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WAVEFORM CONTROL TECHNOLOGY™

AC/DC Submerged Arc Welding

Welding for Offshore

Gulf Marine

Corpus Christi, Texas-based Gulf Marine is a division of Technip, one of the world's leaders of oil, gas and petrochemical engineering, construction and services based in Paris France.

- CHALLENGE -

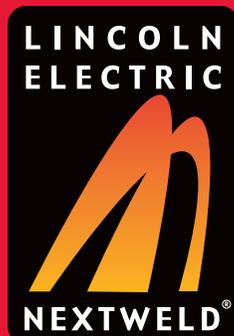
With a new contract to assemble the world's largest piling for an offshore drilling platform, Gulf Marine needed to make smart decisions about welding technology to maximize productivity.

- SOLUTION -

- Lincoln Electric's Power Wave® AC/DC 1000 welding system for single or multiple-arc applications offers Waveform Control Technology™ for easy, software-based adjustment of waveform balance, frequency and amplitude (DC Offset), as well as the phase relationship between multiple wires.
- Lincoln Electric's Lincolnweld® LA-75 submerged arc welding wire and Lincolnweld 880M flux.

- RESULTS -

- An immediate 35% increase in deposition rates using the Power Wave AC/DC 1000.
- A 10-15% reduction in electrical utility costs using the inverter-based Power Wave AC/DC 1000.



Like many fabricators, Gulf Marine Fabricators sought new welding technology that could improve productivity, finished weld quality, and ultimately, the company's bottom line. But the need grew urgent last year, when Daewoo Shipbuilding and Marine Engineering contracted the Corpus Christi firm to fabricate the world's largest piling for a ChevronTexaco offshore drilling platform.

Based on material thickness and other factors, the team at Gulf Marine knew that submerged arc welding was traditionally a viable arc welding process for welding the many fabricated structural weldments required for this project.

Gulf Marine understood even small boosts in productivity would yield substantial returns on a project of that size. Meanwhile, additional large-scale jobs were filling the production schedule, and company engineers were aware of no new significant developments in submerged arc welding. They needed to start their search for new solutions from scratch.

"We really looked hard at a number of welding manufacturers and asked a lot of tough questions," said Jim Miller, the company's welding engineer supervisor. "We spent more than a year examining as many details as we could."

Gulf Marine was to build twelve 600-foot long steel piles to be driven in the ocean floor off the Atlantic coast of Africa. The equipment company engineers elected to incorporate brand new technology that offered welding deposition rate increases of more than 30 percent. However, because the final results exceeded those expectations, Gulf Marine now plans to revamp its entire submerged arc welding operation with the same equipment.



The future of welding is here.®

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Early in 2004, The Lincoln Electric Company® introduced the inverter-based Power Wave® AC/DC 1000 welding system for single or multiple-arc applications in submerged arc welding. This unit is the first and only inverter-based welding power source design for AC/DC submerged arc welding in the industry. Gulf Marine engineers tested the 1,000-amp system and later purchased 16 units, becoming the first U.S. company to implement this new technology on a large-scale operation.

With infinitely variable control settings and software-driven capabilities, the Power Wave's wide flexibility allows operators to easily adjust submerged arc welding (SAW) waveforms to any frequency between zero and 200 Hertz with the turn of a knob. In multiple-arc setups, any phase relationship can be achieved among the lead and trailing arcs to virtually eliminate the unwanted effects of arc blow.

The amplitude and duration of the positive and negative cycles are independently adjustable, providing greater control of bead shape, deposition rates, penetration and heat input. With Lincoln's Nextweld Waveform Control Technology, which uses electronic regulation circuitry to control and shape the output waveform, waveform parameters can be tailored specifically to the application.

“The Power Wave AC/DC 1000 provides much better control of the arc than anything we’ve used, and the waveforms are easily manipulated from the user interface.”

Traditional submerged arc welding equipment could only run DC positive, DC negative or AC at 60 hertz frequency. Changing these parameters required a manual hardware change and added downtime. With the inverter-based Power



Wave AC/DC, polarities and waveshapes can be changed via software on the fly with a much greater degree of control, allowing the welder to optimize the penetration profile while maintaining the highest possible deposition rate.

For Gulf Marine, which set out to weld miles of 2-1/4 to 3-3/4 inch thick base material on an unprecedented scale, engineers chose a tandem wire set-up. In this two wire application, both lead and trail arcs ran AC current on mechanized stations with travel beams, each with



three welding heads. The stations made three girth welds at a time for a total of about 40 weld passes.

Unlike conventional systems, Lincoln inverter-based Power Waves were

capable of running unbalanced AC polarity for each of the two arcs, and that allowed Gulf Marine to obtain the specific penetration required while maximizing the welding deposition rate.

A team of Lincoln technicians worked closely with Gulf Marine to help dial in the right settings. They adjusted variable balance, variable frequency and phase relationships between the two wires to create optimum waveforms.

With both arcs in this tandem wire configuration running on unbalanced AC polarity, Gulf Marine realized immediate increases in welding deposition rates. Once optimized, the change helped stabilize the arc. In turn, the more stable arc allowed the team to increase the operating current from 650 to 775 amps. "These changes added up to deposition rate improvements in excess of 35 percent," Miller said.

"On a project that size, that's unbelievable," he added. "It's a no-brainer for us now to change over all of our operations to this technology. The Power Wave AC/DC 1000 provides much better control of the arc than anything we've used, and the waveforms are easily manipulated from the user interface."

