

# NUCLEONICS WEEK

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## IAEA chief: Nuclear industry is moving on from Fukushima

More than two years after the Fukushima I accident in Japan, the nuclear power industry has "made good progress" in winning back public confidence that had been lost, International Atomic Energy Agency Director General Yukiya Amano said May 20.

Amano spoke at the 12th biennial general meeting of the World Association of Nuclear Operators, or WANO, being held in Moscow May 19-21. WANO, which represents all the world's nuclear reactor operators, is

headquartered in London and has four regional centers, in Atlanta, Moscow, Paris and Tokyo.

"Public confidence in the safety of nuclear power was deeply shaken by the accident," Amano said. Now, the industry is "beginning to put the accident behind us and is looking forward to the future," he said.

Key to the progress in restoring public confidence, he said, was "significantly strengthened" cooperation between WANO and the IAEA in the

past two years.

The IAEA and WANO agreed formally in September to closer cooperation, including better coordination of peer review missions and more sharing of nuclear power plant operating experience. Their memorandum of understanding, signed at the IAEA General Conference in Vienna, was a response to the IAEA's post-Fukushima Nuclear Safety Action Plan as well as to recommendations from WANO

*(continued on page 9)*

## South Korea faces opportunities, challenges to reactor exports: paper

South Korea is positioned to win additional reactor export deals, especially in the Middle East, but the country faces challenges in financing and other areas that could limit sales, two researchers from the Monterey Institute of International Studies said in a paper released May 21.

South Korea's nuclear industry won the United Arab Emirate's tender for four units in 2009 over competitors such as a French group including

Areva and EDF in part because of the low price it offered, which at \$20.3 billion may have been half that of the next-lowest bidder, Chen Kane, one of the co-authors, said during a speech May 21 in Washington. The proposed prices in the other bids have not been made public, she said.

The paper on South Korea's reactor exports was published by the Korea Economic Institute of America, which also sponsored a speech by

the authors. Both researchers work in the Monterey Institute's Center for Nonproliferation Studies.

Although South Korean industry appears to be able to build reactors at lower cost than any other country, there are indications the offer price for the UAE contract contained limited profits for the Korean companies, Kane said. The bid was intended to open the door for a series of future reactor

*(continued on page 11)*

## DOE eyes incentives for fleet of SMRs

DOE plans to go beyond support for two or three small modular reactor designs and provide incentives for commercial deployment of a fleet of the reactors, Rebecca Smith-Kevern, DOE's director for light water reactor technologies, said May 15 at a meeting for companies interested in securing federal funds for small modular reactor projects.

To achieve this "strategic vision," Smith-Kevern said, the US government is considering various incentives to help

industry through the different phases of deployment, including licensing, first construction and establishing sustained factory production of small modular reactors, or SMRs.

"There would be a role for new public policies to support SMR deployments and manufacturing," she said. Those would potentially include loan guarantees to support factory production of SMRs, regulatory changes to support fleet operations and maintenance, export strategies to promote US SMR

### Inside this issue

UK, EDF Energy moving closer to pact on new reactors: official	3
NRC staff proposes post-Fukushima regulatory revisions	4
EPR costs in Finland, France not sustainable, Areva executive says	5
SCE, MHI could not agree on San Onofre repair, documents show	6
German grid operator sees delays adjusting to nuclear phase-out	7

designs and manufacturing capabilities in global markets, and carbon taxes or other policy and economic incentives to support the nuclear industry, she said.

SMRs are defined by DOE as reactors of less than 300 MW that are manufactured in factories and shipped by rail, barge or truck to utilities as demand arises.

SMR vendors are preparing design certification applications for NRC review, with the first applications expected to be submitted in the second half of 2014.

The US government has stepped in to share the risk in this phase of deployment through DOE's SMR licensing technical support program, Smith-Kevern said at an SMR Industry Day hosted by DOE in Bethesda, Maryland to address industry questions regarding DOE's second round of funding under that program.

The program will make \$452 million in government funding available through cost-share agreements for design development and NRC certification and licensing of SMRs.

When first-of-a-kind SMRs are ready for the construction phase, Smith-Kevern said, the US government could serve as first users of the reactors at national laboratory sites or military bases. The government may also provide commercial incentives to motivate companies to pursue these projects, she said, without providing further detail.

"We would hope that by 2030 we could see that maybe 20 SMRs units have been built," Smith-Kevern said, adding that early adopters would benefit from lower overall costs achieved through lessons learned on the first projects.

The final phase of DOE's fleet deployment vision would culminate in the sustained factory production of SMRs.

"This is where a mature industry would be established in the United States with the potential for future export markets," Smith-Kevern said. "The total output we would hope to be around 50 SMRs per year by 2040 or sooner" for the US market.

DOE's current focus is on helping industry navigate the licensing and certification process at NRC.

DOE in November selected a team led by Babcock & Wilcox to receive a portion of a \$452 million, multi-year cost share program to support commercialization of the mPower SMR by 2022. B&W said in a statement April 15 that it would receive at least \$150 million in federal funding under the program.

DOE announced March 11 that it was accepting applications through July 1 for proposals with the potential to deploy a second SMR design around 2025 and with a greater emphasis on innovation.

Following the review of the previous applications from the initial funding opportunity announcement, DOE "believed the 2022 deployment goal may have put too much licensing risk on the applicants, and we may have squelched or inhibited some creativity in the design," Tim Beville, program manager for DOE's SMR program, said at the Industry Day May 15.

The department chose to make a single award to the mPower team, the highest scoring applicant, and develop a second solicitation that would "remove some of those



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inhibitions and allow some more risk-taking on design," Beville said.

Beville said the department expects to announce the funding recipient — or possibly multiple recipients if more than one application of sufficient merit is received — in September and finalize cooperative agreements by December or January.

### What it takes to win

Beville advised potential applicants for DOE's second solicitation to use plain language, avoid jargon and give clear and concise answers in their applications.

"Be sure that you give factual representation of your system capabilities. Don't send us a marketing brochure. Facts are better."

Beville said a merit review panel will be looking for SMR designs with performance characteristics that exceed currently certified large reactor designs.

