THE *NUCLEAR NEWS* INTERVIEW

Dale Walling: Going digital at Comanche Peak

Ease of use, flexibility in application, and improved system performance are some of the benefits of digital I&C.

Nuclear power plants rely on instrumentation and control (I&C) systems for monitoring, control, and protection. Many of the systems in plants today in the United States are analog-based. As such, the primary concern with the extended use of these analog systems is the effects of aging, including mechanical failures, environmental degradation, and obsolescence.

Industries by and large have moved to digital-based I&C systems, and the nuclear industry is following suit. The advantages over analog systems are evident, as reported by the National Research Council's Commission on Engineering and Technical Systems (CETS) back in 1997: Digital electronics are essentially free of the drift that afflicts analog electronics, so they maintain their calibration better; they have improved system performance in terms of accuracy and computational capabilities; they have higher data handling and storage capacities, so operating conditions can be more fully measured and displayed; and properly designed, they can be easier to use and more flexible in application.

Work has started at the Comanche Peak nuclear power plant on changing out analog I&C components to digital systems. The project, which started with a feasibility study in 1998, is expected to continue until 2014. Challenges in the transition to digital I&C, according to CETS, will include the uncertainty inherent in introducing a new technology, along with the necessary shift by plant employees away from an analog knowledge base.

Walling: "The planning is complex, and I equate it to brain surgery."

Dale Walling, an electrical engineer, is manager of the digital upgrade project at Comanche Peak. He has been with the plant for 23 years, and has held several positions in engineering. His I&C background began at an architectural-engineering firm for which he worked before coming to Comanche Peak.

TXU Power operates Comanche Peak, in Glen Rose, Tex. The plant has two Westinghouse pressurized water reactors, each rated at 1150 MWe. Unit 1 started commercial operation in August 1990 and Unit 2 in August 1993. The two units are identical and share a common control room, which contains two control panels in horseshoe configurations that face each other.

Walling talked about the digital I&C upgrade project with Rick Michal, *NN* Senior Editor.

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Comanche Peak operators receive training on the new digital Turbine Generator Control System in the plant's simulator. The displays shown are the same as those installed in the actual Comanche Peak control room. (Photo: TXU Power)

How long has Comanche Peak's digital upgrade project been going on?

We started thinking about doing upgrades to our instrumentation and control equipment back in 1998, and the first step was to put together a feasibility study. To do that we teamed with a preferred equipment vendor and laid out the entire program before we got started. That means that we identified which systems we wanted to upgrade, when we wanted to upgrade them, the sequence in which we would upgrade, and how we would migrate the control room from the analog world to the new digital world—all of that was done in the feasibility study.

What happened after the feasibility study was prepared?

We launched into a pilot program in 2001, and we are still in it. Our first installation, which occurred in fall 2003, was our main turbine control system and main generator voltage regulator in Unit 2. The same installations were done to Unit 1 last spring.

From the time we started the project until the time we finished the first installation, a lot of planning took place before we could do an upgrade. The planning is complex, and I equate it to brain surgery. The I&C system is the nervous system of the plant. Extracting old equipment and putting in new equipment is not much different from brain surgery.

Can you quantify the number of digital upgrades you're doing and which parts of the plant will be upgraded?

We plan to upgrade the entire plant to the extent that it is cost-effective. Our current scope is in the neighborhood of 25 to 30 systems. We also plan to transform the control room to a cockpit-style configuration to take advantage of the inherent fault-tolerant features of the digital technology for improved operator performance.

How will your work plan be phased?

The work plan will consist of seven phases, starting with the first phase that began in 2001 and continuing on to the last phase—the end of the project—in approximately 2014.

Our pilot program was the first phase and consisted of replacing two systems—the main turbine control system and the main generator voltage regulator. During the first phase, we selected a small and straightforward scope dealing with analog systems and equipment that we had a lot of experience with. We felt that there would be a low risk in replacing those controls first because they are nonsafety systems.

The second phase is now in progress. It deals with main turbine and generator protection, which is a more complex part of the turbine generator system. This phase will implement the turbine trips and the reactor protection interfaces. As we work through the pilot program, we hope to learn a lot of lessons to carry forward for the subsequent phases.

Can you talk about a budget for the project?

Without mentioning specific numbers, I can say that it has been more expensive than we anticipated. The cost of the equipment is a relatively low percentage of the total cost. Most of our costs have been in the preparation work—the design, documentation, testing, training, installation, and commissioning. I think it is pretty consistent with what the industry is seeing for something like this.

Which vendors are you working with?

