ANS WINTER MEETING

Crafting solutions to advance nuclear power

THE OPENING PLENARY session of the American Nuclear Society's 2009 Winter Meeting, held November 15–19 at the Omni Shoreham Hotel in Washington, D.C., featured 11 speakers, the largest plenary roster at an ANS meeting in years. Meeting attendance also surpassed the turnouts of other ANS meetings in recent memory—more than 1600 people had registered—bolstered by a strong showing of young nuclear professionals and college students. The theme of the meeting was "Nuclear Power: Crafting Energy Solutions."

ANS President Thomas Sanders welcomed the opening plenary's large audience, and then introduced Carl Rau, president of Bechtel Nuclear Power and general cochair of the Winter Meeting. Rau, whose company is a partner in UniStar Nuclear Energy's effort to build a new nuclear plant—Calvert Cliffs-3—in Maryland, ticked off a list of trends as they relate to the pace and direction of the industry. On the plus side, the capacity factor of the U.S. fleet of commercial reactors is "very, very positive," he said. Domestic nuclear plants have a combined 91.5 percent capacity factor, Rau said, compared with the 25 percent capacity factor each for wind and solar plants in the United States.

Rau

Among the less positive trends, however, is the high capital cost of building a new nuclear plant. With nuclear projects in the United States expected to cost $5 billion to $8 billion each, utilities are looking for suppliers and contractors "to take on more risks," he said. There is no question that the first new plants must "come in on time and on budget," he said. If they do not, it will pose "a threat to the renaissance."

Rau said that compared with the United States, the rest of the world is moving at a rapid pace. "Globally, there are 50 units under construction as we speak, and another 137 planned," he said. "Those numbers change on a daily basis." He noted that new plant announcements have more than doubled in the past year. "I can tell you that when I go to the office, I can expect a query from a new country just about every week," he said.

Those countries with sound energy policies and strategies are leading the renaissance, Rau said, and he challenged the audience—policymakers, regulators, those in academia and at the national labs, and technology providers—to determine their roles in supporting the renaissance in the United States and to ask themselves, "Are we doing enough? Are we doing enough fast enough? Can we do more collectively as a group?"

Following Rau was Warren "Pete" Miller, assistant secretary for nuclear energy at the Department of Energy. He introduced a prerecorded video presentation by Energy Secretary Steven Chu, who was out of the country at the time. Appearing on large viewing screens at the head of the meeting hall, Chu said, "Let me say clearly: President Obama and I are committed to restarting the nuclear industry in the United States."

Chu

He added that the DOE is working in various ways to promote nuclear power in the United States and around the world, including through loan guarantees that will help secure financing for new nuclear plant construction. Guarantees had not yet been announced for any nuclear projects, but Chu noted that a new solar power project had received one in March. "It was the first guarantee since the 1980s," he said. "Now we want to make the first nuclear loan guarantee as soon as possible." He added that he was "hopeful that the first conditional loan guarantees will be awarded this year [2009]."

Another DOE initiative to promote nuclear energy is "a robust science-based nuclear R&D program," Chu said, noting that the agency is currently pursuing Generation-IV reactors that will use advanced fuels, help improve safety and reliability, and possibly help burn down long-lived actinides.

Other avenues to promote nuclear power include the DOE's pursuit of new spent fuel processing methods to reduce proliferation risks (although Chu did not specify any of these new methods) and the development of small modular reactors that could be built and shipped as a single unit. "Ideally, these reactors should not need refueling for an extended period of time, and they may be America's best hope for reclaiming technical leadership in the nuclear industry," he said.

Continued

Meeting session coverage:

- *Reactor construction prospects, in the United States and elsewhere*
- *Efforts to advance small modular reactors*
- *Raising funds for decommissioning*
- *Education, training, and distance learning for the nuclear workforce*

Chu didn't comment on the administration's intention not to go forward with the Yucca Mountain repository project, but he did say that the DOE would help manage spent fuel and dispose of high-level waste. "I am optimistic that science can shed new light on this problem," he said. "There are reprocessing technologies that show great promise for energy recovery, cost reduction, waste reduction, and proliferation resistance." These technologies also went unspecified, but Chu said that the DOE should implement an aggressive research and development program to explore and develop them. He also mentioned the blue-ribbon panel to be commissioned by the administration to conduct a comprehensive review of the back end of the nuclear fuel cycle. The panel members had not yet been named, at least publicly, but Chu said that he looks forward to the panel's recommendations on a number of issues.

Chu also noted that President Barack Obama had called for a new framework for civil nuclear cooperation that would give all countries access to peaceful nuclear power without the risk of proliferation. He said that the framework should comprise "a broad and diverse group of countries, including current and prospective nuclear power users."

"To achieve our goals, we must educate the next generation of nuclear scientists and engineers, and the Department of Energy will continue to be your partner."

Chu concluded his recorded remarks by saying that the DOE will continue to support its nuclear energy university programs. "ANS has always been a strong supporter of nuclear education," he said. "Today, enrollments in nuclear university programs are on the rise, in large part due to your shared efforts. To achieve our goals, we must educate the next generation of nuclear scientists and engineers, and the Department of Energy will continue to be your partner."

Miller then explained a "road map" that his office is completing that focuses on characterizing nuclear energy's role in meeting the administration's objectives. The goals: to extend the lifetimes of the existing reactor fleet, enable new plant construction and improve the affordability of nuclear energy, reduce the carbon footprint of the transportation and industrial sectors, develop a sustainable fuel cycle, and understand and minimize proliferation risks.

Before getting to brief explanations of each of the goals, Miller noted that studies project that between 100 and 200 GWe of new nuclear generating capacity will be needed over the next 30 years in order to meet the nation's energy and environmental goals. Reaching this target, he said, will require a massive building effort on the order of what occurred during the 1970s and 1980s, and it will demand an investment in the long-term safe and reliable operation of the existing nuclear fleet and a robust long-term energy R&D program.


Miller

Returning to his discussion of the administration's goals, Miller said that regarding the lifetime extension of the existing nuclear fleet, the DOE and the Electric Power Research Institute have been working on a research effort aimed at deciding whether to operate the fleet for more than 60 years. The research is focused on the aging of systems and on structures and components, long-term fuel reliability and performance, obsolete analog instrumentation and control technologies, and out-of-date design and safety analysis tools.

Regarding the second goal—enabling new construction—Miller noted the DOE's Nuclear Power 2010 program, which began about seven years ago as an industry-government cost-sharing partnership aimed at reducing the financial and regulatory risk associated with building advanced light-water reactors. The program is in its last year, Miller said, and it has done "a very nice job in helping exercise regulatory processes to clear the way for new reactor builds, six to eight of which will hopefully happen by 2020."