The criteria the panel will use to score applications was left "somewhat abstract" to allow companies "to come to us with good ideas without us prescribing what we wanted exactly," Beville said.

The most important criteria will be innovation and development of new approaches and innovations in safety, operations and economics, particularly "improvements in safety and resilience through the use of innovative design features," Beville said.

The merit review panel will also look for innovation in the management of severe accident consequences, methods to reduce construction, fabrication and component development costs and options to maximize nuclear fuel use that minimize waste, among other things.

Next, the panel will look for the potential benefits to the US a project may have, including a return on DOE's investment. The amount of federal dollars that will remain in the US, the use of US manufacturing and supply chain vendors, and the long-term potential of a project to create and sustain domestic nuclear suppliers will be looked upon favorably during the panel's review, Beville said.

The likelihood that an applicant could receive NRC design certification and be ready to deploy by 2025 is the third criterion. "We'd like to see commitment to meeting the certification goals through realistic schedules, corporate level financial commitment, interactions with the regulator and realistic plant cost estimates to show us that you've got some kind of plan to move forward," Beville said.

DOE will also look at applicant teams' capabilities, experience and success in the past in completing projects of the same scope and complexity.

The lowest weighted factor pertains to project management, and the review panel will be looking for assurances that the applicant is "doing things in a deliberate, reasonable, and efficient way," Beville said.

— *Jasmin Melvin, Washington*

## UK, EDF Energy moving closer to pact on new reactors: official

The UK government and EDF Energy are close to agreement on building new reactors at Hinkley Point C in Somerset and a contract setting the price of power to be produced from the units will be signed "very soon," a UK official involved with the negotiations said May 14 during the German Atomic Forum's annual conference.

Hergen Haye, who is in charge of the UK's new nuclear power program at the Department of Energy and Climate Change, said the so-called contracts-for-difference for the project will only go into effect after Parliament passes an energy bill that includes a strike price to guarantee a nuclear power plant operator a minimum price for electricity from new reactors.

Under the strike price and the related contract-for-difference financial instrument, if wholesale electricity prices fall below the minimum guaranteed price, a UK government-backed counterparty will make up the difference. But if prices go above the minimum level, the reactor operator must pay the counterparty the difference.

EDF Energy, the UK subsidiary of EDF, is the only company negotiating with the UK government to build reactors in the UK. EDF plans to build two 1,600-MW Areva EPRs at Hinkley Point. British nuclear regulators approved the EPR design in December 2012.

Haye, who spoke at sessions May 14 and 15, would not comment on details of the contracts.

But Britain's Daily Mail reported May 15, citing people familiar with the negotiations, that the strike price in the contracts will be between GBP93 and GBP96 (\$140.80-\$143.80) per MWh.

The strike-price system has been highly debated in the UK, and the level at which the price should be set has also been the subject of protracted negotiations between EDF and the UK government.

Haye said the government considers the strike price necessary to help mitigate the risk for investors in new reactors in the UK and to help attract foreign investment. He said the government also wants to ensure through the strike price that consumers do not overpay for electricity.

He added that "we [the government] want to move very quickly back from this arrangement to a competitive arrangement."

He said the government wants the UK electricity generation mix to ultimately be determined by market economics and does not want to mandate how much electricity should be generated by any particular source.

The European Commission has to approve the strike-price system to ensure it does not constitute illegal state aid.

Haye said that the UK government has been discussing the system with the EC's Directorate-General for Competition and that there have not been indications that the DG objects to the plan.

But Steve Thomas, a professor of energy policy and

director of research at the University of Greenwich who has reviewed the strike-price system, called it "a blueprint for illegal state aid. It seems inconceivable to me that it won't be construed as illegal state aid by the European Commission."

Thomas, a frequent critic of nuclear power projects, participated in one of the same sessions as Haye. Thomas also presented his review of the strike-price system to the UK Parliament in June.

Haye said he has "every confidence that the DG will assess this from a competitive point of view, rather than whether they think nuclear power is good or not."

The UK's system also would require that operators of new reactors have plans for financing disposal of nuclear waste and spent fuel when construction contracts are signed. A fund will also be set up for reactor decommissioning and potential reactor operators will have to show that they are financially able to contribute to that fund.

"That is necessary so that the taxpayer doesn't get stuck with that cost," Haye said.

— Ariane Sains, Berlin

## NRC staff proposes post-Fukushima regulatory revisions

NRC staff has released a draft white paper proposing revisions of the agency's regulatory framework, including introducing an extended design basis concept, after the Fukushima I accident in Japan. Staff said it is seeking public comments on the paper and will discuss its proposals during a public meeting June 5.

Staff is developing proposals for consideration by the commission in response to the first recommendation made in July 2011 by the agency's near term task force on the Fukushima accident in Japan (NW, 14 July '11, 1). The proposals will suggest ways NRC could revise its "regulatory framework" to better account for extreme events that could result in accidents, and would be in addition to orders and a request for information issued by the commission in March 2012 requiring US nuclear power plants to upgrade safety equipment and emergency response capability in response to Fukushima.

Recommendation 1 of the near term task force was that NRC establish "a logical, systematic, and coherent regulatory framework for adequate protection that appropriately balances defense-in-depth and risk considerations."

The task force said in its report that NRC's regulatory approach to severe accidents was "established and supplemented piece-by-piece over the decades," and "[t]he result is a patchwork of regulatory requirements and other safety initiatives, all important, but not given equivalent consideration and treatment by licensees or during NRC technical review and inspection."

An "enhanced regulatory framework," the task force said, "would support appropriate requirements for increased capa-

bility to address events of low likelihood and high consequences, thus significantly enhancing safety."

The staff working group developing alternatives for responding to Recommendation 1 said in its draft paper, dated May 14, that it developed "three potential improvement activities." Those activities are to "establish a design extension category of events and associated regulatory requirements," to "establish commission expectations for defense-in-depth," and to "clarify the role of voluntary industry initiatives in the NRC regulatory process," the paper said.

