THE *NUCLEAR NEWS* INTERVIEW

Lennie Daniels: An award-winning welding process

At Calvert Cliffs, a new method for welding pressurizer heater sleeves resulted in increased plant efficiency and improved radiation safety.

Daniels: "This process can achieve efficiencies in the repair schedule and keep people out of the high-dose environment, which helps with radiological safety."

Mini-ID Temper Bead Welding is the innovative process that picked up the B. Ralph Sylvia Best of the Best Top Industry Practice (TIP) Award this year, as well as the TIP Maintenance Award, from the Nuclear Energy Institute. The process is the brainchild of a core team of Constellation Energy Nuclear Group (CENG) and Areva employees led by CENG's Lennie Daniels, senior project manager at the Calvert Cliffs nuclear plant near Lusby, Md., where the process was pioneered last year.

Daniels, a 25-year CENG veteran with 13 years in project management, recently spoke about the development of Mini-ID Welding with *NN* Associate Editor Michael McQueen.

How long have you and your team been working on this project?

If you consider when we first started to think about it, probably four to five years. The actual project start-to-finish time was over three years.

Who else was part of the core development team?

From CENG, Jerry Cravens, weld engineer/construction manager, and Emran Hussain, lead design engineer; from Areva, John Orr, CR&R [component repair and replacement] tooling design manager, and Steven Wolbert, CR&R welding engineer.

How many people overall were involved?

Somewhere between 150 and 200 people were involved throughout the lifecycle of the project, including engineering, craft, and different leadership groups from both CENG and Areva, and the project support people—contract administrators, project schedulers, and construction managers.

What were the issues at Calvert Cliffs that led to the development of this welding process?

At Calvert Cliffs, the pressurizer was the last major plant component containing Alloy 600 welds that needed to be addressed, per industry guidance.

What are Alloy 600 welds?

Alloy 600 is a material used to weld different types of material together, and when you get the right combination of boric acid, pressure, and heat, it's susceptible to a phenomenon called primary water stress corrosion cracking. All pressurized water reactors are susceptible to this to varying degrees—in the reactor coolant system, the reactor head, the steam generators, some of the penetrations in the reactor coolant system pipes. Shortly after this cracking problem was first identified, plant operators were required to put together a plan to address the issue at their plants. The last big thing left for us at Calvert Cliffs was the Unit 1 pressurizer, and we were working to deal with that issue in 2012.

So that was what drove us to perform a repair. Given our plant layout—the way we're designed and built—some of the other alternatives just weren't viable. We couldn't easily replace the entire pressurizer, and we couldn't cut a section out and replace it, so through our alternative analysis, we came up with a solution: to do an *in situ* repair of the penetrations. We started looking at different vendors and were able to come up with a technique that worked best for our plant environment.

Why is the process referred to as Mini-ID Temper Bead Welding? Why the "mini"?

Mini-ID Temper Bead Welding is welding on the inside of a small-diameter pipe—"ID" stands for "inner diameter"—with no pre- or post-heat requirements. Ambient temper bead is an ASME code process that allows for making welds in certain materials without the requirement of preheating the material before welding or after completing a weld. It eliminates a complexity, another step in the process, making it easier.

The Calvert Cliffs pressurizer utilizes small-diameter heaters. The heaters enter the pressurizer through sleeves that have a relatively small bore diameter, so everything had to be shrunk in size to support that kind of welding. The repair tools had to be made

Workers use the mock-up to practice machining activities at Calvert Cliffs. (Photos: CENG)

small enough to operate inside those small diameters. Areva had weld heads to do inner-diameter welds, but they were too big for our application. New weld heads had to be made to function and operate in the small dimensions that we were working with.

And the equipment involved in doing these repairs was Areva equipment?

Yes, the majority of the specialized tooling was designed and developed by Areva, and the equipment was tested in the Calvert Cliffs mock-up.

How was the equipment developed?

At the start of the project, nobody had any of this equipment. We had a concept of wanting to make a repair in this fashion, so we went around to the vendors and said, "Here's what we're thinking, what can you do?" At that time, Areva seemed the farthest along in the tooling development process.

What were the next steps?

We needed to limit our plant risk and ensure that the repair process selected would meet plant requirements. We wanted to add checks and balances throughout the project to prove the plan along the way. So we set up the project in phases to ensure that the

A worker machines the pressurizer to accept the new heater sleeve.

