA ONLY:** Interpass N/A

**EQUIPMENT**
- **Power Supply:** Hobart RC-1000
- **Polarity:** DCEN
- **Wire Feeder:** Hobart

**CONTROLS:**
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

**FILLER MATL.**
- **Size/Type:** 3/32" Dia./Cored Wire
- **Brand:** Hobart PS-588
- **Specification:** EW2 (AWS 5.25-78)

**BASE MATL.**
- **Dimensions:** 27"L x 12"W x 12"T
- **Specification:** MIL-S-15083 Gr. B

**FLUX**
- **Brand/Type:** Linde 124/F74
- **Commercial:** N/A
- **Storage Flux oven @ 250°F,
- **Remained warm to touch:** N/A

**COOLING SHOES**
- **Size/Type:** 24" Long/Copper
- **Flow:** 1.7 GPM
- **Max temp:** 130°F

**FINAL VISUAL**
- **Satisfactory Visual Defects:** LOF on both sides approx. 6" long

**WIRE FEED SPEED VOLTS ELECTRODE EXTENSION AMPERAGE PER WIRE OSCILLATION**

<table>
<thead>
<tr>
<th>START</th>
<th>135 ipm</th>
<th>50 V</th>
<th>1-1/2 in.</th>
<th>395-400 A</th>
<th>4 sec.</th>
<th>13 sec.</th>
<th>4 cpm</th>
<th>1-3/4 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>135 ipm</td>
<td>49 V</td>
<td></td>
<td>390-400 A</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**OCCUPATION**
- **Descrip.:** Spacer bars were not above top of the run-off block
- **Descrip.:** Bars melted prior to reaching run-off.
- **Descrip.:** #1 then arced to the sidewall and stopped working. Joint stopped 1" from top.

**GUIDE TUBE SPACING N/R**

**Technician/SSN**
- Byrd/Meckley

**Charge**
- 1026M-9

**Date**
- 10/30/84

**Joint #**
- M885-17
ELECTROSLAG DATA SHEET

PROCESS: 4 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING

POWER SUPPLY: Hobart RC-1000
POLARITY: DCEN
WIRE FEEDER: Hobart

CONTROLS: Hobart Multi-Torch Control Box
          Hobart Multi-Wire Oscillator

WIRE

3/32" Dia./Cored Wire
Hobart PS-588
EWT2 (AWS 5.25-78)

5/8" Dia. Guide Tubes
Hobart Type No. 58
ASTM A108 Gr. 1018

1/4" Dia. Round Bar
Commercial
ASTM A108 Gr. 1018

BRASS MATT.

Dimensions
30"L x 12"W x 10 - 3/4" T
MIL-S-15083 Gr. B

Insulator
Hobart Type No. 59
5/8" Inside Diameter

BASE MATT.

FLUX

Brand/Type: Linde 124/F74
Flux...remained warm to touch

COOLING SHOES

24" Long/Copper
1.7 GPM
125/125 °F

FURNIT.

R. O. T = 1-1/4" ± 1/16"

R. O. D = 1-1/8" ± 1/16"

GUARD TUBE SPACING 2-25/32"

WIRE FEED SPEED

START

30-400

135 Ipm

V 55 1-1/2 in.

V 1-1/4 sec.

1 17/8 sec.

14 4 cpm

11 #1 Wire Stopped for

2 mins. at start

RUNNING

Transverse shrinkage
from 6" punchmarks

Top -0"

Middle -1/4"

Bottom -3/16"

Technicians/SSN
Byrd/Meckley

Charge
1026M-9

Date
1/22/85

Joint No.
H885-18
ELECTROSLAG DATA SHEET

WIRE CONSUMABLE GUIDE
ELECTROSLAG WELDING

POWER SUPPLY
Polarity
Wire Feeder
Hobart RC-1000
DCEP
Hobart

CONTROLS:
Hobart Multi-Torch Control Box
Hobart Multi-Wire Oscillator

SIZES/TYPES
Brand
Specification
3/32" Dia./Cored Wire
Hobart PS-588
DWT2 (AWS 5.25-78)
5/8" Dia. Guide Tubes
Hobart Type No. 58
ASTM A108 Gr. 1018
1/4" Dia. Round Bar
Commercial
ASTM A108 Gr. 1018

BASE METAL
Dimensions
PO/Heat/Lot
Specification
12"Lx12"Wx12 3/4"T
MIL-S-15083 Gr. B
Hobart Type No. 59
5/8" Inside Diameter
Linde 124/F74
Storage FLUX oven @ 250°F
Remained warm to touch

COOLING SHOES
Type
Flow
Max Temp
24" Long/Copper
1.7 GPM
125 °F

FINISH DESCRIPTION
Visual Defects
Good Appearance

WIRE FEED SPEED
VOLTS
AMPERAGE PER WIRE
OSCIILLATION

<table>
<thead>
<tr>
<th>START</th>
<th>130</th>
<th>53</th>
<th>1-1/2</th>
<th>350-400</th>
<th>4</th>
<th>13</th>
<th>4</th>
<th>1 3/4</th>
</tr>
</thead>
<tbody>
<tr>
<td>ipm</td>
<td>V</td>
<td>in.</td>
<td>A</td>
<td>sec.</td>
<td>sec.</td>
<td>cpm</td>
<td>in.</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Used on water cooler. Joint was restarted after #2 stopped during initial firing. #1 &amp; #4 stopped running for 2-3 Mins. during 2nd firing. RT showed severe cracking in the weld. Final slag depth = 1&quot; 6 rows of RD Bar</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RUNNING</th>
<th>155</th>
<th>55</th>
<th>390-400</th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>ipm</td>
<td>V</td>
<td>A</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Technicians/SSN
BYRD/NECKLEY