Staff is identifying issues which need to be resolved in order to implement the improvement activities, as well as pros and cons for each activity and costs and timetables for completing them, the paper said. It is acceptable from the standpoint of safety to keep existing regulatory processes and policy in place while the improvements are developed, staff said. That is consistent with previous statements by the task force and industry that US nuclear power plants remain safe to operate after the March 2011 Fukushima accident.

The paper is available, and comments may be submitted, at regulations.gov under Docket ID NRC-2012-0173. The comment period closes August 15.

Staff will consider comments received "informally" while preparing a paper for the commission on its recommendations, but it "will not prepare or publish detailed formal responses to comments received," Daniel Doyle, an NRC project manager, said in an email to stakeholders May 17.

The design basis is a compilation of accidents and reactor states that are required to be taken into consideration in the original design of a specific power reactor.

The May 14 draft white paper said "[t]he staff proposes that the NRC adopt a new term — 'design basis extension' — to define and describe the events and requirements which have typically been characterized as 'beyond design-basis,'" the paper said. The proposed definition of "design basis extension," it said, "makes it clear that there are regulations regarding hazards and events that are not included in the set of design-basis accidents (but may still be part of the plant's design bases) and for which, therefore, the regulatory treatment of associated SSCs [systems, structures and components] may be different than that prescribed for safety related SSCs."

Among the "key issues" staff would need to resolve, the paper said, are whether the approach would be specified on a generic or plant-specific basis, or both; whether site-specific probabilistic risk assessments would be required; and whether the approach would only apply to new reactors or also to operating plants.

### Industry sees 'little benefit'

Joseph Pollock, vice president nuclear operations at the Nuclear Energy Institute, said in NEI's April 30 comments on an earlier February 15 draft of the paper that industry has "concluded that there is little safety benefit to be derived from the comprehensive effort contemplated' by the NRC staff task force in Recommendation 1.

"Although we agree that some specific improvements can reasonably be made in the area of beyond-design-basis requirements, we see little additional safety benefit in a complete reworking of the NRC's regulatory framework," Pollock said.

He said "a decision not to implement any of the proposed improvement activities is not a 'do nothing' approach. The NRC would continue to improve portions of its processes and framework in response to operating experience, new information, or emergent issues — just as it has done in the past."

Also, Pollock said, if the proposed actions to implement Recommendation 1 were taken, "both the NRC and industry would necessarily be required to redirect resources (in the form of management, staff, expertise) from ongoing current issues to deal with whatever technical, regulatory, and legal issues are associated with a new regulatory proposal. For example, Recommendation 1 would conceivably involve a substantial impact with respect to probabilistic risk assessments, thus requiring persons with such expertise today to divert their attention from ongoing regulatory matters (e.g., seismic and fire risk evaluations) to this issue."

NRC staff completed most of its work on the May 14 draft of the white paper before reviewing NEI's comments, Richard Dudley of NRC's Office of Nuclear Reactor Regulation said in an emailed reply to questions May 21. Staff and industry representatives will discuss the latest draft and industry concerns during a May 23 public meeting of the Fukushima subcommittee of the agency's Advisory Committee on Reactor Safeguards, Dudley said.

The NRC staff working group "is planning to consider industry, ACRS, and public stakeholder feedback in a later revision of the white paper that will be prepared" after the June 5 meeting, Dudley said. Staff will provide its proposals for addressing Recommendation 1 to the commission in a paper expected early in December, the May 14 paper said.

— *Steven Dolley, Washington*

## EPR costs in Finland, France not sustainable, Areva executive says

The estimated Eur5,000 (\$6,429) per installed kilowatt cost for building the 1,600-MW Olkiluoto-3 and Flammanville-3 EPRs is "not sustainable for future projects," a top Areva official said May 14.

Speaking during a panel discussion at the German Atomic Forum's annual conference, Didier Beutier, vice president of marketing for Areva's international commercial organization business unit, said that Areva will be able to cut those costs for the two EPR reactors it is building at the Taishan site in China, because of what Areva has learned from the problems in building Olkiluoto-3 in Finland and Flammanville-3 in France.

Areva and Siemens are building a 1,600-MW EPR for Finnish power company Teollisuuden Voima Oy or TVO

under a turnkey, fixed-price contract. The original cost of the reactor was Eur3.2 billion.

But the project is about seven years behind schedule and the cost for the unit is now estimated to be more than double the initial price. TVO and Areva are in arbitration to try and resolve who will pay for the additional costs.

Flammanville-3's original cost was about Eur3.3 billion but costs are now estimated to be about Eur8 billion, in part because of additional engineering work. The unit was scheduled to go into commercial operation in 2012, but that has been delayed until 2016.

Beutier said that Olkiluoto-3 is taking so much longer than planned in part because of the time it has taken to manufacture major components such as steam generators. He said that it took five years to make steam generators for the reactor, but that it will take only three years to manufacture them for Taishan.

Some components at Olkiluoto-3 did not meet the Finnish Radiation & Nuclear Safety Authority, or STUK, standards and the agency required that they be fixed, adding to the manufacturing time.

Beutier said that with the Olkiluoto project "the complete industrial supply chain had to be reactivated, in some cases rebuilt," because it had been so long since a reactor had been built in western Europe. In addition, Olkiluoto-3 is the first EPR to be built.

He added that he expects engineering costs for the Taishan project to be lower because of the lessons learned from Olkiluoto and Flammanville. About half of the Areva employees working on Taishan have worked on either Olkiluoto-3 or Flammanville, Beutier said, which should also make the Chinese project easier.

The first Taishan unit is scheduled to come online in late 2013 and the second a year later, Areva has said.

Another major reason for the delay at Olkiluoto-3 is that verification of the digital instrumentation and control system has taken much longer than TVO, Areva and STUK expected.

In an interview May 16, Mika Johansson, who is in charge of reviewing the I&C system for Olkiluoto-3 at STUK, said that the agency received the design documentation it has been asking for on the system about two and a half weeks ago.

He said STUK estimates it will take about two months to review the material, assuming it is complete. If STUK approves the documentation, the review of the more detailed I&C design can begin and STUK can also look at how the I&C will function on the so-called system level; i.e. how it could affect other reactor systems.

