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January—Special Section on Education, Training & Workforce Development

February—Special Section on Instrumentation & Controls

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Power

Permanent shutdown of Oyster Creek ends 49 years of operation. Illinois's ZEC program is upheld by appeals court. Focus on Finance. Vogtle project sparks dueling lawsuits. New Jersey regulator moves to create ZEC program. A steam generator is put in place at Vogtle-4. NRC to review application for subsequent license renewal for Peach Bottom. NRC approves transfer of Summer licenses from SCE&G to Dominion. California legislation approves funds to ease impact of closure of Diablo Canyon. Brunswick plant, other facilities prepared for Hurricane Florence. MIT study finds that nuclear power is necessary to reduce carbon emissions. Indian Point license renewals issued, but plant shutdown is in sight. NRC agrees that small modular reactors can have smaller emergency planning zones. NRC finds that chilled work environment persists at Watts Bar.

Security

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Nuclear Threat Initiative releases 2018 Nuclear Security Index. Senate Judiciary Committee's Subcommittee on Crime and Terrorism holds hearing on cyber threats to U.S. electrical grid. Top U.S., Indian officials hold talks in New Delhi. Defense Nuclear Facilities Safety Board planning major staff reorganization. Down-blended high-enriched uranium to be used for tritium production. U.S.-Russia workshop on nonproliferation and disarmament held in California. NRC considers alternatives to physical security regulations for advanced reactors.

Policy & Legislation

Senate bill aims to boost U.S. nuclear industry. Environmental Protection Agency defends holding Clean Power Plan in abeyance as Affordable Clean Energy Act moves forward.

International

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Russia's Leningrad-II-1 ready for commercial operation. Cold hydraulic test at Slovakia's Mochovce-3 is completed. United Arab Emirates' Federal Authority for Nu-

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clear Regulation and Khalifa University sign research agreement. Youth council created for future UAE nuclear leaders. NuGeneration advances Moorside as site of new nuclear plant in United Kingdom. International Atomic Energy Agency reviews design safety documentation for Bangladesh's Rooppur nuclear power plant. IAEA report shows decline in world nuclear capacity up to 2050.

Waste Management

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NRC resumes review of Waste Control Specialists' application to build a consolidated interim storage facility for spent fuel. Environmental group petitions NRC over FirstEnergy's decommissioning fund. New water pipeline to be installed at Hanford Site; other Hanford news. Finnish firms to provide low-level waste services to China. NRC issues report on spent nuclear fuel inspection at San Onofre.

Fuel

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Orano launches uranium conversion plant at Tricastin site in France. ASLB hearing scheduled for Crow Butte license amendment request. IAEA publishes interactive digital map of uranium deposits worldwide. Denison Mines to increase stake in Wheeler River project. Anfield Energy announces resource estimate for Charlie Project. Researchers study radionuclide transfer at uranium mine sites in South Australia.

Isotopes & Radiation

Purdue University researchers to patent yeast-based dosimeters. Savannah River National Laboratory licenses hydrogen isotope separation technology. Phoenix to open neutron imaging services center.

Research

Record power level reached in neutron production cycle at Oak Ridge National Laboratory's Spallation Neutron Source. MIT researchers overcome plasma density limit to steadystate fusion operation in a tokamak reactor.

Education, Training & Workforce 92

Savannah River National Laboratory retirees to mentor and teach students at University of South Carolina Aiken. Canadian Nuclear Laboratories and Moscow State University host summer programs for students and specialists. National Nuclear Security Administration launches fellowship program for doctoral students.

Industry

BWX Technologies acquires Sotera Health's Nordion medical isotope business; other business developments. Bechtel is named project management contractor for Wylfa Newydd nuclear plant in North Wales; other contracts. Defects found in circuit boards, selector switch; other 10 CFR Part 21 reports.

Standards

Two standards approved, comments requested on three others.

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Texts of most Nuclear News articles are available on the LexisNexis database, from Mead Data Corporation.



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Nuclear Notes

Striving for excellence even while facing challenges

ver the past several weeks, a broad range of nuclear industry stories has played out in the news, some featuring positive developments and others presenting challenges the industry is facing.

The permanent shutdown of Exelon Generation's Oyster Creek plant—a single-unit 625-MWe boiling water reactor

in Forked River, N.J.—is one of those in the "others" category. Oyster Creek began commercial operation in 1969, and at the time of its shutdown on September 17 was the oldest operating commercial nuclear power plant in the United States. Under an agreement with the state, Exelon agreed to retire the plant, which was halfway into its 20-year license renewal period, as the

utility could not justify the cost of constructing the cooling towers that were being required in order for the plant to continue operating. The tally for U.S. plant shutdowns this decade: seven. For details, see the lead story of the Power section on page 20.