Charge
Date
1026M-9
2/14/85

Joint No.
685-19
### ELECTROSLAG DATA SHEET

**PROCESS**: 4 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING

**EQUIPMENT**:
- **Power Supply**: Hobart RC-1000
- **Polarity**: DCEP
- **Wire Feeder**: Hobart

**CONTROLS**:
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

**FILLER MATERIAL**:
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EMT2 (AWS E-25-76)

**BASE MATERIAL**:
- **Dimensions**: 6"L x 4"W x 13"T
- **Specification**: MIL-S-15083 Gr. B

**BASE MATERIAL**:
- **Size/Type**: 5/8" Dia. Guide Tubes
- **Specification**: Hobart Type No. 58, ASTM A108 Gr. 1010

**BASE MATERIAL**:
- **Size/Type**: 1/4" Dia. Round Bar
- **Specification**: Commercial, ASTM A108 Gr. 1010

**FLUX**:
- **Brand/Type**: Linde 124/F74
- **Storage**: Flux oven @ 250°F, remained warm to touch

**COOLING SHIELD**:
- **Size/Type**: 24" Long/Copper
- **Flow**: N/R
- **Max Temp**: N/R

**Procedure**:

**WIRE FEED SPEED**

<table>
<thead>
<tr>
<th>Volts</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
<th>EXPERIENCE</th>
</tr>
</thead>
<tbody>
<tr>
<td>130</td>
<td>55 in. V</td>
<td>350-380 A</td>
<td>4 sec.</td>
<td>13 sec.</td>
</tr>
<tr>
<td>155</td>
<td>55 in. V</td>
<td>380-400 A</td>
<td>✓</td>
<td>✓</td>
</tr>
</tbody>
</table>

**FINAL RT**
- Visual Defects: Good Appearance
- Satisfactory UNsatisfactory N/A

**FINAL VISUAL**
- Description: Satisfactory

**R.O.**
- **R.O.** = 1-1/4" + 1/16" - 0"/16"
- **R.O.** = 1-1/8" + 1/16" - 0"/16"

**GUIDE TUBE SPACING**: 2-7/8"
<table>
<thead>
<tr>
<th>Parameters</th>
<th>Results</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. 130 ipm, 55 volts, no flux added, 1 1/2&quot; E.S.O.</td>
<td>Heavy spatter, mostly large globules Lower voltage reduced spatter. Lower wire feeds slightly reduced spatter.</td>
</tr>
<tr>
<td>2. 110-160 ipm 45 volts</td>
<td>Addition of flux reduced spatter, and did not extinguish arc.</td>
</tr>
<tr>
<td>3. 130 ipm, 45 volts, flux added after steel wool melts.</td>
<td>More spatter than #3, arc was extinguished by addition of flux</td>
</tr>
<tr>
<td>4. 130 ipm, 55 volts, flux added after steel wool melts.</td>
<td>Better start than #4, still a lot of spatter.</td>
</tr>
<tr>
<td>5. 130 ipm, 55 volts, flux added prior to start</td>
<td>Good start, increasing volts to 55 greatly increased spatter, reduced volts back to 35 which reduced spatter.</td>
</tr>
<tr>
<td>6. .130 ipm, 35 volts, flux added after steel wool melts.</td>
<td>Good start. Increasing wire speed 30 degrees did not significantly increase spatter. Increasing volts to 55 did increase spatter.</td>
</tr>
</tbody>
</table>

All Welding Using a single electrode 1 1/2" E.S.O. DCRP.
### Electroslag Data Sheet

**Wire Consumable Guide**
- **Electroslag Welding**
- **Position**: Vertical Up
- **Plate**: Casting
- **Preheat (min)**: N/A
- **Method**: Torch
- **Tempstick**
- **Preheat Sump Area Only**
- **Interpass**: N/A

**Equipment**
- **Power Supply**: Hobart RC-1000
- **DCEP**: Hobart
- **Wire Feeder**: Hobart
- **Controls**: Hobart Multi-Torch Control Box
- **Hobart Multi-Wire Oscillator**
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EWT2 (AWS 5.25-78)
- **Dimension**: 5/8" Dia. Guide Tubes
- **Specification**: Hobart Type No. 58
- **ASTM A108 Gr. 1018
- **Commercial Size/Type**: 1/4" Dia. Round Bar
- **Brand/Type**: Linde 124/F74
- **Storage Flux oven @ 250°F, Remained warm to touch**

**Base Metal**
- **PO/Heat/Lot**: 6"L x 4"W x 13"T
- **Specification**: MIL-S-15083 Gr. B
- **Hobart Type No. 59**
- **5/8" Inside Diameter**

**Cooling Details**
- **Size/Type**: 24" Long/Copper
- **Flow**: N/R
- **Max Temp**: 75°F

<table>
<thead>
<tr>
<th>Wire Feed Speed</th>
<th>Volts</th>
<th>Electrode Extension</th>
<th>Amperage per Wire</th>
<th>Oscillation</th>
<th>Description</th>
<th>Visual Defects</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>130 ipm</td>
<td>35 V</td>
<td>1-1/2 in.</td>
<td>N/R</td>
<td>N/R</td>
<td>3 sec.</td>
<td>12 sec.</td>
<td>5 cpm</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>155 ipm</td>
<td>55 V</td>
<td></td>
<td>N/R</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Technicians/SSN**
- **Mackley/Byrd**
- **Charge**: 1026M-9
- **Date**: 2/21/85
- **Joint No.**: M685-19B-1

**Guide Tube Spacing**: 2 7/8"
ELECTROSLAG DATA SHEET

PROCESS
--- 3 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING

POWER SUPPLY: Hobart RC-1000
POLARITY: DCEP
WIRE FEEDER: Hobart

CONTROLS:
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

PREHEAT (min) N/A
method Torch
measured by Tempstick

PREHEAT SUMP AREA ONLY
Interpass N/A

FILLER MATERIAL

<table>
<thead>
<tr>
<th>Size/Type</th>
<th>3/32&quot; Dia./Cored Wire</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand</td>
<td>Hobart PS-588</td>
</tr>
<tr>
<td>Specification</td>
<td>EWT2 (AWS 5.25-78)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>5&quot;L x 4&quot;W x 12&quot;T</td>
</tr>
<tr>
<td>MIL-S-15083 Gr. B</td>
</tr>
</tbody>
</table>

FLUX
- Brand/Type Linde 124/F74
- Storage Flux oven @ 250°F
- Remained warm to touch

BASE MATERIAL

<table>
<thead>
<tr>
<th>Size/Type</th>
<th>5/8&quot; Dia. Guide Tubes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brand</td>
<td>Hobart Type No. 58</td>
</tr>
<tr>
<td>Specification</td>
<td>ASTM A108 Gr. 1018</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Dimensions</th>
</tr>
</thead>
<tbody>
<tr>
<td>5/8&quot; Inside Diameter</td>
</tr>
</tbody>
</table>

COOLING SHOES

<table>
<thead>
<tr>
<th>Size/Type</th>
<th>24&quot; Long/Copper</th>
</tr>
</thead>
<tbody>
<tr>
<td>Flow</td>
<td>1.7 GPM</td>
</tr>
<tr>
<td>Max Temp</td>
<td>75°C</td>
</tr>
</tbody>
</table>