Johansson said that one key element in reviewing an I&C system is to try to "break it down," to see how robust it is, rather than just testing to ensure that the system works.

He added that "of course, regulators in every country have doubts about software based safety systems because they cannot be proved error free."

As a precaution, STUK has required a backup hardwired system for the digital I&C at Olkiluoto-3.

There also has to be "rigorous baselining" to provide comparisons for I&C systems when they're reviewed, Johansson said, and review and verification should be done by people with a variety of different specialities.

STUK plans to issue new regulatory YVL guides by the end of June, and Johansson said they will include a section on I&C.

— Ariane Sains, Berlin

## SCE, MHI could not agree on San Onofre repair, documents show

Southern California Edison has not yet developed a repair plan for San Onofre-2 and -3 according to letters released during a California Public Utilities hearing May 15 that show that Mitsubishi Nuclear Energy Systems in late 2012 had offered the utility three repair options, at least one of which was rejected.

SCE had asked MNES — the US subsidiary of Mitsubishi Heavy Industries, which manufactured the replacement steam generators — to recommend a repair plan in letters in November and December but reported the options MNES presented did not fit SCE criteria.

The CPUC launched hearings May 13 in the first phase of its 18-month investigation into Southern California Edison's handling of events at San Onofre-2 and -3 that resulted in an extended outage at the units (NW, 7 Feb., 9).

Both San Onofre-2 and -3 were shut in January 2012 after an unusual amount of wear was found in the tubes of their replacement steam generators, which began operating in 2010 and 2011, respectively. The steam generator tube damage was less extensive in unit 2 than in unit 3. San Onofre-1 was permanently shut in 1992.

The letters exchanged between the two companies were released at the May 15 CPUC hearing.

According to the letters, Mitsubishi outlined three options for repair or replacement of San Onofre's steam generators, but none have been implemented.

Option 1 would involve inserting "thicker" anti-vibration bars or tube supports in the steam generators. The thicker bars would prevent tube in-plane displacement and tube-to-tube wear. All work associated with this option could be completed in a year, according to Mitsubishi's letters. MHI has said in-plane fluid elastic instability, which had not previously been seen in U-tube nuclear steam generators, was a leading cause of tube damage at the two units.

Under Option 2, the lower assembly of the steam generator tube bundle would be replaced. The steam generators would be replaced under Option 3.

Mitsubishi said the second two options would take more than five years to research, design and install.

In a December 20 letter to SCE, Hitoshi Kaguchi, MNES project director for San Onofre, referred to a December 14 meeting at which SCE told Mitsubishi it had concerns about the repair plans and that additional time would be needed

to address those concerns.

The outcome of the CPUC investigation will determine what costs related to the outage that SCE and San Diego Gas & Electric have already collected from ratepayers the utilities can keep and how much, if any, must be rebated to customers.

SCE operates San Onofre and owns 78.2% of the station. SDG&E has a 20% stake in the station. The city of Riverside, California owns the remaining 1.8%.

The first phase of the investigation, and last week's hearings, focused on the reasonableness of the 2012 operations and maintenance costs and repair of the unusual wear in the tubes in the new steam generators installed in 2010 and 2011. A decision in this first phase is expected in June.

That will be followed by a phase during which the CPUC will examine whether SCE's rate base and its 2012 revenue requirement should be reduced due to the extended outage at San Onofre. In the final phase, a determination would be made of the causes of the steam generator damage and who is responsible.

At the hearing May 15, Matthew Freedman of the consumer advocacy group The Utility Reform Network asked Thomas Palmisano, SCE vice president for nuclear engineering, why SCE had rejected the first option. "We identified criteria earlier and had questions about it and had not made a decision," Palmisano responded. He did

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not identify the criteria.

Freedman also asked if SCE had planned to pursue the two other options on an expedited timetable instead of the five plus years Mitsubishi outlined. Palmisano said that SCE did not work on timetables. SCE's job was to benchmark what others had done "so we could evaluate Mitsubishi's options," Palmisano said.

### Warranties and insurance

SCE, meanwhile, is continuing to pursue warranties and insurance to mitigate some of its San Onofre costs.

MHI made its first payment of \$45 million to SCE in December under its 20-year warranty to repair or replace defective items and to pay specified damages for certain repairs.

The warranty limits MHI's liability to \$128 million but SCE has notified MHI it believes one or more exceptions, including for the cost of replacement power, apply to the warranty limit. MHI disagrees, according to Edison International's 10K annual financial report to the Securities and Exchange Commission for 2012. Edison International is SCE's parent company.

According to the filing, MHI notified SCE in January that it challenged some of the charges in the first of SCE's three invoices totaling \$106 million for steam generator repair costs incurred through October 31. MHI said it requires further documentation regarding the remainder of the invoice.

This disagreement may ultimately lead to dispute-resolution procedures, including international arbitration, according to an SEC filing by SDG&E's parent company, Sempra Energy this year. The filing also said that SCE has invoiced MHI \$139 million on behalf of all owners for steam generator repairs through February 28.

SCE's insurance policies covering San Onofre are issued by Nuclear Electric Insurance Limited and cover nuclear property and non-nuclear property damage at the nuclear facility as well as accidental outage insurance. SCE has submitted to NEIL a separate "partial proof of loss" in connection with the outages on behalf of each of the three San Onofre owners totaling \$234 million as of December 29. Sempra Energy's 10K report notes that the NEIL policies contain a number of exclusions and limitations that may reduce or eliminate coverage.

### Possible hearing

On May 13, an NRC Atomic Safety and Licensing Board, a panel of agency administrative judges, said the confirmatory action letter central to determining whether SCE should be authorized to restart its San Onofre reactors, constitutes a de facto license amendment and should be subject to an opportunity to request a public hearing.

The decision supports the anti-nuclear group Friends of the Earth's claim that in this instance the CAL amounts to a license amendment and, as such, should be open to a request for a hearing.

It appears that NRC's earlier projection that it might reach a restart decision in late May or June no longer stands.

