

SUCCESS

**LINCOLN**  
**ELECTRIC**  
THE WELDING EXPERTS<sup>SM</sup>

PULSED WELDING ON STAINLESS

## Waveform Control Technology<sup>®</sup>

Nuclear Code Work

**Ranor, Inc.**

**Ranor, Inc., of Westminister, Massachusetts, specializes in precision large-scale metal fabrication and machining for the nuclear, aerospace, military, power generation, process machinery and shipbuilding industries.**

### - CHALLENGE -

A nuclear industry project required welding in 8.70-inch square, 168-inch long fuel openings. As work access was severely limited, welds had to be spatter and defect free. Tight final dimensional tolerances also dictated shrinkage must be kept to a minimum.

### - SOLUTION -

The Power Wave 355M<sup>®</sup> power source and the Power Feed<sup>™</sup> 10M wire feeder loaded with customized welding waveforms work as a system to deliver a pulsed GMAW process.

### - RESULTS -

Ranor acknowledged 100% weld quality in more than 9,500 welds. The low welding heat input generated 75% less weld shrinkage. The process is 500% faster than the plasma arc process tested for possible use on this project.



**A**s a custom fabricator of precision large-scale materials for the nuclear, aerospace, military, power generation, process machinery and shipbuilding industries, Ranor Incorporated has produced a wide variety of products in its nearly 50-year history. Though the company has a wealth of experience in producing canisters that provide primary containment for spent nuclear fuel rods, a new project to fabricate a transportable spent fuel canister required the use of new welding equipment. In addition, a different welding wire electrode for Ranor and a custom-designed manipulator were required to complete the job.

With an internal basket assembly design completely different from that of past fuel canisters, the TN 32PT<sup>®</sup> Transportable Canister Assemblies, a patented product of Transnuclear, Inc., presented new welding application challenges.

The transportable canisters are 168 inches long with 32 fuel openings formed with plate material that are stacked both horizontally and vertically in an "egg crate" fashion. Once constructed, the internal welds in these 8.70-inch squares are not accessible, presenting a significant challenge. Since the opportunity for repair work was severely limited, the Ranor team sought to take every precaution to ensure that the finished welds on the fuel openings were free of weld spatter and any weld defects.



The design also called for tight final dimensional tolerances, since the basket assembly sits inside of a canister that ultimately slides into an exterior cask. These measures safeguard against leakage of radioactive material but also dictate that shrinkage and distortion resulting from the welding process be kept to a minimum.

The project specified a high-strength stainless steel SA240 Type XM-19 (Nitronic<sup>®</sup> 50). (Nitronic<sup>®</sup> is a trademark of Armco<sup>®</sup>, Inc.). 1/4-inch plate with tensile strength of 100 KSI for the basket assembly. This material is stronger than the SA240 Type 304 stainless used to produce a typical fuel canister's basket assembly. The design also specified a .045-inch diameter AWS ER209 filler metal to achieve the tensile strength. Both the exotic base material and filler metal specified for the transportable canister were new to Ranor's 142-employee shop.

The future of welding is here.<sup>®</sup>

NX-4.240 01/06

# Waveform Control Technology®

2/4

## Nuclear Code Work

## Ranor, Inc.

Ranor, located in Westminister, Massachusetts, experimented with plasma arc and submerged arc processes to weld its basket assemblies, but because of the special considerations for this job, using these processes would have resulted in an unusable part.

For the solution, Ranor turned to the welding experts at The Lincoln Electric Company who recommended the use of a Pulse GMAW process with the Power Wave® 355M power source/Power Feed™ 10M wire feeder. Using Lincoln Waveform Control Technology®, the Power Wave-based system offered total customization of the arc.

In combination with Ranor's custom-built automatic manipulator, the new power source/wire feeder was used to weld the 32PT Transportable Canister Assemblies 500 percent faster than the plasma arc process tested for possible use on the project. In addition, the low heat input provided by the Lincoln Pulse GMAW machine generated 75 percent less weld shrinkage.

"Quality of the weld and low defect rates were exceptional," said Norman Banville, Sales Engineer at Ranor Incorporated. "Our machine shop engineers developed a portable machine that could remove defective welds in the event that something went wrong. Out of the 9,540 welds created during the welding of the nine-canister project, Ranor had to use the machine once, due to an oversized weld, not weld quality."