Joint Design & Details

\[ R.O_{c} = 1-1/4'' + 1/16'' - 0/16'' \]

\[ R.O_{b} = 1-1/4'' + 1/16'' - 0/16'' \]

GUIDE TUBE SPACING 3'-7/8" & 4'-3/4'

WIRE FEED SPEED Volts Electrode Extension Amperage Per Wire Oscillation

<table>
<thead>
<tr>
<th>START</th>
<th>130 V</th>
<th>55 in.</th>
<th>1-1/2</th>
<th>350-370</th>
<th>3 sec.</th>
<th>12 sec.</th>
<th>5 cpm</th>
<th>1 15/16 in.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#2 Experienced a 2 min. delay</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RUNNING</th>
<th>170-190 V</th>
<th>55 in.</th>
<th>390-420 A</th>
</tr>
</thead>
<tbody>
<tr>
<td>Final Slag Depth 1 1/4'' 3 rows of RD. Bar</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Technicians/SSN

Meckley/Byrd

Charge 1026M-9
Date 2/28/85
Joint No. MS85-19D
**ELECTROSILG DATA SHEET**

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>WIRE CONSUMABLE GUIDE</th>
<th>ELECTROSLAG WELDING</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>Hobart RC-1000</td>
<td>Hobart Multi-Torch Control Box</td>
</tr>
<tr>
<td>Polarity</td>
<td>DCEP</td>
<td>Hobart Multi-Wire Oscillator</td>
</tr>
</tbody>
</table>

**FILLER METAL**

| Size/Type | 3/32" Dia./Cored Wire | 5/8" Dia. Guide Tubes |
| Brand | Hobart PS-588 | Hobart Type No. 58 |
| Specification | EWT2 (AWS 5.25-78) | ASTM A108 Gr. 1018 |

**BASE METAL**

| Size/Type | 18"LX12"WX15-3/4"T | 5/8" Inside Diameter |
| Brand | MIL-S-15083 Gr. B | Hobart Type No. 59 |
| Specification | | ASTM A108 Gr. 1018 |

**COOLING SHOES**

| Flow | 24" Long/Copper | 1.7 GPM |
| Max Temp | 125°F |

**Joint Design & Details**

- **R.O.**
  - \( R.O. = 1-1/4" \pm 1/16" \)
  - \( R.O. = 1-1/8" \pm 1/16" \)

**WIRE FEED SPEED**

<table>
<thead>
<tr>
<th>Volts</th>
<th>130</th>
<th>135</th>
</tr>
</thead>
<tbody>
<tr>
<td>FEED</td>
<td>ipm</td>
<td>ipm</td>
</tr>
<tr>
<td>SPEED</td>
<td>V</td>
<td>V</td>
</tr>
</tbody>
</table>

**WIRE EXTENSION**

| AMPERAGE | 300-350 | 350-390 |
| PER WIRE | A | A |

**OSCILLATION**

| DWELL | 3 | 12 |
| CYCLE TIME | sec. | sec. |
| FREQUENCY | 5 | cpm |
| AMPLITUDE | 1 | in. |

- **START**
  - #4 experienced a 5 min. delay.
  - Added flux as each wire w started.
  - 4 Rows of RD Bar

- **RUNNING**
  - Final Slag Depth - 1 1/4"
  - Transverse shrinkage from 8" punchmarks:
    - Top -1/8"
    - Middle -1/8"
    - Bottom -1/8"

**Technicians/SSN**

| Meckley/Byrd | 1026M-9 | 2/27/85 | M855-20 |
### ELECTROSLAG DATA SHEET

**EQUIPMENT**
- **Power Supply**: Hobart RC-1000
- **Polarity**: DCEP
- **Wire Feeder**: Hobart

**CONTROLS:**
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

**FILLER METAL**
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EMT2 (AWS 5.25-78)

**BASE METAL**
- **Dimensions**: 18"Lx12"Wx15 3/4"T
- **P.O./Heat/Lot**: MIL-S-15083 Gr. B

**COOLING STOPL**
- **Size/Type**: 24" Long/Copper
- **Flow**: N/R
- **Max Temp**: 135/100 °F

**WEIGHT:**

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>130 ipm</td>
<td>45</td>
<td>1-1/2 in.</td>
<td>350-390 A</td>
<td>Good Start - flux was fired. Approx. 1-1 1/2 mins. between wires starting. 3 Rows of RD Bar</td>
</tr>
<tr>
<td>165 ipm</td>
<td>55</td>
<td>—</td>
<td>380-400 A</td>
<td>Final slag depth - 1 1/4&quot; Transverse shrinkage from 8&quot; punchmarks: Top -1/8&quot; Middle -1/8&quot; Bottom -1/8&quot;</td>
</tr>
</tbody>
</table>

**Joint Design & Details**

\[ R_0 = 1 - 1/4" + 1/16" \]

\[ R_0 = 1 - 1/8" + 1/16" \]

**GUIDE TUBE SPACING**

3-15/16" - 4"
**Electroslag Data Sheet**

### Process
- **Wire Consumable Guide**: Hobart RC-1000, Hobart PS-588
- **Electroslag Welding**
- **Position**: Vertical Up
- **Preheat Method**: 125°F Torch Tempstick
- **Preheat Sump Area Only**: N/A

### Equipment
- **Power Supply**: DCEP
- **Polarity**: Hobart
- **Wire Feeder**: Hobart Multi-Torch Control Box, Hobart Multi-Wire Oscillator

### Filler Matl
- **Size/Type**: 3/32" Dia./Cored Wire, 5/8" Dia. Guide Tubes
- **Brand**: Hobart, HO/N Type No. 59
- **Specification**: EWT2 (AWS 5.25-78), ASTM A108 Gr. 1018

### Base Matl
- **Dimensions**: 18"L x 12"W x 15-3/4"T
- **PO/Heat/Lot**: MIL-S-15083 Gr. B
- **Hobart Type No.**: 59
- **Inside Diameter**: 5/8" Inside Diameter
- **Brand/Type**: Linde 124/F74
- **Storage Flux Oven**: 0-250°F, remained warm to touch

### Cooling Shoes
- **Size/Type**: 24" Long/Copper
- **Flow**: 1.7 GPM
- **Max Temp**: 100/140

### Final RT
- **Visual Defects**: Satisfactory
- **Final Visual Description**: 1 1/2" LG LOF at Bottom of side 2
- **Procedure**: 0900-003-9000 CL 1