Miller also commented on the prospects of small modular reactors, saying that they "represent an opportunity to improve U.S. manufacturing capabilities and build a new generation of nuclear power plants that are 'made in the USA.'"

Regarding the development of a sustainable fuel cycle, Miller echoed what Chu had previously stated about the DOE's working on an R&D program to significantly improve the management of spent fuel, including possibly extracting much of its remaining energy value. He said that the program will be "refocused" on science-based, goal-oriented R&D that integrates theory, experiment, and high-performance computing.

Miller said that the DOE has "defined an agenda that will support the nuclear industry now and well into the future. Our role in government is to help address technical, economic, and regulatory risk so that industry can move forward and meet the energy needs of our nation."

Moving forward

Moving the industry forward through governmental assistance was the subject of Sen. Jeff Bingaman's talk. Bingaman (D., N.M.) said that members of Congress were currently addressing the new-build issue, specifically through the Nuclear Energy Research Initiative Improvement Act of 2009, a Senate bill introduced on October 28 by Sen. Mark Udall (D., Colo.) that seeks to promote research into cost-effective construction. Bingaman said that he was planning to introduce a second bill, to complement Udall's, that would require the energy secretary to develop and demonstrate, in partnership with the private sector, two designs for small modular reactors, each less than 350 MWe. Under Bingaman's bill, the DOE would help demonstrate the ability to license these reactors by funding applications to obtain design certification by 2018, and to obtain a combined construction and operating license (COL) for each of the designs by 2021. "Having certified and licensable designs for small modular nuclear reactors would be a significant boost to the field of nuclear power, and would help nuclear energy be a cost-effective contender for a broader array of carbon-free electric generation needs in the future," he said.


Bingaman

Bingaman also commented that a current barrier to building new nuclear plants is the manpower issue. "The National Commission on Energy Policy, working with Bechtel, has estimated that to design and build a single 1000-MWe nuclear plant will require about 4785 man-years of engineering work and 9575 man-years of skilled trades work," he said.

He also said that the cost of new construction "is giving many who might finance these plants some pause." For example, Finland's Olkiluoto-3 reactor project is now $3.3 billion over its original cost estimate of $4.3 billion, with a project delay now exceeding three years. Also, Florida

Power & Light Company has disclosed that building two units totaling 2614 MWe would cost between $12 billion and $18 billion, or roughly $4600 to $6900 per kW; and Progress Energy has estimated that building two units totaling 2380 MWe would cost $17 billion, or $7100 per kW.

Sen. Pete Domenici (R., N.M.), who retired in 2009 after serving for 36 years as a U.S. senator, wondered why an issue was being made of what to do with spent fuel. "I, for one, believe what the world and America will do with the waste is not as difficult as we are making it," he said. "Sound and solid science and engineering will show us a way to save huge amounts of energy from the residue about which we are now worrying. From what we have left over, we can find a way to put it into repositories and build safe places for its capture for hundreds and hundreds, if not millions, of years."


Domenici

Domenici said that he is an optimist, and that as such he believes that the nation should stop talking about the difficulties of dealing with spent fuel and start talking about solutions—"if America just wants to."

But America may not want to, said Rep. James Clyburn, (D., S.C.), the House majority whip, who said that he is "an ardent supporter of expanding our country's nuclear capacity." Clyburn said that while the nuclear waste challenge is a serious one, current technologies will allow for solving the problem of what to do with it—if the nation develops the will. "The thing that stands in our way is that we have not developed the will," he observed.


Clyburn

Clyburn said that when conferring with colleagues in the House, he has a response for those who are nuclear skeptics: "We simply will not solve the issue of climate change without your renewed commitment to nuclear energy." His opinion is shared, he said, by the administration's "energy czar," Carol Browner, who recently told Clyburn that it is "inconsistent to be *for* solving climate change and *against* nuclear power."

Clyburn said that his advocacy and support for nuclear power comes down to three things: "Jobs, jobs, and jobs." A nuclear renaissance in the United States would constitute an economic stimulus all by itself, he said, adding that to date, the recent growth of the domestic nuclear energy industry has created at least 15 000 jobs, with many more on the horizon. These jobs are in fields such as engineering and design and in the manufacturing of fuel rods and assemblies, pumps, motors, and circuit breakers. Clyburn said that he has seen estimates that the nuclear power industry will create as many as 350 000 jobs over the next 20 years, many in traditional building trades that have been hit hard by global competition and the current economic downturn. "And if we do it right, we can bring many manufacturing jobs back to the United States and build the reactors from parts made here rather than overseas," he said. "The American people are counting on us to deliver," he declared. "The stakes have never been higher, but neither have the expectations."

Clyburn said that his advocacy and support for nuclear power comes down to three things: "Jobs, jobs, and jobs." A nuclear renaissance in the United States would constitute an economic stimulus all by itself.

Gregory Jaczko, chairman of the Nuclear Regulatory Commission, when addressing the topic of new reactors, tweaked the industry by stating that none of the applicants that had submitted requests to the NRC for new-build licensing were following 10 CFR Part 52's licensing process as it was envisioned. (He added, however, that there is no requirement to follow Part 52 as envisioned.) This has resulted in "less predictability in the review process because [the NRC is] doing the environmental reviews, the design reviews, and the COL reviews simultaneously rather than in sequence," he said.


Jaczko

Jaczko noted that the NRC is currently reviewing three design certification applications, two design certification amendments, and 13 of 18 COL applications that have been docketed. "The NRC is prepared for this work," he said. "We have a good new reactor licensing process and an expert, dedicated staff that knows how to review license applications."

Since 2000, the NRC has completed the reviews of 30 license renewal applications, and it currently has 13 license renewal applications under review. Since 2007, the NRC has completed the reviews of four early site permit applications, and, since 1997, has completed four design certification reviews, he said.

A big challenge, however, is the lack of responsiveness by applicants to provide information to the NRC. "In the past," Jaczko said, "this lack of responsiveness has taken two forms: poor quality responses to staff questions that require re-asking questions, and late responses to staff questions."

Another challenge, he said, is presented when significant modifications are made to applications that are unrelated to questions being asked by the NRC's staff.

"So, if there are three things I ask of applicants and vendors on the topic of new reactors, it is to give us high-quality and complete applications, provide sufficient and timely responses to staff questions, and follow the process we have established to review them," he said.

Jobs and labor

Looking at the employment side of the renaissance was Mark Ayers, president of the Building and Construction Trades Department of the AFL-CIO. Ayers, who was cochair of the Winter Meeting along with Rau, revealed that the building trades unions and the North America Contractors Association had signed the Nuclear Construction Agreement, which contains provisions designed for the nuclear industry as it prepares for new builds.