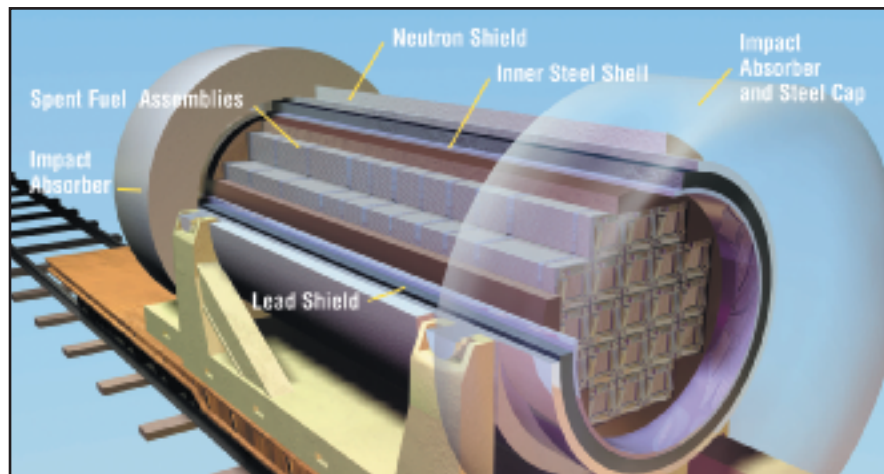
For the outside shell assembly of the fuel canister, Ranor uses a combination of arc welding processes, including SAW, SMAW, GTAW and FCAW.

### Key Challenges Met

When choosing equipment for welding the basket assembly, Ranor personnel evaluated several welding machines and processes. Plasma arc welding caused extensive shrinkage and distortion due to slow travel speeds and heat input while SAW showed similar shrinkages due to increased penetration into the base metal.

What sold them on the Pulsed GMAW capabilities of the Power Wave 355M was a joint demonstration on Ranor's shop floor by Lincoln Electric and authorized distributor representatives from Airgas®, a Lincoln authorized distributor. This team showcased not only the equipment, but their combined technical support and customer service capabilities.

"We started with a baseline waveform programmed into the Power Wave and still were experiencing some spatter,"



**"Quality of the weld and low defect rates were exceptional," said Norman Banville, Sales Engineer. "Our machine shop engineers developed a portable machine that could remove defective welds in the event that something went wrong. Out of the 9,540 welds created during the welding of the nine-canister project, Ranor had to use the machine once, due to an oversized weld, not weld quality."**

said Norman Caron, Welding Engineer at Ranor Incorporated. "But Lincoln's Jeff Nadzam quickly developed a welding waveform unique to us and to this application. With the new waveform and lower heat input of the process, the spatter and distortion were practically eliminated. We saw for ourselves how well the Power Wave 355M could adapt."

"We had considered competitive brands of machines with Pulsed GMAW capabilities, but none provided

adequate distortion control and on-site customization of the waveform like the Power Wave. In addition, the machine smoothly ran the ER209 wire to code requirements, meeting the stringent mechanical and visual requirements of the design," continued Caron.

Airgas brought to the table a specialty blend of shielding gas developed specifically for these types of stainless materials.

# Waveform Control Technology®

3/4

## Nuclear Code Work

## Ranor, Inc.

For the actual welding, the basket assembly is fit and tacked as a complete unit, and welded within the confines of a full-length rotating fixture for in-position welding.

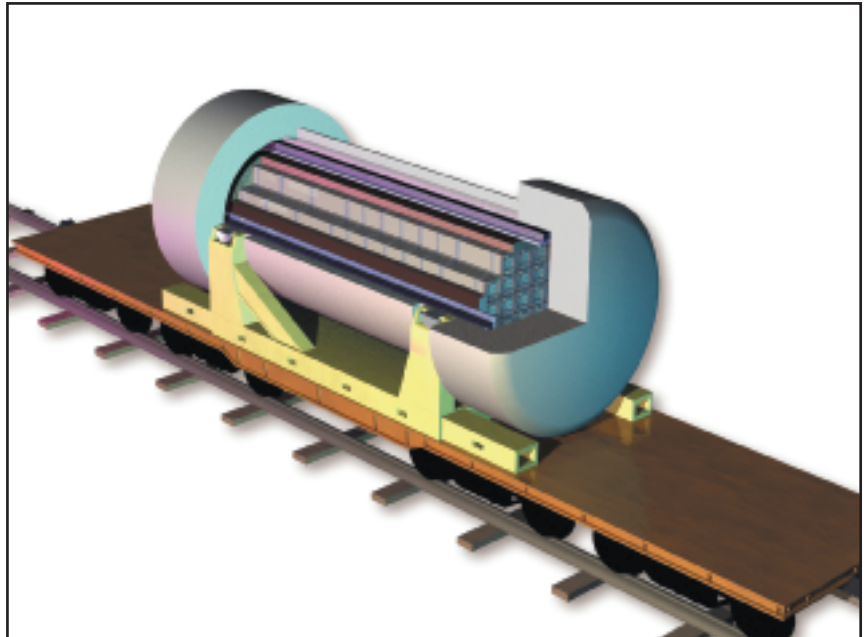
The transportable fuel canister's basket assembly was fabricated to ASME Section III, Division 1, Subsection NG, requiring every inch of weld to be inspected using nondestructive methods. Ranor is one of only a few welding shops in the country that have qualified for the ASME N-type certificate.