### Joint Design & Details
- **W.O.** = 1-1/4" + 1/16"
- **R.O.** = 1-1/8" + 1/16"

### Oscillation

<table>
<thead>
<tr>
<th>Wire Feed Speed</th>
<th>Volts</th>
<th>Electrode Extension</th>
<th>Amperage Per Wire</th>
<th>Oscillation</th>
</tr>
</thead>
<tbody>
<tr>
<td>130 ipm</td>
<td>40</td>
<td>1-1/2 in.</td>
<td>350-370 A</td>
<td>Dwell 3 sec.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>No flux added until wires were fired. Good start. 4 Rows of RD Bar</td>
</tr>
<tr>
<td>Running</td>
<td>165</td>
<td>55</td>
<td>370-400 A</td>
<td></td>
</tr>
</tbody>
</table>

### Technician/SSN
- Byrd/Meckley
- Charge: 1026M-9
- Date: 3/14/85
- Joint No.: M685-22
**ELECTROSALG DATA SHEET**

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>WIRE CONSUMABLE GUIDE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ELECTROSLAG WELDING</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EQUIPMENT</th>
<th>CONTROLS:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Power Supply</td>
<td>Hobart RC-1000</td>
</tr>
<tr>
<td>Polarity</td>
<td>DEEP</td>
</tr>
<tr>
<td>Wire Feeder</td>
<td>Hobart</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>FILLER MATERIAL</th>
<th>Filler Tube Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size/Type</td>
<td>3/32&quot; Dia./Cored Wire</td>
</tr>
<tr>
<td>Brand</td>
<td>Hobart PS-588</td>
</tr>
<tr>
<td>Specification</td>
<td>EWT2 (AWS 5.25-78)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>BASE MATERIAL</th>
<th>Base Tube Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dimensions</td>
<td>5/8&quot; Dia. Guide Tubes</td>
</tr>
<tr>
<td>PO/Heat/Lot</td>
<td>Hobart Type No. 58</td>
</tr>
<tr>
<td>Specification</td>
<td>ASTM A108 Gr. 1018</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>COOLING SHOES</th>
<th>Description</th>
<th>Procedure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Size/Type</td>
<td>24&quot; Long/Copper</td>
<td></td>
</tr>
<tr>
<td>Flow</td>
<td>1.7 GPM</td>
<td></td>
</tr>
<tr>
<td>Max Temp</td>
<td>170°F</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>WIDTH</th>
<th>R.O.t</th>
<th>R.O.b</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**GUIDE TUBE SPACING:** 4-11/16"

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
<th>OXIDATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>START</td>
<td>130 ipm</td>
<td>45 V</td>
<td>1-1/2 in.</td>
<td>350-370 A</td>
<td>3 sec.</td>
</tr>
<tr>
<td>RUNNING</td>
<td>140 ipm</td>
<td>55 V</td>
<td>—</td>
<td>370-390 A</td>
<td>—</td>
</tr>
</tbody>
</table>

**Technicians/SSN**

Meckley/Byrd

Charge 1026M-9

Date 3/29/85

Joint No. M85-22F

Preheat (min) 125°F

Torch method Tempstick measured by Interpass N/A

PREHEAT SUMP AREA ONLY

1/4" Dia. Round Bar Commercial

ASTM A108 Gr. 1018

Brand/Type Linde 124/F74 Storage Flux oven @ 250°F, Remained warm to touch

Visual Defects:

- LoF both sides 1"-4" Long < 1/8" Depth

370-390 A

**Final Slag Depth = 1-1/4"**

Transverse Shrinkage from 8" punchmarks:

- Top -1/8"
- Middle -1/8"
- Bottom -1/8"
ELECTROSLAG DATA SHEET

PROCESS: 4 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING

EQUIPMENT:
- Power Supply: Hobart RC-1000
- Polarity: DCEP
- Wire Feeder: Hobart

CONTROLS:
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

POSITION: VERTICAL UP X casting

Preheat (min) 125°F
Torch Tempstick measured by
PREHEAT SUMP AREA ONLY N/A
Interpass

FILLER BASE MATT.:
- Size/Type: 3/32" Dia., Cored Wire
- Brand: Hobart PS-588
- Specification: E70T2 (AWS 5.25-78)

- Size/Type: 5/8" Dia. Guide Tubes
- Brand: Hobart Type No. 58
- Specification: ASTM A108 Gr. 1018

- Size/Type: 1/4" Dia. Round Bar
- Brand: Commercial
- Specification: ASTM A108 Gr. 1018

BASE MATT.:
- Size/Type: 18"L x 12"W x 18" 3/4"T
- Brand: MIL-S-15083 Gr. B

FLUX:
- Size/Type: 5/8" Inside Diameter
- Brand: Linde 124/E74
- Specification: Flux oven @ 250°F,
- Stressed Remained warm to touch

COOLING SHOES:
- Size/Type: 24" Long/Copper
- Flow: 1.7 GPM
- Max Temp: 140/150°F

FINAL RT:
- Satisfactory
- Unsatisfactory

WIRE FEED SPEED:
- 130 ipm
- 145 ipm

ELECTRODE EXTENSION:
- 1-1/2 in.
- 1-1/2 in.

AMPERAGE PER WIRE:
- 350-370 A
- 370-400 A

OSCILLATION:
- Dwell: 4 sec.
- Cycle Time: 12 sec.
- Frequency: 5 cpm
- Amplitude: 2 3/16 in.