Ayers

Ayers noted that under the agreement, which was endorsed by the Nuclear Energy Institute, multicraft training centers would be established at or near new plant sites. In addition, traditional union apprenticeship parameters would be rearranged so that the apprentices would arrive on the job with productive skills starting on day one. Also, special training partnerships with vendors and suppliers would be developed in order to certify all workers for the installation of components. Ayers added that the development of innovative programs to train local workforces for in-house careers

in the nuclear industry after construction is completed is also being considered.

Even as all of these manpower and construction initiatives are moving forward, Ayers said, it is "utterly perplexing and disconcerting" for the unions to see that some in the nuclear industry "thumb their noses at us and court a low-road approach for construction services." He said that to use nonunion labor to build new nuclear plants would "poison what we believe today is a healthy and mutually beneficial relationship. For this industry to realize success in the long run, it will take two to tango and two to succeed."

"If climate change and low-cost reliable energy are national imperatives, we shouldn't stop building nuclear plants and start subsidizing windmills."

UniStar Nuclear, a Constellation Energy and EDF company, is planning to use union labor to build the new Calvert Cliffs-3 nuclear plant (when the time comes). Michael Wallace, vice chairman and chief operating officer of Constellation Energy, said that he approached the unions over a year ago to discuss a construction partnership for the construction of Calvert Cliffs-3.

Wallace

Wallace expressed his appreciation to Ayers and other labor leaders who have worked the halls of Congress drumming up support for the nuclear industry, and he said that the construction of a new plant would bring 4000 jobs that would contribute about $2 billion annually in local economic benefits. "Nominal seven-year pre-construction and construction is almost a $15-billion stimulus to the local economy around a job site," he said. "And then there are the permanent jobs that go forward. Those numbers obviously don't take into account the manufacturing sector and the benefits that come from that."

To move the Calvert Cliffs-3 effort forward, he said, nearly $800 million has been spent by UniStar and partner company Areva, and more than 800 people are working on the project. Wallace stressed that "zero government funding has brought us to the point where we are today, but we're hitting a very, very critical point, and it has to do with the biggest risk we face of all: It is the financial structure to move a private merchant project forward."

What is needed at this point, he said, is "a workable federal loan guarantee program," and added that when the Energy Policy Act of 2005 was passed, the conservative thought was that the program would help UniStar finance the project within two years. Almost five years later, however, there is still no loan guarantee.

Wallace also noted that a loan guarantee, if it were to come, would have to be "agreeable and workable" regarding the fee paid by the entity receiving it. "The cost of the guarantee has got to be reasonable," he said. "One percent of total loan value is what we deem reasonable. An 8 percent subsidy cost is simply not workable."

Wallace also said that he would like to see the number of guarantees increased. "Greater guarantee volume is needed because it's not one, two, or three nuclear plants that need to move forward, it's six, and then nine, and then a dozen," he said.

Closing out the opening plenary were Sens. Lamar Alexander (R., Tenn.) and Jim Webb (D., Va.), who, in separate speeches, explained the bill—the Clean Energy Act of 2009—that they planned to introduce to the Senate (and which they subsequently did) on November 16 to add $100 billion to the DOE's loan-guarantee authority for new nuclear power projects.

Alexander

Webb

Alexander then touched on the jobs issue, saying that according to DOE estimates, 250 000 construction jobs would be created to build 100 new nuclear plants. By comparison, he said, 73 000 jobs would be created to build the 180 000 wind turbines that would be needed to produce 20 percent of the nation's electricity (which is nuclear's current share).

There really is no fair comparison between nuclear and wind power, Alexander said. "Think of it this way: If we were going to war, we wouldn't mothball our nuclear navy and start subsidizing sailboats. If climate change and low-cost reliable energy are national imperatives, we shouldn't stop building nuclear plants and start subsidizing windmills," he said.

Webb added that the Clean Energy Act of 2009 would call for the creation of five "mini-Manhattan Projects" in order to make advanced clean energy technologies effective and cost competitive. The five projects, which would receive a combined $750 million per year for 10 years, would focus on R&D efforts for spent fuel recycling, clean coal, advanced biofuels, advanced batteries, and solar power.

Finding the right size

The acronym SMR has lately been used to mean both "small and medium-sized reactors" and "small modular reactors." The meanings of the two phrases clearly differ, but they can also be thought of as overlapping. For the purposes of the ANS President's Special Session, SMR can be taken to carry both meanings, generally encompassed in a third phrase used in the session's title, "Global Opportunities for Right-Sized Reactors."

ANS President Thomas Sanders opened the session by introducing Mary Saunders, deputy assistant secretary for manufacturing and services in the U.S. Commerce Department's International Trade Administration. She spoke on the department's Civil Nuclear Trade Initiative, an interagency body involving the departments of Commerce, Energy (including the National Nuclear Security Administration), State, and Defense, as well as the Nuclear Regulatory Commission, the U.S. Export-Import Bank, and other federal agencies. The initiative is to include an industry advisory committee, but Saunders said that no one has yet been appointed to this body.

Sanders

Saunders

Saunders said that there is interest in SMRs in China and India, which are also pursuing larger reactors. She noted that U.S. missions for nuclear trade were scheduled for December in India and the United Arab Emirates, and similar missions may be sent later to Italy, Vietnam, Egypt, the Czech Republic, and the Baltic countries.

The next speaker was Ayman Hawari, a professor of nuclear engineering at North Carolina State University and the commissioner for nuclear reactors on the Jordan

Atomic Energy Commission.

Jordan is one of the comparative have-nots of Southwest Asia in that it does not have the abundance of petroleum that the Arabian Peninsula has. Hawari said that 25 percent of the country's national budget is spent on energy imports. Jordan has some uranium deposits, so the introduction of nuclear power could allow for the use of some domestic fuel resources. Uranium extraction could begin in 2012.

Hawari did not state specifically that Jordan would prefer SMRs over the reactor models now on the market, but the country's electricity usage is at the level sometimes cited by SMR advocates when they refer to such reactors as "grid-appropriate." The total load now is about 2500 MWe, and the grid has connections to Egypt and Syria. Hawari said that demand is expected to be 12 000 MWe in 2037.

Whatever reactor models or sizes are eventually employed, Jordan is clearly taking steps toward a broad-based civil nuclear program. Hawari said that a synchrotron light source is being established in Jordan as a regional facility and that plans call for a contract to be signed in 2010 for the establishment of a research reactor. He noted that the government has signed a pre-construction phase contract with the consultancy Worley Parsons as part of its approach to nuclear electricity. Also, he said, cooperative agreements have been signed with Canada, France, Russia, China, and the United Kingdom, and a memorandum of understanding has been signed with the United States and an agreement is under negotiation. Hawari said that Jordan hopes to have a power reactor on line by 2018.