### Superb Weld Performance

With more than 2,000 linear feet of single pass fillet welds per basket assembly, and hundreds of repeated arc starts and stops, Ranor representatives were concerned that the welding system might leave a ball at the end of the wire. "Because we were welding at more than 150 inches inside of the confined space of the fuel openings, the ability of the Power Wave 355M to effectively leave the wire with no ball on the end of it makes clipping the wire between starts and stops unnecessary. Arc starts were never a problem, which greatly increased productivity," said Banville.

The Power Wave 355M features Waveform Control Technology®, an element of Lincoln's Nextweld Technology® innovations. Waveform Control Technology is Lincoln's proprietary technology platform that controls and shapes the output waveform. Since the waveform is shaped digitally using software rather than mechanically with hardware, equipment with waveform control can be easily adapted to deliver high quality customized results.

As for the system's Power Feed 10M wire feeder, Ranor executives were particularly impressed with the ability of the wire feeder drive system to push the very rigid ER209 wire smoothly and consistently through a line that was nearly 20-feet long without the aid of a push-pull system.



### Filler Metal Problems

One other problem that Lincoln helped Ranor solve was severe crater cracking and centerline cracking. Using Ranor's prototyping mock-ups, Lincoln's lab was able to examine the filler metal and determine that the ferrite in the cracked welds measured 4 FN, which should be sufficient to prevent hot cracking. However, because ER209 is a very high-alloy stainless steel weld metal, this ferrite content was not high enough.

---

**"We had considered competitive brands of machines with Pulsed GMAW capabilities, but none provided adequate distortion control and on-site customization of the waveform like the Power Wave. In addition, the machine smoothly ran the ER209 wire to code requirements, meeting the stringent mechanical and visual requirements of the design," continued Caron.**

---

According to Caron, Lincoln recommended a new heat of ER209 filler metal with a calculated FN of 9 and the hot cracking problem was resolved. "Although the original spool of wire did meet code standards, it was not right for this application. Once we asked for a new heat with higher ferrite levels, our problems were solved."

### Service

According to Caron, it was the teamwork of Lincoln's Brian Sullivan, Airgas East's Michael Luft and the Ranor internal team that accomplished this challenging job. "There are many instances where I've been in touch with Lincoln to work on applications. They are always able to help me with solutions. We have a good relationship and it's much appreciated," said Caron.

Besides technical support, Lincoln provides Ranor with training and maintenance issues with the equipment.

### Conclusion

Based on the success of the basket assembly project, Ranor is now customizing its own welding waveforms as necessary for use with the Power Wave 355M to develop and qualify



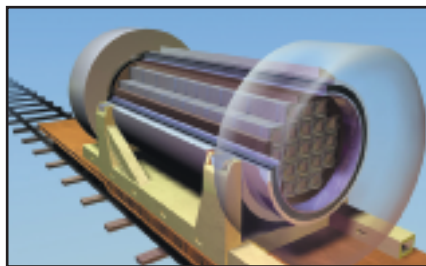
# Waveform Control Technology®

4/4

## Nuclear Code Work

## Ranor, Inc.

procedures for groove welding of heavy section HY-80 to Inconel® 625 (Inconel is a trademark of the Special Metals Corporation®) as well as overlay produced with Inconel 625 for corrosion resistance on HY-80 base material. These welding waveform programs are based on standard programs in the Power Wave modified with fine adjustments made by Ranor personnel.



precise way possible is how we've earned our reputation. That reputation is one of outstanding technical expertise, flawless attention to details and a commitment to quality.

"I think our ability to provide an innovative welding solution for the transportable fuel canister job demonstrates how Ranor will adapt to a customer's needs and go the extra mile to meet the design criteria," said Banville. "Our ability to work one-on-one with customers to manufacture custom parts in the most efficient and

## Featured Lincoln Products



### Power Wave® 355M

Superior Arc Performance. Revolutionary Communication.

The Power Wave® 355M features some of Lincoln's best performance technologies and processes all rolled into one highly efficient inverter power source designed for high-end semiautomatic welding. Lincoln's Waveform Control Technology® is at the heart of the Power Wave 355M's performance, enabling processes such as Pulse-On-Pulse™ and Power Mode™. Precise control of process parameters allows you to weld on a variety of materials, including steel, stainless steel, aluminum and nickel alloys in virtually any application. Optimize the arc for each wire type and size for a consistent weld time after time with the Power Wave® 355M.

## 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.*



THE LINCOLN ELECTRIC COMPANY  
[www.lincolnelectric.com](http://www.lincolnelectric.com)  
 1.216.481.8100