- Flux around #2 prior to start, then added as wires fired.
- #1 & #3 stopped briefly during start.
- 5 rows of RD Bar

- Parameters checked every 5 mins.
- Transverse shrinkage from 8" punchmarks:
  - Top -5/32""
  - Middle -5/32"
  - Bottom -1/8"

Joint Design & Details:

R.O.t = 1-1/4" + 0 11/16"
R.O.b = 1-1/8" - 0 1/16"

GUIDE TUBE SPACING: 4-11/16"
ELECTROSLAG DATA SHEET

PROCESS: 4-WIRE CONSUMABLE GUIDE
ELECTROSLAG WELDING

EQUIPMENT:
- Power Supply: Hobart RC-1000
- Polarity: DCEP
- Wire Feeder: Hobart

POSITION: VERTICAL UP
- Preheat (min): 125°F
- Torch: Tempstick
- Method: measured by
- Preheat Sump Area Only
- Interpass: N/A

FILLER MATERIAL:
- Size/Type: 3/32" Dia./Cored Wire
- Brand: Hobart PS-588
- Specification: EW22 (AWS 5.25-78)

BASE METAL:
- Dimensions: 18"L x 12"W x 18-3/4"T
- PO/Heat/Lot: MIL-S-15083 Gr. B
- Insulator: Hobart Type No. 59
- Inside Diameter: 5/8"

COOLING SHOES:
- Size/Type: 24" Long/Copper
- Flow: 1.7 GPM
- Max Temp: 125/145°F

Joint Design & Details:
- Joint Design & Details: X Satisfactory
- Visual Defects: in 2 locations repaired
- Description: <1/16" deep undercut
- Flux: Satisfactory
- Procedure: N/A

Flux around #2 prior to start, then added as wires were fired.
4 rows of RD Bar

Final Slag depth = 7/8"
Transverse shrinkage from 8" punchmarks:
- Top: -1/8"
- Middle: -1/8"
- Bottom: -3/16"

WIRE FEED SPEED

<table>
<thead>
<tr>
<th>Volts</th>
<th>Electrode Extension</th>
<th>Amperage Per Wire</th>
<th>Oscillation</th>
</tr>
</thead>
<tbody>
<tr>
<td>155 Vpi</td>
<td>55</td>
<td>(#1,4)</td>
<td>370-400 A</td>
</tr>
<tr>
<td>140 Vpi</td>
<td>55</td>
<td>(#2,3)</td>
<td></td>
</tr>
</tbody>
</table>

GUIDE TUBE SPACING: 4-11/16"
ELECTROSLAG DATA SHEET

4 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING

POSITION VERTICAL UP X casting Preheat (min)

PROCESS

POWER SUPPLY

DC EP

Hobart RC-1000

Hobart Multi-Torch Control Box

PREHEAT SUMP AREA ONLY

CONTROLS:

Hobart Multi-Wire Oscillator

Interpass N/A

EQUIPMENT

WIRE FEEDER

Hobart PS-588

EWT2 (AWS 5.25-78)

1/4" Dia. Round Bar

Commercial

18"L x 12"W x 15-3/4"

Hobart Type No. 59

ASTM A108 Gr. 1018

5/8" Dia. Guide Tubes

1/4" Dia. Round Bar

ASTM A108 Gr. 1018

FLUX

Linde 124

Storage Flux oven @ 250°F

Remained warm to touch

BASE METAL

Dimensions

18"L x 12"W x 5/8" Inside Diameter

MIL-S-15083 Gr. B

Hobart Type No. 59

5/8" Inside Diameter

PILLER METAL

WIRE TYPE

3/32" Dia./Cored Wire

24" Long/Copper

.75 GPM

155/155°F

250-300 A

350-400 A

35 V

55 V

130 ipm

145 ipm

WIRE FEED SPEED

OCCUPATION

WIRE EXTENSION

ELS WIRE PER WIRE

OSCLATION

DWELL

11.5 sec.

3.5 sec.

FREQUENCY

5 cpm

1-5/8 in.

START

1-5/8 in.

1-1/16" + 0/16"

1-1/8" + 0/16"

FINAL VISUAL

Satisfactory

Unsatisfactory N/A

L

R.D.

R.D.

ROB

R.D.

R.O.

R.O.

W

L

Joint Design & Details

GUIDE TUBE SPACING 3 7/8"

6 mins. to start

No flux added prior to arc initiation

Final slag Depth=1-1/8"

Transverse shrinkage from 8" punchmarks

Top -5/32"

Middle -3/16"

Bottom -1/8"

Byrd/McKley

1026W-9

4/30/85

M685-25

Charge

Date

Joint No.
**ELECTROSLAG DATA SHEET**

**PROCESS**
- **WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING**

**EQUIPMENT**
- **Power Supply**
  - **Hobart RC-1000**
- **Polarity**
  - **DC**
- **Wire Feeder**
  - **Hobart**

**CONTROLS**
- **Hobart Multi-Torch Control Box**
- **Hobart Multi-Wire Oscillator**

**FILLER WIRE**
- **Size/Type**
  - **3/32" Dia. Cored Wire**
- **Brand**
  - **Hobart**
- **Specification**
  - **B522 (AWS 5.25-78)**

**BASE METAL**
- **Dimensions**
  - **24" L x 12" W x 22" H**
- **PO/Heat/Lot**
  - **N/R**
- **Specification**
  - **MIL-S-15083 Gr. B**

**FUEL & INSULATING FLUX**
- **Type**
  - **Hobart Type No. 59**
- **5/8" Inside Diameter**
- **Remained warm to touch**

**JOINT DESIGN & DETAILS**
- **W.R.**:
  - **R.O.**:
    - **R.O.\(t\) = 1-1/2" + 1/16"**
    - **R.O.\(b\) = 1-3/8" + 1/16"**

**WIRE FEED SPEED**
- **Volts**
  - **155**
- **Electrode Extension**
  - **45** in.
- **Welding Current**
  - **1-1/2"**
- **Maximum Temperature**
  - **350-400 A**
- **Dwell**: 4 sec.
- **Cycle Time**: 12 sec.
- **Frequency**: 5 cpm
- **Amplitude**: N/R

**GUIDE TUBE SPACING**
- **5"**

**DEPOSITION RATE**
- **72#/hr.**

**INSTRUCTIONS**
- **Byrd/Meckley**
- **Date**: 6/17/85
- **Joint**: 6685-28
ELECTROSLAG DATA SHEET

WIRE CONSUMABLE GUIDE
ELECTROSLAG WELDING

PROCESS

EQUIPMENT

Power Supply: Hobart RC-1000
Polarity: DCEP
Wire Feeder: Hobart

EQUIPMENT

FILLER MATERIAL

Size/Type: 3/32" Dia./Cored Wire
Brand: Hobart PS-588
Specification: EWT2 (AWS 5.25-78)

EQUIPMENT

INTERPASS

Dimensions: 18"L x 12"W x 21-3/4"H

WELDING SPEED

Flow: 24" Long/Copper
Max Temp: N/R

WELDING SPEED

OCCUPATION

Wire Feed Speed: 150 ipm
Volts: 45 V
Electrode Extension: 1-1/2 in.
Amperage Per Wire: 350-400 A
Dwell: 4 sec
Cycle Time: 12 sec
Frequency: 5 cpm
Amplitude: N/R

WELDING SPEED

OCCUPATION

Wire Feed Speed: 165 ipm
Volts: 55 V
Electrode Extension: 400-450 A

WELDING SPEED

OCCUPATION

Joint stopped after 77 minutes when #4 arced against the sidewall. Shrinkage after welding 14" = 3/16"

Byrd/Meckley

Charge: 1026M-9
Date: 6/12/85
Joint No: M685-27
Extention of current surface combatant, designed to make massive strike attacks and fend off massive attacks.