A list of San Onofre milestones posted on NRC's website last week indicates that tentative dates are yet to be determined for notifying the ASLB of the agency's intent to issue a restart decision, issuing a decision on SCE's license amendment request related to operation of San Onofre-2 and issuing a restart decision.

SCE filed a license amendment request with NRC in April that is tied to the utility's restart proposal for unit 2 and seeks to change a technical specification in order to limit that reactor to 70% capacity for one operating cycle. Under the restart proposal, San Onofre-2 would operate at 70% power five months and then be shut for a steam generator tube inspection. The scenario would be repeated several times during a two-year operating cycle.

The ASLB in its May 13 ruling said that operation of San Onofre-2 would be beyond the scope of its license "until the [steam generator] tube degradation mechanism is fully understood, until reasonable assurance of safe operation of the replacement steam generators is demonstrated and until there has been a rigorous NRC staff review appropriate for a licensing."

NRC Chairwoman Allison Macfarlane said that any party — including NRC staff, SCE, or Friends of the Earth — has until June 7 to file an appeal of the ASLB decision.

The ASLB said the proposed 70% limit would be "a deviation from the technical specification requirement that tube integrity be maintained over the 'full range of normal operation conditions' up to 100%."

— *Lyn Corum, Santa Monica, California;*  
*Elaine Hiruo, Washington*

## German grid operator sees delays adjusting to nuclear phase-out

German grid operator TenneT has enough money to upgrade and expand its transmission networks as nuclear power is phased out, but permit delays could cause problems, a company official said in an interview May 15.

"The key success factor for a successful energy turnaround is to build the lines," Jens Goerke, head of system operation concepts at grid operator TenneT said. "Without them, I cannot imagine how this will succeed."

After the Fukushima accident, the German government reversed itself on lifetime extension of nuclear reactors and moved for a nuclear phase-out. Eight units are already permanently offline and the last of the seven reactors now operating is scheduled to be shut in 2022.

To help replace nuclear generation, the government wants to bring more renewable energy online. Goerke said even before the phase-out decision, more renewable generation was being built and conventional power plants are being shut down as a result because they aren't profitable compared with renewables because of subsidies for those energy sources.

But he said the conventional plants are needed to bal-

ance the intermittent renewable energy load.

To connect renewable energy to the grid and ensure that power can be transmitted, grid operators need to expand and upgrade their grids.

But to do that, Goerke said the permit process for building new transmission lines must be streamlined so that approval is faster and building can begin more quickly.

TenneT has come under criticism from the political opposition to German Chancellor Angela Merkel's conservative-coalition government for not expanding the grid fast enough and getting wind farms, which are already built, online.

TenneT is one of four main grid operators in Germany.

In May 2012, the four released a plan requested by the German government on grid upgrades. The plan was coordinated by the federal network agency, the Bundesnetzagentur, and calls for investment of Eur20 billion (\$25.7 billion) by 2022.

Plans include upgrading about 4,440 kilometers (2,760 miles) of existing transmission lines and building about 3,800 kilometers of new lines.

Goerke said that from TenneT management's point of view, the decision to phase-out nuclear power "was made from one day to the next. As a transmission system operator, we were not able to prepare."

Goerke said he expects TenneT to sign contracts for about 2,400 MW of reserve power for winter 2013-2014, about the same level as for the winter of 2012-2013. Reserve power is particularly need to ensure stable electricity supply in southern Germany, since that is the area most affected by the nuclear shutdown.

He said that a transmission cable which Swedish grid operator Svenska Kraftnaet is considering building from Sweden to southern Germany could also help balance power, through imports. But such a transmission line would also allow Germany to export electricity from its wind farms to the Nordic countries, Goerke said.

— Ariane Sains, Berlin

## NRC concluding intense two-week inspection of TVA's Browns Ferry

NRC is this week wrapping up its intensive inspection at the Tennessee Valley Authority's Browns Ferry plant, which follows up a violation associated with a 2011 finding of high safety significance.

The so-called 95003 inspection is being held as a result of a "red" finding and violation relating to the failure of TVA to keep a 24-inch valve in a low-pressure cooling system operational, NRC said. The valve in the Browns Ferry-1 residual heat removal system is critical to providing core cooling during a fire, which raised the safety significance of its degraded condition, William Jones, deputy director of the division of reactor projects in NRC's Region II, said May 16 during a briefing with reporters at the plant in Alabama.

The inspection is rarely carried out at US nuclear plants, since it follows an unusual red finding. Before Browns Ferry was cited for the finding, the most recent red finding had been issued by NRC in 2003, the agency said.

NRC categorizes inspection findings using a color-coded system based on safety significance, with red indicating the greatest significance.

TVA must complete the inspection successfully to reduce NRC oversight of unit 1 at Browns Ferry. That unit is currently in column 4 of the agency's matrix for reactor oversight. Units receive progressively greater oversight from NRC as they move into higher-numbered columns and must shut down to correct deficiencies if they reach column 5.

The valve failed to open in October 2010 and was considered to be inoperable back to the last date it was known to have worked properly, which was 18 months before, Jones said.

The agency's 23-member inspection team is taking a broad look into TVA's safety procedures, operations and performance and the fire safety risk caused by the valve malfunction, Jones said. The inspection, which began May 13, will end May 24 with a briefing with TVA on the findings, he said.

NRC will brief the public on its findings from the inspection in late June, and at that time it will announce whether TVA has more work to do to resolve the red finding or whether the unit can be moved to a lower category of oversight, Jones said.

The 95003 is a "very intrusive" diagnostic inspection to look for root causes of the failure, Jones said. It has three phases. The first two phases were completed in 2011 and 2012, during which the NRC broadened the scope of the review.

At that time NRC looked at the implications of the risk involved had there been a fire at Unit 1 when the valve was not operating. When the risk was found to be of high significance, NRC began to look for other issues that should be added to the agency's review, Jones said.

NRC extrapolated from the valve failure to consider how TVA's processes and procedures could cause other problems throughout the three-unit plant.