The final plant configuration with the new sleeves and heaters installed. The final electrical terminations have been made on the heaters.

plan would be successful or to give us enough time to refine the repair strategy.

The first phase was proof of principle: We instructed Areva to make equipment small enough to weld in this diameter bore and then prove that the concept and tools work. It was a quick benchtop test to prove that Areva could make the equipment small enough and that a weld could be made that would meet all the requirements. Also, we asked that they get this done very quickly so that we would know whether the concept was viable and that we wouldn't have to jump into a plan B right away.

Once phase one was completed, phase two was used to prove that the tools and process—the repair system—would perform as expected in simulated field conditions. A lifelike mock-up was used to test whether the equipment would work properly and complete the repairs. We had a lower hemisphere, full-scale mock-up of the geometry of the vessel built, and we had two repair systems working simultaneously to minimize the overall repair duration. Then we took the phase-two repair durations and extrapolated those times to determine the time it would take to work on the 119 nozzles that needed to be repaired during the actual outage. We used ASME code inspection requirements and outage repair durations as the acceptance criteria.

At this point, we knew we had a functioning system that met all of the repair requirements. Phase three, field hardening, was designed to ensure that the repair system was ready to perform production welding. Repairing 10 sleeves—five sleeves for each repair system—in a mock-up is very different from repairing 119 sleeves around the clock. We still needed to refine the process and the tools to make the system robust enough to support production welding of 119 different nozzles in one outage. In phase three, we were doing 20 and 40 repairs at a time to find weak spots in the equipment and process.

We made adjustments both in the equipment and the work flow and then tested things again. This phase of the project was extremely beneficial. We were able to identify the majority of the equipment and process issues before the outage.

It sounds as though the mock-up was an integral part of the project's success.

Yes, we were able to learn all of the potential problems and equipment limitations long before the start of the outage, so nobody received unnecessary dose trying to learn the lessons of the process. The work environment was much safer and easier to address, and, more important, we weren't forced to learn a hard lesson during the outage that would have extended it, potentially for days, while we tried to overcome the issue. We modified the tooling and tweaked the process long before we ever started to work for real in the field. Doing that inside a shop or training environment is certainly much easier—there's less risk, and there are no contamination worries. We learned all the hard lessons in the shop rather than underneath the vessel during the outage, when a hard lesson can cost you days and days and a lot of money.

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How did your use of the Mini-ID Welding process improve efficiency and safety at Calvert Cliffs?

The biggest thing is that the welding was done remotely. Somebody would align the system at the pressurizer, and then the weld head would be controlled remotely outside of containment. The NDE [nondestructive examination] inspections were done similarly. Someone would align the system, and the inspections would be controlled remotely outside of containment. This eliminated the need to have people in high-radiation-dose environments. As for efficiency, we don't have to replace major components in the plant anymore. We can do localized repairs. And on top of that, we're set up to do several repairs simultaneously, and we can do several different steps simultaneously.

The repair of the pressurizer wasn't one of those situations where you just have one tool and you hook it up and you're done. It was a major machining evolution. We had to go in there and cut a heater weld, remove the heater, sever the heater sleeve, machine the vessel to accept the new heater sleeve, weld the heater sleeve, and clean up the weld to support the NDE inspections. There are all kinds of different tools and steps along the way, and different pieces of that process can be performed simultaneously while other things are going on. So this process can achieve efficiencies in the repair schedule and keep people out of the high-dose environment, which helps with radiological safety.

It also minimizes the overall impact to the outage because we set the process up in such a way that once we met our initial conditions, the plant could continue the outage behind our work. The whole outage followed its normal flow path while we were doing this major repair. That is a big help—everybody in the outage isn't waiting for us. They can carry on a major refueling outage while we're doing this modification, which is a big time saver as well.

Is this process applicable elsewhere?

This technique can be expanded to other similar locations. It doesn't have to be a pressurizer—it could be the bottom-mounted instruments on a reactor vessel. I think a lot of the Westinghouse plants have bottom-mounted instruments. The same technique can be used at those locations as well, so it lends itself to other components in different environments.

Now that we know that we can make weld repairs in this small of a bore diameter, it gives us a lot of flexibility, and major components don't have to be cut out in the plant anymore. Instead, localized repairs can be done. NN