Japan already has a highly advanced nuclear program and almost 50 GWe of large light-water reactors already in service, so introducing a relatively small amount of nuclear power to a modest grid is certainly not an issue. As part of its transition toward a fully connected fuel cycle, however, Japan is looking at other reactor models, both to optimize resources (starting with mixed uranium-plutonium oxide fuel) and to reduce fossil fuel consumption (by bringing nuclear power into applications such as industrial process heat). Shunsuke Kondo, chairman of the Japan Atomic Energy Commission, said that design studies and research and development are being carried out for a variety of SMRs, including Toshiba's 4S and CCR, Mitsubishi's IMR, Hitachi's DMS, and the HTTR for process heat.

Gustavo Alonso, head of the Department of Nuclear Systems at ININ, Mexico's nuclear research agency, said that the country's sole electric utility, Comisión Federal de Electricidad (CFE), has plans to raise the nuclear share of Mexico's installed capacity from the current 2.7 percent (the two-unit Laguna Verde plant) to 12 percent. This would require about 11 GWe of new power reactors—an uncertain prospect because, as Alonso put it, "the decision is highly political." CFE, and also the national oil company PEMEX, are interested in small reactors for cogeneration and possibly to provide heat for the extraction of petroleum from otherwise uneconomical sources (as is also being considered in western Canada). Alonso said that seven states in Mexico have a "water deficit," raising the possibility of using SMRs for desalination. He added that there is interest specifically in South Africa's PBMR, the pebble-bed modular gas-cooled reactor, for which prototype construction has not yet begun.

Evgeny Velikhov, president of Russia's Kurchatov Institute, used his presentation as an appeal for the United States and Russia to form a new joint venture to develop and deploy what he called a moderate capacity nuclear power plant (MNPP). The two countries would market the system jointly to customers, who would receive the energy produced by the plant but would not have access to its technology. Velikhov noted that Russia is already working both on smaller reactors and on some degree of modularity with the ship-based reactors now being built (one in Pevsk, for service in 2012; one in Chersky, 2013; two in Kamchatka, 2013–2015; and three for the Yamal Peninsula, in the same time frame). He cited General Electric's PRISM and Westinghouse's IRIS as options for development into the MNPP.

During the later question-and-answer period, Sanders asked Velikhov whether all materials from the MNPP would be returned to Russia when decommissioned.

Continued

A gathering of bloggers

An unofficial session was held by nuclear bloggers attending the ANS Winter Meeting. Like the nuclear industry in general, the bloggers wrestle with the problem of getting their messages out to the public.

These bloggers generally are skilled communicators who are passionate about nuclear technology. It shows in the depth of their coverage of industry issues, from Dan Yurman's piece on the nuclear renaissance and small reactors at his blog site, Idaho Samizdat (<djysrv.blogspot.com/>), to Rod Adams's article about efficiency improvements and cost-reduction efforts related to uranium enrichment on his Atomic Insights blog (<www.atomicinsights.blogspot.com/>), to John Wheeler's comments on the media's misinterpretation of a tritium incident at a nuclear power plant in India at his Web site, This Week in Nuclear (<thisweekinnuclear.com/>).

More than 40 people attended the session, which was organized by Yurman, Adams, Wheeler, and the Nuclear Energy Institute's Dave Bradish, and sponsored by Areva and the Cool Hand Nuke Web site (<www.coolhandnuke.com/>). Using an open-dialogue format, the bloggers and others in attendance shared their experiences in the use of the new social media, including blogs, Twitter, Facebook, and other online tools and services. The discussion touched on issues such as the Department of Energy's ill-fated Yucca Mountain Project, the DOE's loan guarantee program, and the rhetoric of antinukes who connect commercial nuclear power to nuclear weapons.

Many attendees commented during the session. Lisa Stiles, project manager of workforce planning for Dominion Resources Services, related a story about how Twitter was used in an effort to frustrate noted antinuclear author Helen Caldicott during a book tour. Stiles related that nuclear engineering students sent out "tweets" about Caldicott's planned visits to various universities, and students flocked to Caldicott's appearances to question her about the nuclear misinformation in her book. Eventually, according to Stiles, Caldicott stopped taking questions from the audience during her book tour.

Bradish, a blogger on NEI's site (<neinuclearnotes.blogspot.com/>), related a similar tale. He said that he had used a four-part blog post to rebut Amory Lovins's essay about Stewart Brand's new book, *Whole Earth Discipline: An Ecopragmatist Manifesto,* which includes a chapter on nuclear energy. Bradish noted that Lovins "shovels data" at his opponents while at the same time supporting his argument by cherry-picking the information he needs. Bradish said that the result, as Yurman wrote in a recent blog about the session, is that the reader doesn't have a context in which to logically question what Lovins writes.

Yurman stressed, and others agreed, that a good way to get reasonably good readership for a blog is to post it on The Energy Collective (<www.theenergycollective.com/TheEnergyCollective/>), a Web site for bloggers that carries the tag line "Power. Policy. Climate. The conversation happens here."

Among those in attendance at the session were William Tucker, the author of *Terrestrial Energy*; Nancy Roth, of *Fuel Cycle Week*; and Laura Hermann, of Potomac Communications.—*R.M.*

Velikhov affirmed that in this proposal, not only spent fuel but all materials would be returned to Russia.

Cleanup notes

The session titled "Future of Decommissioning Funds" touched on a variety of topics related to the cleanup of nuclear sites.

Corey McDaniel, legislative director for Sen. James Risch (R., Idaho), explained that Risch was once the governor of Idaho and thus has had to deal on a state level with radioactive cleanup, specifically at the Department of Energy's Idaho National Laboratory (INL). The site is contaminated with waste generated from World War II–era conventional weapons testing, government-owned research and defense reactors, laboratory research, and defense missions at other DOE sites.

The Idaho Cleanup Project—a seven-year, $2.9-billion effort to decontaminate and dismantle the site—is funded through the DOE's Office of Environmental Management. Its focus is on reducing risks to workers, the public, and the environment and on protecting the Snake River Plain Aquifer, the sole drinking water source for more than 300 000 residents of eastern Idaho.

Scheduled for completion in 2012, the cleanup project involves treating 1 million gallons of sodium-bearing waste, removing transuranic waste from subsurface disposal, and demolishing more than 200 structures, including reactors, spent-fuel storage basins, and laboratories used for radioactive experiments.

About $470 million from the American Recovery and Reinvestment Act of 2009 (ARRA) stimulus package was targeted for cleanup work at INL. As a result, more than 250 cleanup jobs have been retained and another 250 jobs created, McDaniel said. ARRA funding will be provided for the cleanup work for up to three years. After that, the amount of funding is yet unknown, according to McDaniel. "Specifically, on the cleanup issue, I'm hopeful we can work this out," he said.