"The overall issues were broader than we first thought," Jones said. NRC saw problems with TVA's maintenance, including timing, availability of parts and lack of proper maintenance walk downs, Jones said. It also found problems with its safety culture, he said.

TVA took a number of actions including development of a corrective action program, and notified the NRC in February that it was ready for the third phase of the inspection (NW, 27 Sep. '12, 1).

As part of its plan to reduce the risk of fire, TVA developed a plan to reduce its fire risk profile by agreeing to adopt the voluntary National Fire Protection Association standards known as NFPA 805, which rely on risk-based protective measures instead of the more deterministic ones previously in use.

In the 95003 third phase, currently underway, NRC is



looking at TVA's operations, engineering, maintenance, management governance and its safety-conscious work environment, Jones said.

Phase three is a comprehensive assessment of TVA's performance in strategic performance areas. It is designed to provide the NRC with enough information to determine the breadth and depth of existing safety, organizational and programmatic issues. Inspectors will determine whether TVA's corrective actions since the discovery of the broken valve have been enough to overcome deficiencies and achieve long-term improvement, Jones said.

NRC has concerns about the safety culture of the plant and the willingness of workers to report safety issues, Jones said. In a safety-conscious work environment, workers and staff are willing to challenge other departments if something does not seem quite right in order to get to the heart of issues, he said.

Management governance will be looked at closely to see what standards they have set and whether workers and staff are given the tools needed to support the proper safety culture, Jones said.

Overreliance on process, instead of using a questioning attitude, is one example of how a safety culture can be inhibited, Jones said.

TVA's improvement plan includes a corrective action program and actions to improve personal accountability, operational decision-making, fire risk and equipment reliability, Jones said.

TVA will be briefed on the agency's finding at the end of the week of May 20.

TVA has made improvements in its accountability, corrective action program, decision-making, equipment reliability and fire protection in response to the finding, the federal power producer said in an email statement May 17.

"We believe we did a good job identifying our issues and developing action plans to address them. We also recognize that it would be naive to think the NRC wouldn't find additional areas that need to be addressed," TVA said.

— Mary Powers, Athens, Alabama

## New WANO chief calls for prospective new entrants to join early

The new president of the World Association of Nuclear Operators, or WANO, May 21 called on countries thinking about adopting nuclear power to join the organization as soon as they can.

Duncan Hawthorne spoke to reporters at WANO's 12th biennial general meeting held in Moscow, his first press conference in his new role. Hawthorne's election to the most senior role at WANO was approved at an extraordinary meeting of WANO members May 20. Hawthorne, who is president and CEO of Canadian utility Bruce Power, takes over from Vladimir Asmolov, director general of Russia's Rosenergoatom.

WANO and the nuclear industry "is still expanding rapidly," Hawthorne said, "and despite the setback" of the Fukushima I accident in 2011. That expansion includes development of countries that are already familiar with nuclear power, such as Russia, China and India, he said. "But there are clearly a number of new entrants," he said, meaning countries that do not yet have nuclear power plants.

"WANO recognized that this was likely to happen and over the last few years we have developed guidelines, arrangements, for new entrants. Within those guidelines we encourage people who are considering nuclear power to join WANO early," Hawthorne said.

"We have seen the success of [doing] this with new members such as the UAE through Emirates Nuclear Energy Corporation, which joined WANO two years ago, and we have seen interest from Saudi Arabia at this conference although they do not yet have operational [nuclear power] plants," he said.

London-headquartered WANO has regional centers in Atlanta, Moscow, Paris and Tokyo. In September, it opened an office in Hong Kong to house its pre-startup peer review team, which assesses new nuclear power plants under construction. The office, based in the Central District of Hong Kong, is led by Jean-Marie Baggio, WANO's pre-startup peer review team leader.

The Hong Kong office "will serve to assist new entrants as they embark on a nuclear career," Hawthorne said.

"Even the most conservative estimates of nuclear growth would expect more than 50% expansion of the world's existing fleet within the next 15 years. Our job at WANO is to make sure that that expansion is achieved while maintaining the growth in standards and expectations we drive for in our organization," he said.

WANO members operate some 440 nuclear units in more than 30 countries around the world.

— Claire-Louise Isted, Moscow

## Amano ... from page 1

member organizations. That plan has been endorsed by all of the IAEA's 159 member states, Amano said May 20.

Examples of the "solid progress" that has been made include the fact most IAEA member states have completed stress tests at their operating nuclear power plants to ensure their ability to withstand extreme natural events, Amano said. The Fukushima I accident was caused by the combined impact of an earthquake and tsunami on the eastern coast of Japan. Many countries have developed action plans to implement the findings of those stress tests, Amano said.

IAEA safety standards have been "subject to further review," he said, especially related to nuclear power plants and the storage of spent nuclear fuel.

The IAEA has also expanded its program of Operational Safety Review Team, or Osart, reviews, Amano said. In addition, the IAEA established the Emergency Preparedness and

Response Expert Group to strengthen international practice in radiological emergencies, he said.

The IAEA's Action Plan calls on operators to have one Osart peer review within three years, but some countries have not yet requested an Osart, he said. The IAEA has also invited reviews of severe accident management and urged operators to make the results of those reviews public.

Unlike the IAEA's Osart reviews, WANO's nuclear power plant and corporate peer reviews have never been made public, but outgoing WANO President Vladimir Asmolov has championed a change to that policy. Asmolov, who is also first deputy general director of Rosenergoatom, was elected president of WANO in October 2011 at its last biennial general meeting in Shenzhen, China. Rosenergoatom, a subsidiary of Russian state nuclear corporation Rosatom, operates Russia's 33 civilian nuclear power reactors.

In the wake of the accident in Japan, WANO created a Post-Fukushima Commission, which put forward five recommendations for discussion by the WANO Governing Board in advance of the latest BGM. Those recommendations were expanding the scope of WANO's activities; developing a world-wide integrated event response strategy; improving WANO's credibility, including important changes to WANO's peer review process; improving visibility; and improving the quality of all WANO products and services. WANO's board approved the recommendations October 23 and they came into force April 5, Amano said.