"Large" weapon capability.

Multi-warfare complete fighting units.

Centralized Force command.

Highly cooperative systems to enhance capability.

Would stress mobility and endurance to continue limited overseas operations.
Mother Ship Force

- Force consists of large transport ships, each transporting smaller combatants.
- This smaller surface craft, smaller than typical today (4,000 tons or less) with emphasis on speed, would be a high performance offensive capability.
**ELECTROSLAG DATA SHEET**

**PROCESS**
- **WIRE**: 4 Wire Consumable Guide
- **ELECTROSLAG WELDING**

**EQUIPMENT**
- **Power Supply**: Hobart RC-1000
- **Polarity**: DCEP
- **Wire Feeder**: Hobart

**CONTROLS**
- Hobart multi-torch control box
- Hobart multi-wire oscillator

**FILLER METAL**
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EMT2 (AWS 5.25-78)
- **Dimensions**: 5/8" Dia. Guide tubes
- **Flux**: Brand/Type Linde 124

**BASE METAL**
- **Dimensions**: 24"L x 18"W x 18-3/4" H
- **PO/Heat/Lot**: N/R
- **Specification**: MIL-S-15083 Gr. B
- **Dimensions**: Hobart Type No. 59 5/8" Inside Diameter

**COOLING WATER**
- **Size/Type**: 24" Long/Copper
- **Flow**: 0.75 GPM
- **Max Temp**: N/R

**WIRE FEED SPEED**
- **Volts**: 155
- **Electrode Extension**: 40
- **Amperage per Wire**: 1-1/2
- **Wires**: 250-300 A
- **Dwell**: 3.5 sec.
- **Cycle Time**: 11.5 sec.
- **Frequency**: 5 cpm
- **Amplitude**: 2-5/16 in.

**PREHEAT**
- **Method**: Torch Tempstick
- **Preheat**: 150°F
- **Interpass**: N/A

**PROCEDURE**

R.O.ₜ = 1-1/4" + 1/16"

R.O.₅ = 1-1/8" + 1/16"

**GUIDE TUBE SPACING**
4 11/16"

 технологічна експлуатація

<table>
<thead>
<tr>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
<th>GUIDES</th>
</tr>
</thead>
<tbody>
<tr>
<td>155</td>
<td>40</td>
<td>1-1/2 A</td>
<td>250-300</td>
<td>3.5</td>
<td>11.5</td>
</tr>
<tr>
<td>Y</td>
<td>55 V</td>
<td>-</td>
<td>350-400 A</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Technicians/SSN**
Byrd/Hookley

**Charge**
1026H-9

**Date**
5/2/85

**Joint #**
M685 - 220
# Electroslag Data Sheet

<table>
<thead>
<tr>
<th>Wire Consumable Guide</th>
<th>Electroslag Welding</th>
<th>Process</th>
<th>Vertical Up</th>
<th>Preheat (min)</th>
<th>Torch Method</th>
<th>Tempstick</th>
</tr>
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<tbody>
<tr>
<td>4</td>
<td></td>
<td>Hobart</td>
<td>X</td>
<td>150°F</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Equipment
- **Power Supply**: Hobart RC-1000 DCEP
- **Polarity**: Hobart
- **Wire Feeder**: DCEP
- **Controls**: Hobart Multi-Torch Control Box
- **Hobart Multi-Wire Oscillator**

## Filler Matl.
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EMT2 (AWS S.25-78)
- **5/8" Dia. Guide Tubes**
- **Hobart Type No. 58**: ASTM A108 Gr. 1018

## Base Matl.
- **Dimensions**: 24"L x 12"W x 24"H
- **PO/Heat/Lot**: N/R
- **Specification**: MIL-C-15083 Gr. B
- **Hobart Type No. 59**: 5/8" Inside Diameter
- **Remained warm to touch**
- **Brand/Type**: Linde 124 & PF-20 Storage flux oven @ 250°F

## Cooling Shores
- **Size/Type**: 24" Long/Copper
- **Flow**: N/R
- **Max Temp**: 165°F

## Joint Design & Details

![Joint Diagram](image)

- **R.0.₀ = 1 - 1/2" + 1/16"**
- **R.0.₀ = 1 - 3/8" + 1/16"**

## Guide Tube Spacing
- **6"**

## Wire Feed Speed
- **Volts**: 155 V
- **Electrode Extension**: 1-1/2 in.
- **Amperage Per Wire**: 350-400 A
- **Dwell**: 4 sec.
- **Cycle Time**: 12 sec.
- **Frequency**: 5 cpm
- **Oscillation**: N/R
- **Joint was restarted after 1 misfire. 7 mins. to start.**

## Deposition Rate
- **85# h:**

---

### Technicians/SSN
- Byrd/Meckley

---

### Charge
- 1026M-9

### Date
- 6/19/85

### Job No.
- 655-29
## ELECTROSLAG DATA SHEET

### PROCESS
- **4 WIRE CONSUMABLE GUIDE**
- **ELECTROSLAG WELDING**

### EQUIPMENT
- **Power Supply**: Hobart RC-1000
- **DCEP**: Hobart
- **CONTROLS**: Hobart Multi-Torch Control Box
- **Wire Feeder**: Hobart Multi-Wire Oscillator

### FILLER METAL
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EWT2 (ANS 5.25-78)

### BASE METAL
- **Dimensions**: 24"L x 12"W x 19"H
- **PO/Heat/Lot**: N/R
- **Specification**: MIL-S-15083 Gr. B
- **INSULATOR**: Hobart Type No. 59
- **FLUX**: 5/8" Inside Diameter

### COOLING SPACES
- **Size/Type**: 24" Long/Copper
- **FLOW**: N/R
- **Max Temp**: 150°F

### Joint Design & Details
- **W**:
- **R.D.**:
- **T**:
- **L**:
- **R.O. t = 1-1/2" ± 1/16"**
- **R.O. b = 1-3/8" ± 1/16"**