Commenting on the funds that have been set up by nuclear utilities for decontamination and decommissioning (D&D) work at nuclear power plants, McDaniel said that difficulties in market conditions have affected the investments of those reserves. Because of the stock market decline from fall 2008, decommissioning funds have suffered a decline in equity. The market slump may have left some nuclear D&D funds underfunded, he said, and they may have difficulty correcting to adequate levels. "Obviously, the stimulus hasn't done anything about that," he said. "When the economy recovers, hopefully the decommissioning funds will [recover] as well."

The issue of D&D funding shortfalls has been discussed on Capitol Hill, he said, but at this point not a lot is going on. "There are so many things in the stimulus that are being fixed, and this is not one of the things that's come up," he said.

Thomas Magette, a senior vice president for EnergySolutions, talked about the confusion that can result when D&D funding is at issue. In 2008, he said, Duke Power wanted to use some of the funds it had set aside to dispose of eight retired steam generators that were stored at a plant site. The Nuclear Regulatory Commission, however, disallowed the use of the funds until the site itself was permanently shut down, even though Duke had collected the money specifically for steam generator disposal. Magette said that this decision by the NRC seems to run contrary to its own rules, which define steam generator disposal as a decommissioning activity.

Magette warned utilities to use caution when reporting to the NRC about how they plan to use decommissioning funds. For example, $100 million put into a fund for spent fuel disposal must be reported as exactly for that purpose, or the NRC will consider it part of the decommissioning fund, which would make it ineligible to be used on spent fuel. "You'll have to go out and find another $100 million somewhere else," he said. "So, be careful."

Magette said that he had tried to correct this disconnect within NRC regulations by submitting a proposed rulemaking, but his attempt was unsuccessful.

He also said that in some instances, state approval is needed for decommissioning work. For example, at a Duke plant in North Carolina, the North Carolina Utilities Commission would need to issue approval for D&D work to proceed. On the other hand, he said, if Duke wanted to do the same thing at one of its plants in South Carolina, state approval would not be needed. This would be the case even if some of the funds used to dispose of the South Carolina–based steam generators were collected from ratepayers in the state of California, where the South Carolina-generated power was sold. "As you can see, these things are complicated," he said.

Jack Surash, deputy assistant secretary for acquisition and project management in the DOE's Office of Environmental Management, noted that the agency's nationwide effort to clean up the environmental legacy from the nuclear weapons development program and from other nuclear energy and research projects is "essentially the largest program in the world."

Surash said that $6 billion in stimulus funding went to DOE cleanup jobs at 17 sites. Some of those sites and the funds allotted were the Hanford Site, $1.6 billion; Idaho National Laboratory, $468 million; Argonne National Laboratory, $99 million; Portsmouth, $118 million; the Savannah River Site, $1.6 billion; Oak Ridge National Laboratory, $755 million; and Los Alamos National Laboratory, $212 million.

The funding went largely to soil and groundwater cleanup, solid waste disposition, and facility D&D. "The great thing is that some of these were things we were really ready to do," he said. "We just didn't have the funding."

Surash added that by the end of September, almost 99 percent of the $6 billion had been put under contract for the cleanup work, and that by the end of October, 12 700 jobs had been retained or created because of the ARRA funding.

The agency's nationwide effort to clean up the environmental legacy from the nuclear weapons development program and from other nuclear energy and research projects is "essentially the largest program in the world."

Providing insight into cleanup work at a specific DOE site was Dennis Ferrigno, site manager of the Paducah Remediation Project in western Kentucky. The Paducah site was part of the Kentucky Ordnance Works, a World War II–era munitions plant. In October 1950, the Atomic Energy Commission picked the site for the second of three planned uranium enrichment plants. Construction began in 1951 and was completed in 1954 at a cost of $800 million. The first enriched uranium was shipped in 1952.

During the 1970s, the federal government upgraded or rebuilt substantial portions of the facility at a cost of $600 million. The DOE operated the plant until the Energy Policy Act of 1992 created the United States Enrichment Corporation (USEC) to take over the Paducah plant and the one in Portsmouth, Ohio.

The Paducah site today consists of 3420 acres with lease/license agreements in place for USEC (for the operating area of the

plant) and the West Kentucky Wildlife Management Area, which borders the plant on three sides. Ferrigno said that the cleanup site consists of about 2500 acres.

So far, the cleanup has resulted in nearly 830 000 ft^3 of waste being packaged in 160 storage containers. For comparison, Ferrigno said that a nuclear power plant typically produces about 30 000–40 000 ft^3 per year of material waste that goes to a low-level waste disposal facility or to some other site. He said that the amount of material that has been shipped off site from Paducah would cover a football field to a height of 20 ft. "That's not a small amount of material," he said.

In comparison with the large sites—and large amounts of funding—discussed by some of the previous speakers, Ferrigno noted, the Paducah site is relatively small. With an additional $78 million in ARRA funding over a nine-month period, he said, "This is a good example that even a little site can be impacted by some of these programs in a favorable way. We see an opportunity to accelerate some of the work and train some of our folks."

New construction, old extension

The technical program at ANS national meetings frequently includes a session on prospects for new reactor construction, sponsored by the Operations and Power Division's Committee on New Construction. In introducing this session at the Winter Meeting, the session cochair, ANS past President Ted Quinn, showed a curve indicating that the costs of an nth-of-a-kind reactor would be 55 to 70 percent of that of the first-of-a-kind, suggesting that once the first few reactors can get through licensing and construction, the process ought to be much easier for those that come later. The first speaker at the session, however, had at least as much to say about existing reactors—and about keeping them in service—as he did about reactors that have not yet been built.

Richard Reister is the director of the Light Water Reactor Sustainability Program in the Department of Energy's Office of Nuclear Energy. Part of the program's mission is to explore the possibilities for operating reactors—more than half of which have already had their licenses renewed to allow a total of 60 years of operation—to continue in service beyond the 60-year mark.

Reister cited a projection by the DOE's Energy Information Administration that electricity demand in the United States will increase by 24 percent between now and 2030, and carbon dioxide emissions will rise by 296 million metric tons by then if fossil fuels are not substantially replaced by other means of electricity generation. The expected arrival of four new reactors per year would roughly double U.S. nuclear capacity (to around 200 GWe) by about 2030, but after that, nuclear capacity would roughly level off—even with four more reactors coming on line every year—because of the retirement of operating reactors. If the operating reactors' licenses are renewed again—for as many as 80 years of operation each—national nuclear capacity would rise to about 300 GWe in 2050.

