because the decommissioning of the reactor and its buildings was done in large part to make room on the site for the plant's ISFSI. St.Onge said that the deadline to complete the ISFSI was 2006, and the decommissioning of San Onofre-1 began in 1999.

Despite the restrictions imposed by the physical space, St.Onge said, the management of the reactor vessel posed one of the biggest challenges to the project. Southern California Edison was unsuccessful in gaining the necessary permits to ship the reactor vessel to the Barnwell disposal facility in South Carolina. The vessel remains onsite, awaiting the decommissioning of Units 2 and 3.

St.Onge

Much of the Unit 1 decommissioning work, however, was done prior to the September 11, 2001, terrorist attacks, which made operations much simpler than they are today, St.Onge said. Waste haulers, for example, did not have to undergo as extensive a security check when driving in and out of the site.

Bruce Watson, of the NRC, closed out the special session with a discussion of the regulatory experience in the decommissioning of nuclear power plants. Watson, who is chief of the NRC's Reactor Decommissioning Branch, focused his talk on the agency's progress in revising its rules on reactor decommissioning, which Magwood had touched on in his plenary speech.

Watson

The new regulations are intended to improve the efficiency of transitioning from the operations phase of a nuclear power plant to the D&D phase. Currently, plant operators must seek license exemptions from the NRC as systems are shut down and fuel is removed from the reactor core after a plant is officially closed. According to Watson, under the current rulemaking schedule, the NRC will release the regulatory basis for the new rules in November of this year, with a proposed rule issued by 2018, and the new rule issued in 2019.

Robotics and Remote Operations

While facility owners and operators, contractors, and regulators all value the use of mature, proven technologies in conducting nuclear D&D, there are times when new technologies need to come into play. A prime example of that is in the inspection and maintenance of underground waste tanks at the Department of Energy's Hanford Site near Richland, Wash. The hazardous nature of the waste, along with limited accessibility, makes the tanks an ideal venue for specialty robots.

The technical session "Robotics and Remote Operations in Hazardous Facilities—III" explored some of the robotic systems being developed to inspect Hanford's AY-102 double-shell tank, which in 2012 was found to be leaking waste from its primary shell. Dwayne McDaniel, a senior scientist at Florida International University (FIU), detailed the university's development of a peristaltic robotic crawler to inspect the tank, accessing it through ventilation pipes.

According to McDaniel, the crawler will need to travel about 100 feet, crawling through pipes less than 4 inches in diameter while withstanding temperatures of around 170 °F and radiation of about 80 rad per hour. The crawler will be mounted with a camera and front and back grippers for collecting samples. A modular design is being used to allow the crawler to travel through the pipes and turn through any bends. Pneumatic actuators are used to create the peristaltic movement of the crawler.

McDaniel said that the crawler is currently being tested on a full-scale mock-up of the piping system and that future iterations of the crawler will include additional sensors and nondestructive examination capabilities.

Another remote-controlled inspection tool that FIU is developing for Tank AY-102 was introduced by Michael DiBono, an undergraduate student at FIU. Unlike the peristaltic crawler, the small, four-wheel rover DiBono is working on is designed to travel through the narrow refractory air slots beneath the base of the primary tank shell. The rover will need to access dimensions as small as 1.5 in. × 1.5 in. and will need to be capable of making 90-degree turns. Four motors—one connected to each wheel—allow the wheels to move independently in order to make the tight turns. To avoid traveling over debris, the rover uses magnets that allow it to roll upside down, clinging to the bottom of the carbon steel tank.

DiBono said that one of the challenges his team faced was in designing a cable management system that would both tether and remotely control the rover. The system had to let out cable easily enough to allow the rover to move without resistance, but to also be capable of precisely reeling in the cable to recover the rover. The team settled on a reel and winch system for the cable.

DiBono said that his team will explore an alternative design that will use only two wheels, allowing the design to be made even smaller.—*Tim Gregoire*