### GUIDE TUBE SPACING
- **4 11/16"**

### WIRE FEED SPEED

<table>
<thead>
<tr>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
<th>WIRE FEED SPEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>150</td>
<td>55</td>
<td>1-1/2 in.</td>
<td>325-350</td>
<td>4 sec.</td>
<td>12 sec.</td>
<td>5 cpm</td>
<td>N/R</td>
<td>4 1/2 mins. to start</td>
</tr>
<tr>
<td>175</td>
<td>55</td>
<td></td>
<td>450-500</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Final Slag Depth = 1-1/</td>
</tr>
</tbody>
</table>

### DEPOSITION RATE
- **Deposition Rate = 76#/h**

### Signatures
- **Byrd/Meckley**
- **Charge**: 1026M-9
- **Date**: 6/26/85
- **Joint No.**: M685-30
ELECTROSLAG DATA SHEET

POWER PROCESS 2 WIRE CONSUMABLE GUIDE ELECTROSLAG WELDING

POSITION VERTICAL UP X Plate casting

Preheat (min) 150°F Torch Tempstick measured by
PREHEAT SUMP AREA ONLY N/A Interpass

EQUIPMENT Power Supply Hobart RC-1000
Polarity DEP
Wire Feeder Hobart

CONTROLS: Hobart Multi-Torch Control Box Hobart Multi-Wire Oscillator

FILLER MATERIAL Size/Type 3/32" Dia./Cored Wire
Brand Hobart PS-588
Specification EWT2 (AWS 5.25-78)

5/8" Dia. Guide Tubes
Hobart Type No. 58
ASTM A108 Gr. 1018

BASE METAL Dimensions: 1/4" Dia. Round Bar
PO/Heat/Lot Commercial
Specification ASTM A108 Gr. 1018

COOLING SHOES Size/Type 24" Long/Copper
Flow N/R
Max Temp 160°F

Visual Defects Satisfactory

Satisfactory

FINAL VERTICAL N/A W/7018

WIRE FEED SPEED VOLTS ELECTRODE EXTENSION AMPERAGE PER WIRE O SCILLATION Dwell CYCLE TIME FREQUENCY AMPLITUDE

START 175 ipm 45 V 1-1/2 in. 400-450 A 3 sec. 10 sec. 6 cpm N/R

Good start.
Color not as red as with Hobart flux.

running 175 ipm 55 V -- 400-450 A

Deposition rate = 36 #/hr
Normalized @ 1600°F for 11 hours

GUIDE TUBE SPACING 4"
## ELECTROSLAG DATA SHEET

**PROCESS**

4 WIRE CONSUMABLE GUIDE  
**ELECTROSLAG WELDING**

**POSITION**

VERTICAL UP  
X casting

**CONTROLS:**

Hobart Multi-Torch Control Box  
Hobart Multi-Wire Oscillator

**EQUIPMENT**

Power Supply: Hobart RC-1000  
DCEP  
Wire Feeder: Hobart

**FILLER METAL**

Size/Type: 3/32" Dia./Cored Wire  
Brand: Hobart PS-588  
Specification: EWT2 (AWS 5.25-78)

**BASE METAL**

Dimensions: 24"L x 12"W x 16"H  
PO/Heat/Lot: N/R  
Specification: MIL-S-15083 Gr. B  
Incl Incon:

**BASE/shoes**

Size/Type: 24" Long/Copper  
Flow: N/R  
Max Temp: 165°F

**Joint Design & Details**

W = W.O.  
Z.O. = Z.O.

R.O.T = 1-1/2" ± 1/16"  
R.O.B = 1-3/8" ± 1/16"  

**WIRE FEED SPEED**

Volts  
Electrode Extension  
Amperage Per Wire  
Oscillation  
Oscillation  
Deposition rate = 74 #/hr.

<table>
<thead>
<tr>
<th>Wire Feed Speed</th>
<th>Volts</th>
<th>Electrode Extension</th>
<th>Amperage Per Wire</th>
<th>Dwell</th>
<th>Cycle Time</th>
<th>Frequency</th>
<th>Amplitude</th>
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</thead>
<tbody>
<tr>
<td>165 ipm</td>
<td>55 V</td>
<td>1-1/2 in.</td>
<td>400 A</td>
<td>3.5 sec.</td>
<td>11.5 sec.</td>
<td>N/R</td>
<td>1-11/16</td>
</tr>
</tbody>
</table>

**FINAL R.T.**

Satisfactory  
Unsatisfactory: N/A

**GUIDE TUBE SPACING**

3-7/8"
Low Energy Maintain
Burst Combat For

A Force that
"Peace-Time"

Produces power
for speed and
utilization

wants power
for its en-

requirement

wind or...
**ELECTROSLAG DATA SHEET**

**PROCESS**
- WIRE CONSUMABLE GUIDE
- ELECTROSLAG WELDING

**EQUIPMENT**
- Power Supply: Hobart RC-1000
- Wire Feeder: DCEF
- Hobart

**CONTROLS:**
- Hobart Multi-Torch Control Box
- Hobart Multi-Wire Oscillator

**FILLER METAL**
- Size/Type:
  - Brand: 3/32" Dia./Solid Wire
  - Specification: Hobart 25-P

**BASE METAL**
- Dimensions: 24"L x 12"W x 24"H
- PO/Heat/Lot: N/R
- Specification: MIL-S-15083 Gr. B

**COOLING SHIELD**
- Size/Type:
  - Flow: 24" Long/Copper
  - Max Temp: 175°F

**FINAL VISUAL INSPECTION**
- Description: x Satisfactory
- Visual Defects: N/A

**FLUX**
- Brand/Type: Linde 124 & PF-2C
- Storage: Flux oven @ 250°F, Remained warm to touch

**WIRE FEED SPEED**
- N/R

**VOLTS**
- N/R

**ELECTRODE EXTENSION**
- 1-1/2 in.

**AMPERAGE PER WIRE**
- N/R

**OSCILLATION**
- Dwell: 4 sec.
- Cycle Time: 12 sec.
- Frequency: 5 cpm
- Amplitude: N/R

**START**
- 225 V
- 55 ipm

**RUNNING**
- 500-525 A

**GUIDE TUBE SPACING**
- 6"
# ELECTROSLAG DATA SHEET

<table>
<thead>
<tr>
<th>PROCESS</th>
<th>WIRE CONSUMABLE GUIDE</th>
<th>ELECTROSLAG WELDING</th>
<th>POSITION</th>
<th>VERTICAL UP</th>
<th>DATE</th>
<th>PREHEAT (min)</th>
<th>METHOD</th>
<th>TEMPERATURE</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>200°F</td>
<td>Torch</td>
<td></td>
</tr>
</tbody>
</table>