The DOE's sustainability program is working to develop the scientific basis for extended operation and the technical and operational improvements needed to ensure the reactors' economic viability. Reister said that the scope of work includes materials aging and degradation, risk-informed safety margin characterization, efficiency improvements, advanced fuel development (with silicon carbide cladding offering potential safety improvements over zirconium), and advanced instrumentation and controls. He also noted the various issues with cooling water for both existing and new reactors—such as the availability of water as more plants are built, and the need for plant operations that will release effluent at temperatures that are environmentally acceptable.

As for the DOE's involvement in new reactors, Reister said that the first round of loan guarantees are "in the works" and are "making progress," and that there is talk in Congress of more loan guarantees. He said that while Nuclear Power 2010 accomplished a great deal, no licenses have been issued (an original goal of the program) and uncertainties remain regarding plant cost, worker availability, spent fuel disposition, and unproven aspects of the licensing process, such as inspections, tests, analyses, and acceptance criteria (ITAAC).

David Matthews, director of the Division of New Reactor Licensing in the NRC's Office of New Reactors, summarized the status of applications for combined construction and operating licenses (COL) and early site permits (ESP) already in the pipeline and yet to be submitted. Based on what he has been told by forthcoming applicants, he projected that five new ESPs were on the way: one for Exelon's Victoria site in Texas (formerly a COL application, to become an ESP in 2010), one from Public Service Electric and Gas (2010), two from applicants not yet willing to be disclosed (2012 and 2013), and one, at an unspecified date, from a consortium calling itself the Southern Ohio Clean Energy Park Alliance, whose members include Duke Energy, Areva, and USEC Inc. and whose goal is to develop a U.S. EPR at the former Portsmouth Gaseous Diffusion Enrichment Plant.

Matthews

Matthews said that the NRC is allocating resources to respond first to projects in which the applicants seek to load fuel in 2016 to 2017.

Another possible ESP is the Blue Castle Project, currently listed as a COL application expected in 2010, but which Matthews believes might become an ESP instead. The other forthcoming COL activities Matthews expects are a resumption of the slowed-down Nine Mile Point-3 (2010), two applications from undisclosed parties (one in 2010–2011, the other in 2011–2012), a second application from Southern Nuclear (2012), and another undisclosed application at an unspecified date.

Matthews noted the suspended status of Entergy's Grand Gulf-3 and River Bend-3, adding that from what he has seen, AmerenUE's application for Callaway-2 has been canceled, although it is still officially listed as suspended. He also showed the current budget figures for the NRC, which indicate that new reactor activity takes about one-quarter of the agency's money, and added that he expects the budget to stay at the same level for the next several years.

Matthews said that the NRC is allocating resources to respond first to projects in which the applicants seek to load fuel in 2016 to 2017, and so the new reactor program is seeking to complete three major goals by the end of fiscal year 2011 (September 30, 2011): finish its reviews of design certifications, limited work authorizations, and COL applications for those projects; have in place the necessary construction inspection and support infrastructure; and set up an advanced reactor organization to address the Next Generation Nuclear Plant and other new reactor designs. If resources are still available beyond those needed to meet those three goals, the NRC will devote them to reactor projects intended to begin operation out to 2020.

Doug Walters, vice president for regulatory affairs at the Nuclear Energy Institute, said that NEI continues to expect four to eight new reactors to be built and enter service in the near term. This statement is in agreement with what other NEI officials

have been saying for about the past five years. He described the developing construction inspection effort at the NRC as similar to the reactor oversight process (ROP) for operating reactors, but without the ROP's performance indicators because of the lack of experience. The subject of ITAAC was raised again here, and in response to a question from the audience, Walters said that some ITAACs that emerge near the end of construction might be worked into license conditions for operation, thereby not causing a delay in fuel loading if they have not been completed.

Hitachi and Toshiba have scaled back somewhat on modular construction because in some cases, stick-built construction of some systems has turned out to be more efficient.

Atam Rao, head of nuclear power technology development at the International Atomic Energy Agency, looked beyond the U.S. program, especially at the effort of countries that seek to establish nuclear programs for the first time. He said that the IAEA wants any such country to make a 100-year commitment to its nuclear program—although this has never happened anywhere, since the first human-induced nuclear fission took place just over 70 years ago. Regarding existing programs, he noted recent developments in India, not just in reactor construction and planning (with new vendors seeking to enter the market), but in infrastructure and the expected emergence of an indigenous capability to produce ultraheavy forgings for reactor components.

John Polcyn, vice president and chief nuclear officer of the consulting firm Invensys, also surveyed reactor construction beyond the United States and sounded at least one note that didn't match with the chorus often heard about Generation-III+ reactors.

Polcyn

He said that Hitachi and Toshiba have actually scaled back somewhat on modular construction—long stated to be a hallmark of current practice—because in some cases, stick-built construction of some systems has turned out to be more efficient.

Commenting on the difficulties in construction at Olkiluoto-3 in Finland, Polcyn said that the most-spoken of the 30 languages used by workers brought to the site is Polish, which the supervisors don't speak—a situation that was made public by Greenpeace.

Education, training innovations

During the session titled "Cutting-Edge Techniques in Education, Training, and Distance Learning," Michael Mann, an instrumentation and controls technical instructor at Constellation Energy's Ginna nuclear plant, explained how concept mapping can be used to improve the common understanding of the complex interrelations of nuclear concepts.

The technique of concept mapping was developed by Joseph Novak and his research team at Cornell University in the 1970s as a means of representing students' emerging science knowledge.

The concept map is a diagram that shows the relationships among concepts and serves as a graphic tool for organizing and representing knowledge. Concepts, usually represented as boxes or ovals, are connected by labeled arrows in a downward-branching hierarchical structure. The relationship between concepts can be articulated in linking phrases such as "gives rise to," "results in," "is required by," or "contributes to."

At its most basic, the concept map can convey at a glance what is important about a job or process at a nuclear plant and what is less important. This same information can be conveyed by pages of written text, but a graphic illustration seems to make knowledge-capture a quicker and easier process.