As part of their enhanced cooperation, the IAEA has given WANO "broader access" to the agency's web-based database and they have exchanged information on schedules of their peer reviews.

"We plan to coordinate our respective peer reviews in future," Amano said, "in order to reduce duplication [of effort] and also the burden on our members."

### More peer reviews

Ken Ellis, WANO's managing director since April 1, said the organization carried out two corporate peer reviews and 81 nuclear power plant peer reviews between 2011 and 2012.

"We as members all committed, at the 2011 BGM, to complete a corporate peer review [of every WANO member] by the end of 2017. In order to achieve that we have had to schedule 21 corporate peer reviews every year for the next five years. Considering we just did two over the past two years, this represents a significant ramping up of activity and resources in this area," Ellis said.

The frequency of WANO's nuclear power plant reviews is also changing, Ellis said, from every six years to four years, commencing after its meeting in 2015.

WANO completed seven pre-start up nuclear power plant peer reviews in 2011 and five in 2012, Ellis said. It has completed two so far this year and another five are scheduled for 2013, he said.

The IAEA will finalize its report on the Fukushima accident by the end of 2014, Amano said. The report will be an "authoritative and balanced assessment of real value to

experts on the causes and consequences of the accident as well as on lessons learned." The report is a major undertaking, he said, involving more than 100 experts from more than 40 countries.

"Despite the Fukushima accident, nuclear power will remain a very important part of the world's energy needs for at least decades to come," Amano said. There are 436 nuclear power reactors in operation worldwide and that number could increase by at least 80 to 90 units in the next 20 years, he said.

The IAEA will hold its next Ministerial Conference next month in St. Petersburg. That meeting "could prove to be a turning point" for nuclear power, Amano said, "with the emphasis on the way forward."

Created in Moscow 24 years ago, WANO represents 36 countries, including new entrants like Saudi Arabia, WANO Chairman Jacques Regaldo said. Some 640 delegates are attending the meeting in Moscow, he said.

Two years ago, "we decided WANO should become more visible and that is why the press have been invited to all the sessions, with only the Extraordinary General Meeting to be limited to our members," Regaldo said. "This open attitude towards the media will clearly show the seriousness of our discussions and our overriding commitment to safety," Regaldo said.

— Claire-Louise Isted, Moscow

## WANO members 'improving performance' in non-design areas

Members of the World Association of Nuclear Operators, or WANO, are improving their performance in three of the four areas the organization assesses that are not specific to reactor design, according to data presented May 20.

WANO's performance indicator trends reflect the performance of the operating fleet of nuclear power plants. They do not include the units of Fukushima-Daiichi and other units that were permanently shut down after the accidents at Fukushima in 2011.

WANO Managing Director Ken Ellis, who spoke at the organization's 12th biennial general meeting held in Moscow this week, said there had been improvements in the past 10 years in the industry's record on unplanned automatic scrams, forced loss rates and industrial safety accident rates. But there has also been "a slightly degrading trend" in the unplanned capability loss factor.

Formerly executive vice president of Bruce Power, Ellis took over from WANO's previous managing director, George Felgate, April 1.

"We have had continuous improvement for over a decade now in unplanned automatic scrams per 7,000 hours critical, which challenge both equipment and operators," Ellis said. The highest rate between 2000 and 2012 was in 2001, at 1.03, and the lowest was in 2009 and 2012, at 0.46.

There was an "anomaly" in the trend for forced loss rate

in 2010, when it was 1.47, Ellis said. The lowest rate was 1.0, in 2011, and in 2012 it was 1.10, he said.

The industrial safety accident rate shows “dramatic continuous improvement,” he said. The highest rate in the past decade was 1.26 fatalities per 200,000 workers in 2001, while the lowest was 0.21 in 2010, he said. But there have been five fatalities in the nuclear industry in the past six months. “The chart is good news, but five fatalities are unacceptable,” he said.

It will be a challenge, Ellis said, to reverse the trend in unplanned capability loss factor, which was at its highest level of 2.31 in 2010 and lowest of 1.71 in 2009. Last year, it was 2.0, he said.

According to the American Nuclear Society, the unplanned capability loss factor is the percentage of maximum energy generation that a plant is not capable of supplying because of unplanned events, such as unplanned shutdowns or outage extensions.

### Ten-fold increase in events?

The increase in “noteworthy events” reported each year under WANO’s operating experience program is easily misunderstood, Ellis said. Their number has risen each year, from 167 in 2000 to 1,504 in 2012. The increase is “thanks to on-going encouraging of members to report events and the continual lowering of reporting threshold criteria,” he said. This is a “healthy situation” because WANO continues “to extract and benefit from the lesson learned of these cumulative 9,700 events,” he said.

WANO has issued three significant operating event reports, or SOERs, since its 2011 meeting and, in addition to those, four as a result of the Fukushima accident, he said.

It has consolidated three of the SOERs, meaning only two now pertain to Fukushima, he said.

Recommendations by WANO’s Post-Fukushima Commission at the 2011 BGM “spawned” 12 projects, Ellis said. These include the addition of emergency preparedness, severe accident management guidelines, on-site fuel storage, and “some aspects of design” to the scope of WANO activities.

They also include implementation of an integrated emergency response strategy and improved visibility and transparency of the organization. Also on the list is implementation of a real-time event reporting process; addressing “equivalency” of peer reviews by the Institute of Nuclear Power Operations, Japan Nuclear Safety Institute and the IAEA, among others; conducting a corporate peer review of every member within six years; increasing the frequency of nuclear power plant peer reviews from every six to every four years; adding a post-peer review grading process; and conducting internal assessments of each WANO regional center and its London office.

Of those 12 projects, nine have a team leader and an action plan, and “are progressing well,” he said.

“We have to be very thoughtful and selective as to what design aspects WANO wishes to evaluate,” he said, but approval of the scope of this project will be submitted to

WANO’s governing board oversight committee “imminently.”

WANO’s Atlanta center already “more than meets” the aim to increase the frequency of power plant reviews after the biennial meeting in 2015, but “others do not,” he said. To meet this objective the centers must increase staffing levels and deliver associated training, he said.