The strategy we have chosen is to stick with one vendor throughout the project. The reason for that is primarily for ease in training—one system, one set of software tools, one set of maintenance procedures, one set of spare parts across the whole upgrade cycle—as opposed to Vendor A here, Vendor

B over there, Vendor C for something else, and then having to have expertise in all the different systems. So, we chose a single vendor for the entire project. We think there will be significant advantages to that.

What kind of training is involved in an upgrade like this?

Training is probably the biggest part of the project, as a matter of fact. The installation, the hardware and software design, the wiring, and the connections are really the easy part. The hard part is preparing the plant for this change. When we think about the analog world, we think about analog components—transistors, capacitors, potentiometers, I&C technicians in the field with screwdrivers making adjustments and tweaking control systems by hand. In the digital world, all of that is done with software. There is a significant change in the jobs and responsibilities. The self-diagnostic capabilities of these systems make it very straightforward to do troubleshooting, but it's a computer technician now who is doing the troubleshooting as opposed to an I&C technician. It's someone sitting down at a work station with a set of software tools looking at what is going on with the system and identifying where the repairs are needed. It is a complete change in how we do maintenance.

We have installed software-based controls, so the operator can sit at a computer terminal and start up the turbine. That is a big change for the operators. Before that they would stand at the control board with switches and knobs and buttons to start the turbine. Now they are in a seated position with a mouse, clicking on various commands on the screen to do that same procedure.

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Obviously, there is a lot of training involved up front with the operators to get them ready for this change. There is a big investment in training and a lot of preparation for it. Using the Institute of Nuclear Power Operation's systematic approach to training, we first have to identify new tasks and then design our training around those new tasks. In some cases, we found that some of our I&C technicians did not have the necessary schooling to be able to adapt to this new environment, so we had them take some mathematics and science courses through a local university. It was necessary to give them some of the prerequisites they either did not have or had forgotten since they were in school as long as 30 years ago.

It goes both ways, of course. The trade schools and colleges today are not turning out the types of technicians who can work on the analog equipment that we now have in the plant. Instead, they are turning out people who can work on this digital equipment. That is a plus, of course, because when we recruit now, we are looking for engineers and technicians with some computer training who can come in and perform in this new digital world.

"We've done some studies and worked with our vendor to make sure that our system can migrate to future revisions—that is what we call forward compatibility."

Does your training encompass all plant departments or is it only for the operations department?

The training is for all departments in the plant. The college courses I mentioned were specifically for the I&C technicians in maintenance. We have other training tailored specifically to engineers.

As for the operations department, we're finding that it takes about three cycles of requalification training—three one-week training cycles—to give the operators what they need to be able to do their jobs after the new digital systems are installed. That's a significant investment and a significant lead time in the project. We found out that we needed to have our design done far in advance so that we can then effect the training that the operators need. That is a different training approach from what we have done in the past with the analog systems.

What about security of these digital control systems?

We have several barriers in place to prevent any cyber intrusion. The control system architecture is designed such that there is no direct connection to the plant LAN (local area network) or any outside connection through modems.

Have you planned for the eventual obsolescence of this new digital equipment?

Yes. One of the requirements we had when we evaluated the various vendors was what we call forward compatibility. A typical digital system installed in the plant consists of modules, cards, and components. Vendors will periodically upgrade those components through various revisions to improve performance of the system. What we wanted was to make sure that our installed system was compatible with those subsequent revisions. For example, if we now have Revision 0 installed for this system and then Revision 6 comes along in 10 years, we can pull out Revision 0 and plug in Revision 6 with minimal impact. We've done some studies and worked with our vendor to make sure that our system can migrate to future revisions—that is what we call forward compatibility.

How are I&C upgrades improving equipment reliability?

With the old analog equipment that we had for turbine controls, for example, we had three plant trips over a two-year period that were caused by component failures in the analog system. The new digital system that has been installed in Unit 2 for almost 16 months now and in Unit 1 for about 10 months has been rock solid. It is very predictable and stable, and the operators are much more comfortable with it. We have seen some significant improvements in turbine control stability since we did the installation, and there have been no plant trips due to turbine controls.

Are there cost advantages or other improvements in asset management practices when converting to digital I&C equipment?

There are a lot of advantages—on-line diagnostics being one of the most significant. We can sit down at a computer terminal and analyze our system, as opposed to having to open junction boxes and cabinets in the field and troubleshoot with voltmeters and ammeters. It makes the repairs much quicker and easier, and it means we can have a smaller staff to do it. The components are also very robust, and they have very high mean-time between failures—they seldom fail.