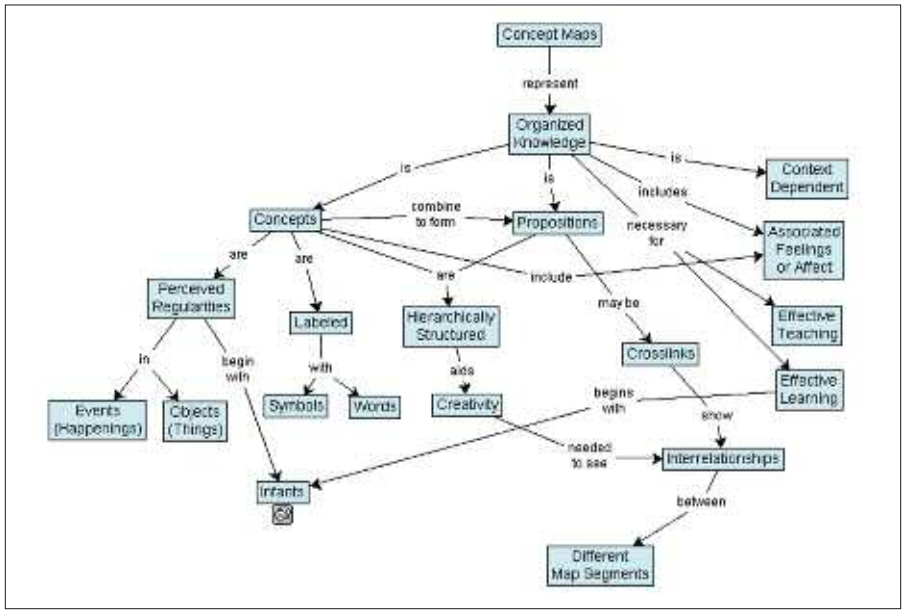
"Concept maps are used all over the world," Mann said. "The U.S. Navy, NASA, and all levels of education from preschool through doctoral programs, as well as industry training, all use concept mapping."

Concept maps mimic the intuitive discovery learning of children assimilating new knowledge with existing knowledge frameworks. In the nuclear industry, Mann said, the maps can be used for knowledge retention and transfer, and they are effective because they drive trainees toward meaningful learning and help integrate new knowledge with knowledge already possessed by the learner. "Meaningful learning tends to be retained longer and contributes much more to our knowledge structure than rote learning," he said.

Mann

At the Ginna plant, concept mapping has been used to capture expert knowledge; to develop lesson plans and outlines for presentations; as an evaluative tool to establish baseline knowledge; as a trainee project to stimulate ideas; to organize notes as a study aid for exams; and as a quiz in class to evaluate student competence.

Mann said that concept mapping has been shown to help trainees learn about the



A concept map is a diagram that represents relationships among ideas, images, or words in the same way that a sentence diagram represents the grammar of a sentence. (Graphic: Institute for Human and Machine Cognition)

relationships of complex information, researchers to create new knowledge, administrators to better structure and manage organizations, authors to write more clearly, and evaluators to assess learning in new ways. "It is time for the nuclear community to make full use of this valuable tool," he said. A download of concept mapping is available free to individuals at <cmap.ihmc.us/>.

Mark Pierson, an associate professor of mechanical engineering in Virginia Tech's nuclear engineering program, explained some of the educational innovations used at the university. Virginia Tech had established a nuclear engineering program in about 1956, but suspended it in about 1990 because of a decline in the number of students enrolled in the program. The program was restarted in the fall of 2007, and since then it has grown from an enrollment of 60 students to about 200 students.


Pierson

The new program initially offered certificates in nuclear engineering at the undergraduate and graduate levels, but it has been expanded to include a minor in nuclear engineering at the undergraduate level and a master's and Ph.D. in nuclear engineering at the graduate level. "A bachelor's degree is still several years away, dependent on the rate at which we can grow our faculty and facility resources," Pierson said, adding that Virginia Tech's vision is to establish a School of Nuclear Science and Engineering that will cross departmental and college boundaries and incorporate the areas of health physics and nuclear medicine.

Virginia Tech also offers graduate nuclear engineering courses via distance learning. Having begun with four off-campus graduate students, the distance learning program has grown to nearly 40 students. "We started with live video teleconferencing and recorded lectures for delayed playback," Pierson said. The types of technology and advanced tools available for the students have been expanded to include the use of social software features such as blogs, discussion forums, chat rooms, and wikis (collaborative Web sites whose content can be edited by anyone who has access to them) to promote greater interaction among students during learning, information processing, and problem solving.

These technologies aid the students not only in learning, but also in interacting with the instructor, Pierson said. For example, the chat room feature is used for virtual office hours, and blogs and forums take the place of e-mail conversations. In addition, new software features allow the recording of videos and podcasts on various topics that may not be covered in the lecture.

Virginia Tech is also taking steps to transform the existing graduate nuclear engineering certificate program offered via distance learning into problem-based learning courses taught in an asynchronous manner using a collaborative online format.

Pierson said that problem-based learning was pioneered at medical schools to improve the problem-solving abilities of physicians. After its implementation at a major medical school, "mean scores on both knowledge acquisition and clinical case analysis improved by one entire standard deviation," he said, adding that Virginia Tech wants to have that same impact in the nuclear engineering field.

Pierson said that by using cases derived from industry problems, students would become familiar with the nature of the problems that engineers typically solve in the workplace. In addition, this approach would provide an effective means for grounding course content in the cultural and work contexts of the nuclear industry.

Larry Zirker, a senior engineer at the Department of Energy's Idaho National Laboratory, presented the case for the establishment of an advanced nuclear welding technician training program to meet the demands of the nuclear renaissance. The new program would focus on three areas: advanced welding processes, welding engineering technicians, and welding quality technicians.

"Prospective trainees for the program could come from a variety of backgrounds and from a variety of places," he said. For example, the trainees could be experienced welders seeking to augment their skills beyond that of production line welders. They could also be recent two-year welding program graduates, or senior craftsmen from the welding trades "who may no longer have the eyes, backs, or hand-eye coordination to manually perform X-ray quality pipe welds, but with proper training could perform computerized welding/cutting operations, collect real-time welding quality data, provide supervision/management, or perform welding inspections," Zirker said. Others who may qualify would be wounded veterans or returning U.S. soldiers from the Middle East campaign, and industry or union journeymen and apprentices.


Zirker

The reasons to develop the advanced training program are many, Zirker said. One of them is to enhance the skills and knowledge of future welders to prepare them to work on the next generation of nuclear plants, which are designed to use higher temperatures and pressures and new materials and for which strict codes will require welding automation to ensure repeatable weld quality.

Other reasons to establish the training program, according to Zirker, are to develop the skilled welders needed to meet current industry needs; fill the gap created by the lack of current programs for comprehensive training; prepare workers to handle the new computerized/mechanized welding and cutting machines that weld and cut faster and achieve up to 300 percent more production; and retain and retrain skilled laborers, which will help build the economy and assist the United States in achieving energy independence by putting highly trained workers on the job.

Steven Biegalski, an assistant professor in the Nuclear and Radiation Engineering Program at the University of Texas at Austin, talked about the Texas Atomic Film Festival, which he helped found. The first festival was held on the UT campus in May 2009 and featured 10 short films about nuclear technology. The goal of the festival was for nuclear engineering students enrolled at the university and distance-learning students from Iowa State University to form teams to communicate technical subjects to peers by using digital movie content.