There has been limited progress on the grading process for nuclear units, he said and a “deliberate decision” was made to hold off on this action while efforts were focussed on the other 11 projects. The Atlanta center has had a grading process in place “for years,” he said, and both the Paris and Moscow centers are about to embark on pilot projects.

WANO completed in late 2012 the project for self-assessments every four years of the four WANO regional centers and the London office. A summary report on this project is in its final stages of approval and will be published shortly, he said. Follow-up reviews will be needed, starting in 2014, he said, with status updates to be reported at each future biennial meeting.

### New report card

In March, WANO approved its new peer review performance objectives and criteria, or PO&C, which take effect in January, Ellis said. “They will be your new report card by which you are measured,” he said.

The new PO&Cs have four sections, he said. “Foundations” details the necessary fundamental behavior of all nuclear workers, regardless of their positions in the organization along with leadership behavior. “Functional areas,” such as operations and maintenance remain as before but with refinements, as does the “cross-functional area,” but this has been expanded to include emergency preparedness, project management, among others. “Corporate” has been included with more details on oversight and governance, he said.

— Claire-Louise Isted, Moscow

## South Korea ... from page 1

exports, she said.

“Some criticized it in South Korea as unsustainable,” she said.

South Korea’s Ministry of Knowledge Economy said in 2011 it planned to secure 20% of the global market for new reactors over the next two decades (NW, 1 Dec. ’11, 1). That goal was scaled back as the impact of the Fukushima I nuclear accident in March of that year was felt, and after realizing there might be a shortage of qualified personnel to develop more than 10 nuclear plants outside South Korea, said co-author Miles Pomper during the same presentation.

### The 'golden case'

South Korea was willing to accept a lower profit margin on the UAE project in view of competition from government-sponsored national nuclear industries in Russia and

China that have offered deals for strategic geopolitical reasons. "You're competing with companies that are not really doing this on economic terms," Pomper said.

"The UAE financial offering is the golden case that will not happen again. This was 'let's make a really low price right now to get Korea's foot in the door,'" Pomper said. That could cause problems negotiating further sales, as future buyers seek similar prices, he said.

Another challenge facing South Korea as it moves to export reactors and components is the fact that portions of the technology that underlies its reactors is owned by Westinghouse, and consequently the country's exports face scrutiny under US laws, Pomper said.

A sale by South Korea of its reactors could be deemed a re-export of US technology, requiring US approval, he said. Those reactor sales may also require that the buying country have a nuclear cooperation agreement with the US meeting the requirements of Section 123 of the Atomic Energy Act, he said. In addition, the US requires such an agreement with South Korea to be in place, he said.

The current US-South Korea Section 123 agreement was set to expire at the end of the year, but the two countries announced last month they were extending the deal by two years after failing to successfully negotiate a new pact (NW, 2 May, 5).

That could limit exports, especially if a new agreement is not reached because of disagreements over whether South Korea should be allowed to pursue enrichment or reprocessing of US-origin nuclear material, Pomper said.

"The United States is going to have a strong say over South Korea's nuclear power plant exports under any scenario," Pomper said.

Future exports will also depend on the availability of personnel, Pomper said. An aggressive domestic reactor construction program and the need to staff the UAE plants being built could stretch the ability of the country to supply qualified workers, the authors said in the paper.

Even with those challenges, South Korea could continue to have success in the Middle East, Kane said. The country's Korea Atomic Energy Research Institute is leading a group that will build a \$130 million research reactor in Jordan, which is planning on starting a commercial nuclear program.

The research reactor contract shows that South Korea is serious about that program, Kane said. Although the country's bid was not selected for a short-list of technologies by Jordan, that tender could be re-opened and South Korea could re-enter it, she said.

A coming tender for power reactors in Saudi Arabia could also be fertile ground for South Korean industry,

Pomper said. The APR1400 reactor being offered by Kepco and its partners has already been customized in the UAE to the security, geographical and grid requirements of the region, he said.

In addition, many regional countries are oil and gas producers, meaning they have revenue to pay for nuclear units and could provide fossil fuel security for South Korea in exchange for plant deals, he said. The UAE contract led to an agreement under which UAE stores six million barrels of oil in South Korea, which that country can use in emergencies, the paper said.

### Factors in UAE win

South Korea leveraged political, financial and cultural factors to win the UAE tender, Kane said.

South Korea and UAE had cooperated previously on trade and infrastructure projects, and the government of South Korea at the highest levels supported the effort, she said. Former President Lee Myung-bak, a former CEO of South Korean construction company Hyundai Engineering, made several visits to UAE in an effort to secure the contract, Kane said. Hyundai Engineering and Construction is a member of the consortium building the new units, she said.

In addition, South Korea offered "diplomatic carrots," or incentives, not linked directly to the deal, but which supported it, Kane said. South Korea agreed to station 200 special forces troops in UAE for two years to provide training to the Gulf nation's security forces, she said. The presence of South Korean troops, and other military cooperation that has been agreed to, could deter potential hostile action from UAE's neighbor and rival Iran, Kane said.

The Korean business model — in which a group of companies, led by Korea Electric Power Co., that had previously built several reactors together domestically — was attractive, Kane said. Other bidders brought together companies that had not worked together previously, or added such partners late in the process, she said.

In addition, the fact that Kepco agreed to shoulder all operational risks for the project was an advantage, Kane said. In the French bid, risks were shared by partners Areva, GDF Suez and Total, she said.

There may have been cultural factors that helped the South Korean bid succeed, Kane said. South Koreans came to believe there were similarities between the two countries, both of which have a legacy of colonialism, developed economically in recent decades and have a strong concern for the preservation of their traditional "ethics and manners," Kane said.

— William Freebairn, Washington

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- ▶ Europe in the context of international nuclear development
- ▶ Establishing nuclear power in Central and Eastern Europe: plans, status and achievements so far
- ▶ New build momentum and uprate potential in Europe: opportunities, risks and timescales
- ▶ Nuclear power in the context of evolving EU energy policy frameworks
- ▶ Having the ability to act - attracting investment, developing skills and maintaining public support in the current climate

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