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In addition, the digital systems are inherently redundant. In other words, they have backup processors. If there is a failure of a processor, for example, we can take that processor off line and still keep the plant on line while we're doing the repairs, whereas with analog components, many times the unit would have to be shut down or the system would have to be shut down to effect those repairs. That makes the digital system much more beneficial from the standpoint of stocking spare parts. Now instead of needing to have a large inventory of spare parts, most of the parts needing repair can be fixed at a more leisurely pace, and we can get new parts shipped from warehouses around the country. We do not have to stock parts on the site, and we do not have to pay taxes on that inventory. Those are important advantages.

Are there hurdles to clear in upgrading to a digital system?

The biggest hurdles that we have had were in change management. We underestimated what it was going to take to prepare the plant for the digital upgrades—specifically, the amount of time required to prepare for training operators, engineers, and maintenance people. To some degree today, if we had a failure, we would probably have to call in the equipment vendor to help us make the repairs, because we are still learning about the system, and there is so much to learn. There is nothing that can replace experience, of course, and we simply underestimated the amount of time needed to train.

That was a valuable lesson that we learned. For anyone entering into this, make sure you understand what it is going to take to get your operators, maintenance technicians, and engineers trained and the plant ready to be able to work with this new technology.

When you first started the feasibility study, did you look at other plants that might have done this?

Yes, we did. We did benchmarking in Europe, primarily because no one in the United States had done what we wanted to do. There were a few plants in Europe that had done a complete I&C modernization program, but no one domestically had embarked on it. There were a lot of folks talking about it, but no one had actually done it. So, we benchmarked some European plants to see what they did. It was this benchmarking that led us to do the feasibility study before starting the project.

Comanche Peak was the U.S. trailblazer, then?

Well, we are out in front, but I'm not sure if we are the trailblazer. There are other plants that are doing upgrades, but I don't know of many plants that have committed to it to the extent that we have.

Comanche Peak is one of the newer plants in the United States, and yet it is undergoing such an extensive I&C upgrade. Why is that?

Actually, Comanche Peak is a newer plant by license, but it is about the same age as most of the nuclear plants currently operating in the United States. Our construction took a little longer, and we didn't actually receive an operating license until 1990. But we started construction in 1975, so the I&C components are original equipment and are about 30 years old.

What final bit of advice would you give a plant that is considering doing an I&C digital upgrade?

There is one thing, and that is to make sure you give yourself enough time to plan—that you get a good set of system requirements up front and that roles and responsibilities are clearly understood by the equipment vendor, the architect-engineer, and the installer. Make sure you have good relationships and communications with all of those partners, including the stakeholders in the plant—the operators and the maintenance technicians. If there was one single lesson we learned from our pilot program, that is it. Make sure you do a good job up front in planning what it is going to take to design, manufacture, test, install, and commission an upgrade. NN

The culture of digital I&C

Digital I&C means culture change, according to a consultant who has worked on I&C projects overseas and has studied how upgrading from analog systems will affect the nuclear power industry in the United States.

Lochner: U.S. nuclear plants should abandon "single platform approach."

Karl-Heinz Lochner, president and chief executive officer of KHL Consulting, LLC, in Alpharetta, Ga., said that nuclear power plants in the United States use many more written procedures to operate than do their European counterparts, and that changing the U.S. operating standard won't be easy. "In Europe, the automation level is higher and so it is part of the operating approach," he said. Upgrading to digital I&C "means more than changing hardware in the control room. When you are trained as an operator to always handle with procedures, you are very trained," he said. But once digital upgrades are completed, "now you have to believe the automation system and not believe so many of the written procedures. That is definitely a culture change," he said.

Lochner emphasized that it will also be important for U.S. nuclear plants to abandon their "single platform approach," whereby individual mechanical systems in the plant are operated by individual control platforms—such as one specific system for feedwater control and another specific system for turbine control—often based on cost factors. By contrast, he said, the European way is to have a "single common platform approach," meaning that one platform is used to control every mechanical system in the plant, with less emphasis on cost.

U.S. nuclear plants must also start preparing now for digital upgrading, even if development plans are still far in the future. "When you are not prepared, you create a very high expectation—what this system can do, and what you think you can do with this system," he said. Training sessions should be developed to help customers (plant managers and operators) understand what digital systems are in general and what they offer as far as advantages and disadvantages. The seminars should not be product-oriented, but instead should offer digital system information. Lochner, who assisted with the first phase of Comanche Peak's upgrade project, said that power generating plants in Europe developed training sessions in the late 1980s in preparation for their digital upgrading. "From experience, I think we need a similar approach in the U.S.," he said. "We have to prepare the management. We have to prepare the customer to make this big step."

Lochner concluded that moving to digital I&C without the proper knowledge would ultimately leave the customers stunned, like "jumping into cold water."—*R.M.*