Biegalski

Among the films in the 2009 festival were *An Intercomparison of Electricity Sources* by a team of Iowa State students; *The Carbon Footprint of Nuclear Power,* by a UT team; *Chernobyl: The Movie,* by a UT team; and *Not Quite 60 Minutes: Is America Ready for Nuclear Power?* by a UT team.

Biegalski said that while many students had their own equipment, two high-definition digital video camera systems were purchased for the competition. Each system included an Aiptek Action-HD GVS high-definition camcorder, an 8-GB SD RAM card, an external microphone, and a tripod. A small computer laboratory was set up with three Macintosh computers and iMovie software for video editing.

An independent panel of judges rated the films, each of which was three to five minutes long. The panel consisted of two individuals with expertise in visualization and film and two others who are experts in nuclear engineering. Each film was evaluated and scored by the judges on its video quality and technical content. After each video was shown, the judges provided their assessments to the viewing audience. The scores for each film were compiled and the winning team was awarded trophies at the

end of the film festival.

The winning film, *"Radiation: Should You Be Afraid?"* by a team of UT students, is available for viewing on YouTube at <www.youtube.com/watch?v=uKk5-j1qKQE>.

Biegalski said that the film festival was "a tremendous success," and that evaluations done afterward by the students provided very positive reviews of their experiences. "In our new digital age, there is an increased need for engineers to convey technical content through digital media," he said.

The next film festival will be held in May 2010. Biegalski said that all schools are invited to participate.

New construction, again

As more U.S. organizations get involved in new reactor projects and the prospect of actual construction seems to be gaining focus, it is understandable that ANS meetings would devote more time in technical sessions to what is now commonly referred to as "new build." The session on challenges to constructors went beyond the usual forecasting of license applicants to discussions of what would actually take place at a construction site.

Ken Aupperle, a partner in the consulting firm High Bridge Associates, asserted that construction is done by a team made up of the owner, the EPC contractor, the equipment manufacturer, and perhaps others, and he stressed the need for simplicity. He warned that reactor licensees have developed an "outage mentality" aimed at getting work done quickly, which if carried over to construction could lead to work being rushed. He also said that the tools and technology available now can be almost *too* sophisticated, powerful, flexible, and complex. Referring to an article by Jim O'Brien in *Engineering News Record,* he said that software has become so complex that it runs counter to project management principles. Aupperle went so far as to compare project control professionals to clerks, more involved in maintenance than analysis because "digital capabilities have created a clinical/impersonal process."

Bruce Hinton, general manager for strategic planning for Westinghouse Welding and Machining, said that the installation of the reactor coolant loop in Westinghouse's AP1000 reactor will require only 12 welds on site; there would also be about 400 welds in the containment and about 700 in the auxiliary building. Westinghouse has set up welding schools in Chattanooga, Tenn., and Rock Hill, S.C., with the aim of "franchising" welder training so that on-site work is as standardized, safe, and efficient as possible.

Hinton also said that new welding technology is being adopted so that welders can deliver appropriate results even if they are not, by traditional standards, the absolute best in their field. He called this an adjustment to "reduced welder skill levels," in the expectation that a great many welders may be needed. Hinton forecasted the addition of 1280 GWe of new nuclear capacity worldwide by 2050.

An ongoing theme in the upturn of nuclear construction activity in recent years is the return to the fold of companies that had worked in nuclear power for decades but had to look for other work after the reactor backlog dwindled, with some reactors having been finished and the rest canceled. Robert J. Taylor Jr., vice president of nuclear development for Kiewit Power, noted that his company gave up its ASME accreditation ("N" stamps) in 2000 but got it back in 2006, along with an NQA-1 stamp for concrete certification. He said that Kiewit is now working to develop the NuScale small-reactor concept and to gain sub-tier contracting roles in COL projects.

John Simmons, senior vice president for nuclear projects at URS's Washington Division, said that he has already found instances in which the location and orientation of plants and their buildings were done without proper consideration for routine site layout criteria. In one case—at a plant that still exists only on paper—turbine generators were located too far from the circulating water source, leading to the addition of piping that otherwise would not have been necessary. He attributed this to some extent to knowledge not having been captured from personnel who have since gone elsewhere.

New welding technology is being adopted so that welders can deliver appropriate results even if they are not, by traditional standards, the absolute best in their field.

Other sessions

At the panel discussion on the linear no-threshold (LNT) model for estimating radiation health effects, Kenneth Mossman, a professor in the School of Life Sciences at Arizona State University, summarized the essentials of this hotly debated topic. He explained what the LNT is used for (setting federal policy through the endorsement of the National Academies and other bodies, translating dose to risk, establishing a dose floor in a top-down approach to radiation protection, and estimating cancer risk at low doses); what it is not used for (setting dose limits or establishing risk-management strategies); and what he believes it should not be used for (estimating individual radiogenic risk or public health impacts from collective dose estimates).

While the LNT model has been criticized from the beginning by nuclear advocates, Mossman said that recent radiobiology data call into question the assumptions behind the LNT and that there is a lack of conclusive evidence at doses below 100 millisieverts to give the LNT a clear advantage over competing theories.

■ The session on medical accelerators included presentations on proton therapy systems from Hitachi, presented by Takashi Okazaki on behalf of the four authors, and Still River Systems, presented by Stanley Rosenthal, the company's vice president for clinical systems. Hitachi's linear accelerator system at the University of Tsukuba in Japan, with a 7-MeV injector and extraction of pulses ranging from 70 to 250 MeV, has been used to treat more than 1000 cancer patients since 2000.

Rosenthal said that Still River's superconducting synchrocyclotron design allows for counterweighted rotation to train the beam in virtually any direction. The entire machine weighs about 20 tons. The first unit is being developed for a treatment center in St. Louis, and other potential customers have expressed an interest. Rosenthal said that protons provide a more level dose than photons and create less unintended damage to healthy tissues. Protons, he added, can also be focused better than X-rays can.

■ At the session on aerospace nuclear science and technology, John Bess, a research and development nuclear engineer at Idaho National Laboratory, reported on the Coordinating Space Nuclear Research Advancement and Education program, which is based at the lab. Bess listed the projects taken on by each group of summer fellows in the program: in 2006, a proposed augmentation of the next lunar mission with a nuclear thermal rocket (NTR), and NTR use to enable the current launch fleet; in 2007, a lunar isotope power source and a radioisotope-powered unmanned aerial vehicle; in 2008, an uncrewed underwater vehicle and a mobile nuclear lunar outpost; and in 2009, comet interception with NTR, and fission surface power shielding studies.—*E. Michael Blake and Rick Michal*