THE *NUCLEAR NEWS* INTERVIEW

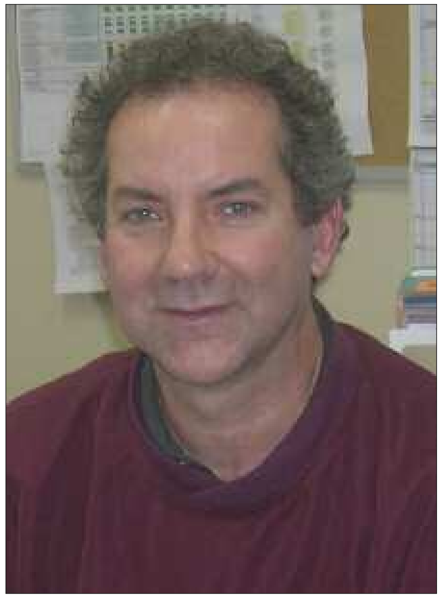
# Rick Libra: A safe and successful outage

*About 2.5 million person-hours were worked during TMI-1's recent outage, with no lost-time injuries.*

Rick Libra, director of work management at Exelon Nuclear's Three Mile Island-1 Generating Station, was one of the leaders of the plant's recently completed outage, which included replacing the plant's two steam generators and the 18th refueling in the reactor's history. About 3000 contract workers participated in the outage—about 2.5 million person-hours were worked—and Libra said that he was pleased to report that no time was lost during the outage due to injuries.

TMI-1, located in Londonderry Township, Pa., is a Babcock & Wilcox pressurized water reactor rated at 819 MWe net (design electrical rating). The plant started commercial operation in September 1974, and it recently received a 20-year license renewal from the Nuclear Regulatory Commission.

Libra talked about the recent outage with Rick Michal, *NN* senior editor.



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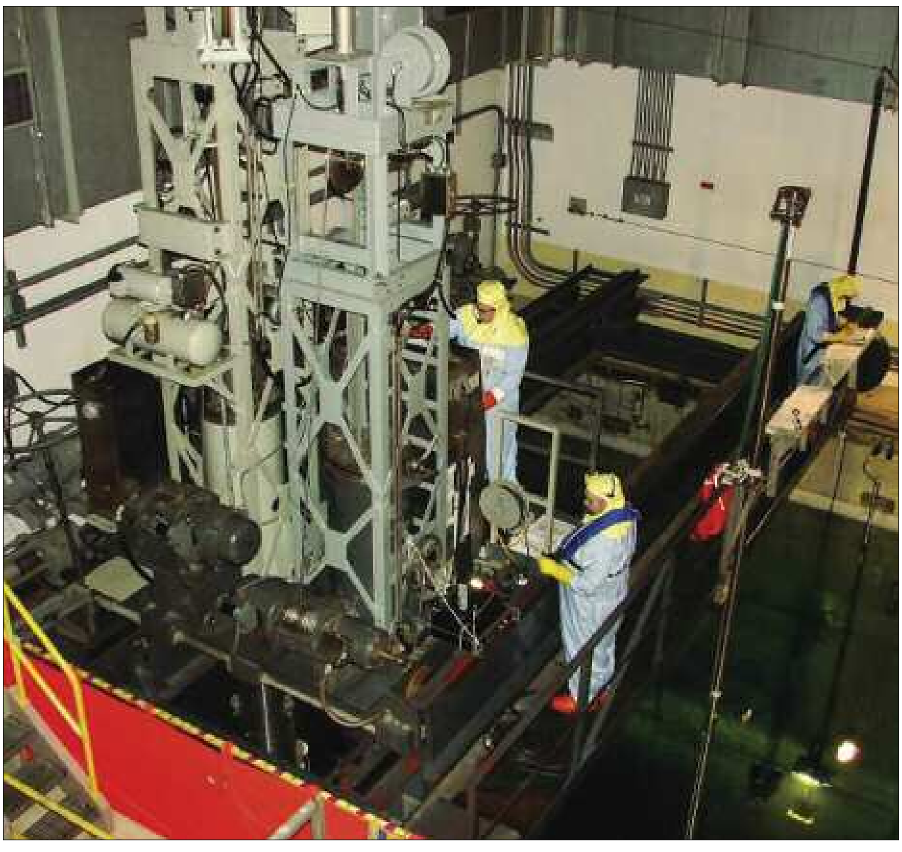


TMI personnel refuel the reactor. (Photos: Exelon Nuclear)

*What was the duration of the outage?*

The outage started October 26, 2009, and lasted for 90 days, which was a little bit off of our target.