## EQUIPMENT
- **Power Supply**: Hobart RC-1000
- **Polarity**: DCEP
- **Wire Feeder**: Hobart

## CONTROLS
- **Hobart Multi-Torch Control Box**
- **Hobart Multi-Wire Oscillator**

## FILLER METAL
- **Size/Type**: 3/32" Dia./Cored Wire
- **Brand**: Hobart PS-588
- **Specification**: EWT2 (AWS 5.25–78)

## BASE METAL
- **Dimensions**: 24"L x 12"W x 8"T
- **Specification**: MIL-S-15083 Gr. B

## COOLING SHOES
- **Site/Type**: 24" Long/Copper
- **Flow**: N/R
- **Max Temp**: N/R

## Joint Design & Details

![Joint Design Diagram]

- **R.O.t** = 1-1/4" + 1/16" - 0
- **R.O.b** = 1-1/8" + 1/16" - 0

## GUIDE TUBE SPACING

4"

## WIRE FEED SPEED

<table>
<thead>
<tr>
<th>WIRE FEED</th>
<th>VOLTS</th>
<th>ELECTRODE EXTENSION</th>
<th>AMPERAGE PER WIRE</th>
<th>OSCILLATION</th>
<th>WAVE DURATION</th>
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<tr>
<td>175 ipm</td>
<td>175 V</td>
<td>1-1/2 in.</td>
<td>400-450 A</td>
<td>3 sec.</td>
<td>10 sec.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>6 cpm</td>
<td>N/R</td>
</tr>
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</table>

**FINAL VISCOSITY:

- Satisfactory
- Visual Defects

**FILLER METAL:

- Satisfactory
- Procedure

**GUIDE TUBE AMMOUNT:

- N/A

**GUIDE TUBE SPACING:

4"

**DEPOSITION RATE:

- 34# per hour Normalized @ 1600°F for 11 hours.

**TECHNICIAN/SSN:

Meckley/Byrd

**CHARGE:

1026M-9

**DATE:

7/5/85

**JOINT NO.:

M685-32
APPENDIX E

PROCEDURE QUALIFICATION OF ESW FOR SHAFT STRUTS
Purpose:

This qualification provides supporting data for a procedure to weld thick carbon steel castings using the electroslag-consumable guide welding process.

Process Description:

Electroslag-consumable guide welding (ESW) is a single pass process performed in the vertical position. Current is passed through one or more electrodes into a bath of molten slag. The resistivity of the slag maintains a molten bath and melts the electrode as it exits from the consumable guide. The consumable guide and the base metal are also melted by the slag bath. Shielding from the atmosphere is accomplished by the molten slag. A diagram of the process is shown in figure 1. A sump or run-off tab is placed at the top and bottom of the joint. The bottom sump allows the process to stabilize and insure fusion. The top sump allows molten flux and molten metal to extend beyond the joint so joint fill is obtained. Water cooled copper shoes are placed along the joint sides for the full length of the joint. This contains the molten flux and weld metal in the joint and gives the contour to the weld bead faces.

Discussion:

Two carbon steel castings were joined using multi-consumable guide ESW. Three consumable guides were connected by 1/4” diameter carbon steel round bar. The ends of the outside guides were cut at a 45 angle to protect the electrode openings from spatter at the start (figure 2). Insulators, composed of a material similar to the flux, were used to protect the consumable guides from making contact with the side walls. Parameters used to produce the weld are recorded in Technique Sheet 1.

After welding, the test assembly was annealed. The assembly was heated to 1600 F, soaked for 11 hours, oven cooled to 500 F, then air cooled.

Nondestructive testing was done in accordance with Military Standard 271D. Magnetic Particle testing met the requirements of NavShips 0900-003-8000. Radiographic testing met the requirements of NavShips 0900-003-9000 Class 1.

Destructive testing was performed in accordance with and met the requirements of Military Standard 248B. A curve of charpy impact values for the weld metal and the base material are being submitted for information (figure 3). Results of the destructive testing are recorded in Table 1.
**TECHNICAL REPORT**

NEWPORT NEWS SHIPBUILDING AND DRY DOCK CO.
NEWPORT NEWS, VIRGINIA

<table>
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<th>AUTHOR</th>
<th>DEPT.</th>
<th>037</th>
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<tr>
<td>M.J. Rice</td>
<td></td>
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<td>Procedure Qualification for Electroslag (Consumable Guide) Welding (ESW) of Carbon Steel Castings</td>
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<tr>
<td>Unclassified</td>
<td>6</td>
<td>4-8-83</td>
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**ABSTRACT**

Two 10 3/4" thick carbon steel castings were welded using the electroslag (multi-consumable guide) welding (ESW) process. The finished weld was annealed prior to nondestructive testing.

The completed weld satisfactorily met the requirements of Military Standard 00248B (Ships), "Welding and Brazing Procedure and Performance Qualification". Welding parameters for performing the subject weld and mechanical test results have been recorded herein.

**DISTRIBUTION:**

**REQUESTER:**

**COPIES TO:**
1 - Engineering Research Dept., 033
1 - 037 File

**APPROVED BY:**

[Signature]

Date: 5-5-83
### Destructive and Non-destructive Test Results

#### Nondestructive Test 'G'

<table>
<thead>
<tr>
<th>technique</th>
<th>acceptance</th>
<th>sat</th>
<th>unsat</th>
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<tbody>
<tr>
<td>MT Mil-574-271D</td>
<td>0700-003-000</td>
<td>X</td>
<td></td>
</tr>
<tr>
<td>ET Mil-574-271D</td>
<td>0700-003-900</td>
<td>X</td>
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#### Drop Weight Test

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#### Guided Bend Test

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**S-side** | **F-face** | **R-root**

#### Deposit Analysis

- 
- 
- 

#### Macro Test

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#### Intergranular Corrosion Test

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#### Delta Ferrite

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*1- location of failure: W-weld; F-fusion line; B-base metal.

#### Toughness Test (for information)

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Welding Engineering
Figure 1  Electroslag Welding Process

Figure 2  Consumable Guide Arrangement

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Page 5
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Figure 3  Base and Weld Metal Charpy Curve

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