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Lending the project an additional hand was Lincoln's Lincolnweld® LA-75 submerged arc wire electrode. Paired with Lincolnweld 880M flux, the wire was specifically selected to maintain or improve travel speeds at these higher amperages while delivering improved mechanical properties.

Finally, with the switch from conventional welding power sources to inverter-based systems, the company's electrical energy consumption dropped 10 to 15 percent for a significant utility bill cost savings.

Monitoring the progress

Lincoln's Power Wave technology was put to work joining about 720 sections, each 10 feet long and 11 feet in diameter. Each pile weighed about 1,000 tons, and once assembled, the twelve tubes that comprised the entire piling weighed about 12,000 tons – slightly more than the weight of the Eiffel Tower.

With welding jobs that large, fine-tuning productivity really pays off. Now, Miller monitors a variety of activities from his personal computer, such as weld history and performance parameters, using Lincoln's accompanying Production Monitoring® software. He can check arc time and deposition rates. The system



can even alert him when more wire is required.

Supervisors can review productivity on present and past shifts—a personal favorite for Gulf Marine managers, who pride themselves on efficiency. They set limits on current and voltage, program alarms and monitor performance. They check arc-on time per shift and real time voltage and amperage. If needed, the data can be saved for future reference.

The maintenance department uses the monitoring software to track the total arc-on hours for a given machine, so they can deliver preventative maintenance at

set intervals during the machine's service life. If there is a malfunction, the monitoring software has a built-in diagnostic tool that will help to pinpoint the cause of the problem.

Miller said another advantage of the Power Wave AC/DC 1000 was greater consistency and better quality welds. The precise waveform control allowed for more accurate arc starts and weld settings. On this particular offshore piling, the welds needed to meet the standards of API RP 2X and AWS D1.1. The repair rate came in at notable 0.042 percent, checked entirely by ultrasonic inspection on nearly 300,000 inches of weld.

“Our new design, coupled with the Power Wave technology will make us even more competitive for new projects.”

Looking ahead

Recently, Gulf Marine patented a new design in offshore floating platforms called cell spars. Unlike the traditional single spar hull design for a floating platform, cell spars use bundles of smaller cylinders that use less material to construct.

Cell spar hulls consist of a bundle of seven long, thin cylinders welded from hundreds of small steel plates. They require heavy use of welding automation. Pairs of 10- by 31-foot plates are butt jointed with tandem submerged arc welding on a mechanized travel along the short sides. The pieces then are plate-rolled into approximately 300 tube sections.

Productivity, effective automation and efficiency all play key roles in maximizing the quality and cost savings of the new design. In doing so, the company plans to incorporate Lincoln's Power Wave AC/DC 1000 in all of its submerged arc operations, said Ramiro Cortez, pipe mill superintendent for Gulf Marine.

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"This equipment is light years ahead of the other stuff," he said. "I'm really looking forward to the productivity we'll get on the cell spar work. Our new design, coupled with the Power Wave technology will make us even more competitive for new projects."

Last year's equipment transition was nearly seamless, Cortez explained. He said operators picked up the changes quickly and learned the new system with relative ease.

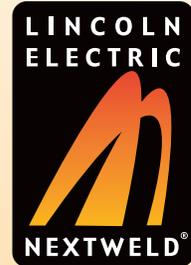
"The changeover really didn't slow us down at all," he said. "There was very little learning curve, which is unusual. The team of Lincoln technicians was very helpful and many of them returned a number of times until we were dialed into the best possible settings."

Miller said that as the changeover continues and flexibility of the equipment is better understood, even more productivity will follow.

"The possibilities with this technology are endless," he said. "There's no telling where it will take us next."

WHAT IS NEXTWELD?

The challenges facing industrial fabricators today are increasingly difficult. Rising labor, material, and energy costs, intense domestic and global competition, a dwindling pool of skilled workers, more stringent and specific quality demands.



Through our commitment to extensive research and investments in product development,

Lincoln Electric has established an industry benchmark for applying technology to improve the quality, lower the cost and enhance the performance of arc welding processes.

Advancements in power electronics, digital communications and Waveform Control Technology™ are the foundation for many of the improvements.

NEXTWELD brings you a series of Process, Technology, Application and Success Story documents like this one. NEXTWELD explains how technologies, products, processes and applications are linked together to answer the important questions that all businesses face:

- How can we work faster, smarter, more efficiently?
- How can we get equipment and people to perform in ways they've never had to before?
- How do we stay competitive?

NEXTWELD is the future of welding but its benefits are available to you today. Ask your Lincoln Electric representative how to improve the flexibility, efficiency and quality of your welding operations to reduce your cost of fabrication.

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Featured Lincoln Products

Power Wave® AC/DC 1000



The Power Wave AC/DC 1000 is the first power source to introduce Waveform Control Technology™ to submerged arc welding. Variable frequency and amplitude AC, DC positive or DC negative output allows the user to control the deposition rate and penetration. An operator can increase weld speeds, yield higher quality welds and improve efficiencies in a single or multi-arc environment. The phase angle and frequency of different machines can also be synchronized to balance the interactions between multiple arcs and minimize arc blow. Depending on the output, a welding arc may be driven by a single machine or multiple machines in parallel for applications that require more than 1000 amps of continuous operation.