*Could you talk about the scope of the outage?*

We replaced the two steam generators, as well as both hot legs that tie the steam generators to the reactor vessel. In addition, we redesigned and replaced the infrastructure associated with one of our natural-draft cooling towers, and we upgraded our other cooling tower with some internal structural replacements. We performed a lot of Alloy 600 mitigation, too. Alloy 600 is weld material from original construction that is susceptible to primary water stress corrosion cracking (PWSCC). To preclude having to inspect this material over the life of the plant, we proactively replaced a lot of the Alloy 600 welds on our core-flood system and high-pressure injection system and on our hot legs, and we also replaced a pressurizer thermowell.

Also, we replaced both of our diesel generators' cylinder liners, which involved a significant amount of work. We also performed large-scale replacements of our cooling water system piping to attack problems with MIC—microbiologically induced corrosion—which is caused by algae and crust that grow inside of pipes. When you're next to freshwater and saltwater regions, especially with freshwater—as in the case of TMI—you get algae in some of the low-flow piping.

And we replaced the last of six power inverters in our vital power system. It was a huge project, involving a total upgrade of that system with new state-of-the-art inverters and the addition of redundant capability to our vital power system. Finally, we performed some fuel assembly upgrades, replacing 88 upper-end fittings on our Areva fuel, and we continued our campaign to upgrade to Areva's HTP fuel.

*Could you talk about the various outage goals?*

Our collective radiation dose for the outage was about 280 rem. The biggest radiological challenge we faced was the large number of workers we had during this outage. A few millirems times 1000 workers equals a lot of dose that we had to manage very closely. We had to make sure that the new nuclear workers coming on site met our high radiological standards, and ensuring that those workers maintained the standards took a lot of oversight and coaching. I think we did a good job with the radiological environment regarding the workers and their safety. It was a big challenge and it took a lot of planning, but we think it was well executed.

Under a full moon, a new steam generator is moved inside of the reactor building.

We are very proud of the safety performance during the outage. In addition to TMI personnel, we had about 3000 contract workers at the site during the outage, and there were no lost-time injuries, even though we did a significant amount of work. About 2.5 million person-hours were worked during the 90 days, with zero lost-time injuries. I think that's an excellent achievement, and it's something that we emphasize at Exelon.

Another goal was to complete all of the work that was needed to support the renewal of our plant operating license. Just before the outage, our license was renewed for 20 years by the Nuclear Regulatory Commission. A significant amount of the work that I previously described has set up the plant to operate until 2034.

*What was the total cost of the outage?*

The capital investment was about $350 million. That included the steam generator replacements, the cooling tower work, and other equipment upgrades, and is a significant investment in the future. That was probably the overriding theme of this outage: Exelon invested in TMI to significantly improve our plant reliability and safety margins, setting ourselves up for running our plant until at least 2034.

*Who were the major vendors for the outage?*

SGT, which is owned by Areva and URS, is the company that worked with us to replace our steam generators. Mammoet, a heavy-lifting company that subcontracted with SGT, is expert at lifting unbelievably large equipment. Areva partners with us to perform many of the welding activities and the reactor vessel refueling activities for our outages. And Shaw is our primary maintenance contractor here at TMI.

*What would you consider the outage's main successes?*

I mentioned the "no lost time" safety performance. I think that is huge. We want people to go home as good or better than when they came here each and every day.

In addition, we took more than 400 radiography test (RT) shots of new welds with no issues. Because of the large number of component replacements that we did concurrent with radiography inside of our containment, we had to perform multiple RT shots per shift. For that, we basically had to clear people out of portions of the containment building. But we had no issues with the number of radiographs that were performed during the outage. That was significant, and I've never heard of such success before in our industry. A radiography shot is an X-ray, but in some cases it involves an exposed 80-curie source. The coordination and planning associated with that, in parallel with all the work that was done, was really a significant effort.

*How many welds did you check using radiography?*

We had to check more than 300 welds. We had to cut out both steam generators and all the appendages from them, as well as other equipment. When we cut those welds out and then reapplied new ones, the ASME code required us to do either a pressure test or radiography. A pressure test is very difficult to set up and is a less efficient way to test the welds, so instead, we chose to do radiography.

We also had no plant restart issues following the outage. We had flawless performance from our operators and reactor services people in doing more than 1000 fuel assembly moves. That included defueling the reactor to our fuel pool and then refueling it after all the work was done, including changing the design of the fuel assemblies. All this work was done without a single human performance issue.

*Were there problems moving so many workers through the security process?*

Not at all, but it took a lot of focus and planning. It was the first time in our history that we had to bring 3000 people onto the site. We set up a parking area on the south side of the site and bused the workers back and forth between the parking area and the plant.

In all, the outage involved more than 19 000 work activities. To manage all the work activities, 350 additional computers and radios were installed and 63 trailers were set up outside the plant, with six buses to transport workers. With about 3000 workers, you can imagine the logistical planning that had to go into that. It was several years in the making.

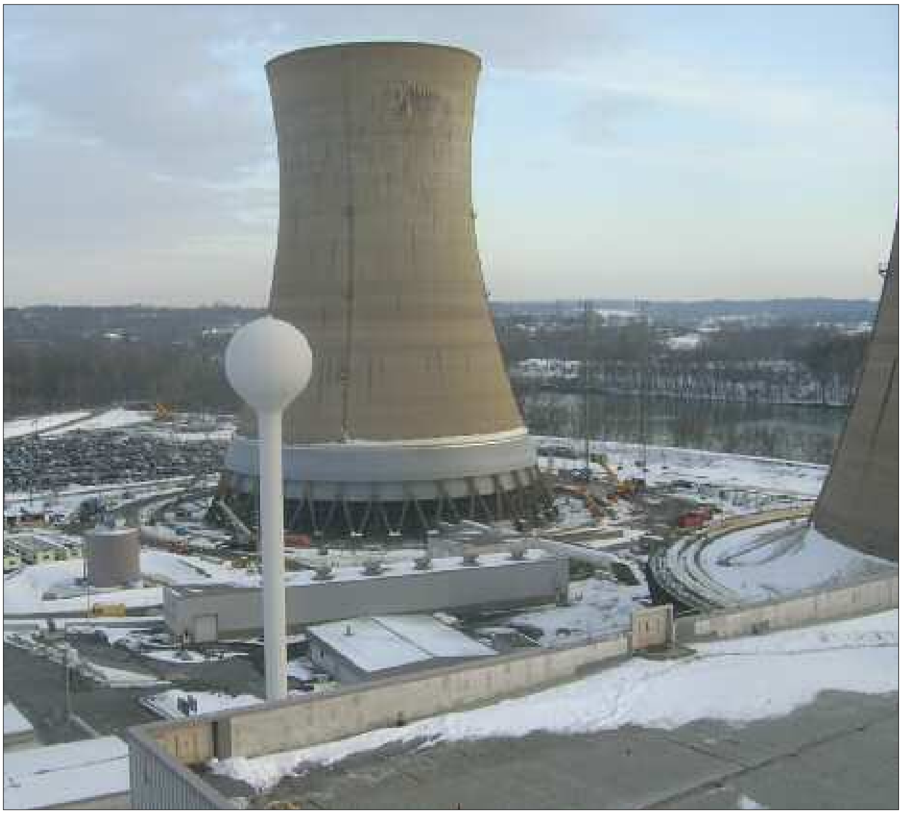
*What challenges were encountered during the outage?*

I would say that the number one challenge was integrating the large number of contract workers into our workforce, making sure they understood the high expectations we had and the high standards that are required when working at a nuclear plant. We found that for many of them, it was the first time they had worked at a nuclear power plant. That was a challenge—to have them experience what it was like to work here, to go through some of the processes that we have here that are unique to nuclear power.

These were mostly craft workers. I think what's happening in our industry right now is that the economy has hit a lot of workers. Now, when calls go out for outage workers, a lot more people are available in the shops than in the past, but many of them have never worked at a nuclear plant before. That presents some challenges with respect to training and getting them into the nuclear mindset.

*Were there other challenges related to the work that had to be done?*

A significant challenge involved the Alloy 600 replacements. I mentioned briefly that we had to mitigate PWSCC. When plants were first built years ago, we welded carbon steel to stainless steel. Over time, 20-something years later, in the environment of the water inside our reactors, PWSCC can occur. There can be microcracks in the welds themselves. It's not a safety issue, because we inspect the welds and if there is an issue, we have to grind out the welds and reweld them to make them 100 percent. But to proactively deal with that, many plants—TMI included—have developed a mitigation strategy using a couple of methods. One involves clamping both sides of the weld and squeezing like crazy. Through that squeezing process, the material structure of the weld is changed, preventing the occurrence of microcracking,



The drift eliminator on TMI-1's "A" cooling tower, which extended out about 30 feet all the way around the base of the tower, was removed during the outage. The plant's "B" cooling tower, of which part of the base can be seen at right in the photo, still has its drift eliminator in place.

and the weld is basically strengthened.

The other method involves grinding out a portion of the weld and putting a new weld material on it that is resistant to PWSCC. We did what is called an onlay weld—11 feet down inside a pipe—by employing a robotic welder using remote technology to access the area. This in particular was a 182-82 dissimilar metal weld (the 182-82 relates to a particular alloy that was in the original weld). What we did was cut back the 182-82 material and then apply a different material on top of it. We had some challenges associated with that welding process and learned a lot from it. I mention this only because I think that outage managers at other plants will want to know that using this unique welding approach on old welds that were placed during original plant construction can be somewhat problematic.

*Could you talk about the steam generator replacements?*

We had to cut a 23 ft × 26 ft rectangle in the side of our containment in order to move the steam generators in and out. We took out the cement to a depth of 3 feet and a few inches of steel rebar, and then cut through the steel liner. After we were done, we moved the old steam generators out of the building and moved the new ones in. We also had to install totally new cranes and heavy-lifting equipment with platforms to get the steam generators in and out. It was a real engineering feat, and SGT and the project team did a great job. It's probably the only time in my career that I'll see something moved quite like that.

*Was the opening in containment created with a water-jet cutter?*

Yes, it was. We had the water jet cut the outside of the concrete until we got down to the containment liner itself. We then cut through the containment tendons before cutting the liner using more conventional methods. Once the new steam generators were moved inside the containment building, the liner was put back in place and the concrete was replaced. Then the containment was pressurized, using 16 huge air compressors that were lined up outside the building. This was followed by a leak-rate test to measure the amount of leakage and ensure that we were within our design basis.

*Could you talk about the upgrade to the woodfill at the bottom of one of the cooling towers?*

There are two types of cooling towers—cross-flow and counterflow. After this outage, we now have one of each. The "A" cooling tower was converted from a cross-flow to a counterflow. The tower's exterior wood structure, which consisted of a drift eliminator—asbestos fill and spill ponds—is gone.

Both of our hyperbolic cooling towers are still here, but if you look at the base of one of them, you'll see that it extends out about 30 feet or so all the way around the entire circumference. That is the drift eliminator, and it looks like the head of an inverted pin. But the "A" cooling tower no longer has that because of the work we did during the outage. We removed the drift eliminator section altogether. And the fill of the cooling tower is all internal, making it a counterflow cooling tower now. It's much more efficient. We're going to get about 3 more megawatts in the summer from that design change.

Also, there's no wood to decay over time inside the cooling tower because the wood has been replaced by a fiberglass-composite–type material that requires less maintenance, is much more efficient, and sets us up for the lifetime of the plant. The new material, which is much more environmentally friendly, replaced 550 tons of nonfriable asbestos fill. It's a huge improvement for the site.

*How long did you plan for the outage?*

Planning for the steam generator replacement itself was done over a four-year period. Design changes were happening several cycles ago to prepare for that.

*What jobs were on critical path?*

Primarily, it was the steam generator replacement, which was the pacer for the outage. And the Alloy 600 work on the unique weld configuration was also critical path due to the difficulties encountered in applying the welds.

*Who were the leaders for the outage—individuals, departments, management?*

That's an interesting question. When plants get into an outage, each organization has leaders who step up and perform a different role in a plant. I've always said that every nuclear worker has three jobs—their normal "on-line" job, their "emergency response" organization job, and their outage job. We take leaders from each organization—operations, maintenance, engineering, and others—and we make them outage managers, so to speak. They lead special outage projects. So, the leaders of the outage are typically from across the organization. We think it's part of our normal operations to do an excellent job, not only on line but also when managing the outages. I think that's what sets Exelon apart: We insist on excellence in outage performance as well as during on-line performance. NN