In the "positive developments" category, fortunately, there are a number of stories to cite, including the following:

■ An Illinois appeals court has upheld the state's zero emissions credit (ZEC) program (page 22).

■ New Jersey's Board of Public Utilities has initiated a proceeding to establish a ZEC program for its remaining nuclear plants (page 24).

■ The owners of the Vogtle-3 and -4 AP1000 reactors being built at the existing Vogtle site in Waynesboro, Ga., voted to continue construction work, despite an anticipated \$2.3-billion cost increase (page 17), and another milestone was achieved at Unit 4 (page 24).

■ Legislation was introduced in the U.S. Senate to support advanced nuclear energy goals (page 39).

■ The first AP1000 reactor—adapted from Westinghouse's design—has begun commercial operation at China's Sanmen site (page 18).

The Special Section on Outage Management and Plant Maintenance also reflects the current environment in which the nuclear industry finds itself. The first article provides an overview of the spring outage at First Energy Nuclear Operating Company's (FENOC) Davis-Besse plant near Oak Harbor, Ohio. The plant's 20th outage, dubbed the "Drive For 25," was completed in just under 25 days, setting a plant record. The outage was approached with the mindset that things needed to be done differently in order to achieve the designated work scope within the allotted time frame and

Although the nuclear industry continues to face a number of challenges in a changing energy environment, it is still working to achieve and maintain plant safety and reliability. involved two years of detailed, careful planning. Three months prior to the start of the outage, however, FirstEnergy decided to spin off FirstEnergy Solutions and FENOC into stand-alone companies, resulting in speculation about the company and the future of the plant. Under that shadow of uncertainty, the outage team realized that achieving their goals was more important

than ever, and although Davis-Besse now faces the possibility of permanent shutdown within the next few years, there is still hope that state legislation could be passed to provide the equitable consideration of nuclear as a clean energy source. Read about the accomplishments of Davis-Besse's outage team starting on page 44.

Also in the special section is a report by Associate Editor Michael McQueen on the ANS Utility Working Conference, held August 5–8 at the Omni Amelia Island Plantation Resort in Florida. The report leads with three of the sessions on maintenance and work management issues, followed by two of the daily plenary sessions. Similar to Davis-Besse's approach to its 20th refueling and maintenance outage, the topics covered in the UWC sessions also emphasized the need to change how things are done in order to achieve different and better—results. Maintaining a skilled workforce, improving efficiency, and reducing expenditures were discussed and deemed necessary to help ensure the viability of the nuclear industry. Also addressed were the challenges facing the industry, most notably in the areas of policy, regulation, and the economy. McQueen's report begins on page 58.

I noted in my May 2017 editorial that the news at that time was inclined to induce whiplash, and in many ways, that is still occurring. It does seem, however, that more recently, the positives have outweighed the negatives—at least for now.—*Betsy Tompkins, Editor and Publisher*

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Calendar

October

Oct. 17–18 **Celebrating 90 Years of Expertise—Radiation Protection in the Next Decade,** Stockholm, Sweden. Hosted by the Swedish Radiation Safety Authority (SSM), with the International Commission on Radiological Protection and the International Commission on Radiation Units and Measurements. Contact: Andrea Wolde, SSM, phone +46 8 799 40 00; fax +46 8 799 40 10; email <andrea.wolde@ssm. se>; Web <www.stralsakerhetsmyndigheten.se/en/icrpicru90>.

Oct. 22–24 International Conference on Dismantling Challenges: Industrial Reality, Prospects, and Feedback Experience, Avignon, France. Organized by the French Nuclear Energy Society (SFEN). Contact: SFEN, phone +33 1 53 58 32 12; email <dem2018@sfen.org>; Web <www.sfen-dem2018.org/>.

Oct. 22–27 **27th IAEA Fusion Energy Conference (FEC 2018),** Gandhinagar, India. Organized by the International Atomic Energy Agency. Contact: IAEA, email form <www.iaea.org/contact/ official-mail>; Web <www.iaea.org/events/fec-2018>.

Oct. 24–26 International Symposium on Cement-based Materials for Nuclear Wastes, Avignon, France. Organized by the French Commission for Atomic and Alternative Energies and the French Nuclear Energy Society (SFEN). Contact: Patricia Hamel-Bloch, SFEN, email cpatricia.hamel-bloch@sfen.org>; Web <www.sfen-nuwcem2018.org/>.

Oct. 28–31 International Uranium Fuel Seminar, Boston, Mass. Sponsored by the Nuclear Energy Institute. Contact: NEI, phone 202/739-8000; fax 202/785-4019; email <conferences@nei.org>; Web <www.nei.org/conferences>.

Oct. 28–Nov. 1 National Organization of Test, Research, and Training Reactors (TRTR) Annual Conference, Newport, R.I. Hosted by the Rhode Island Nuclear Science Center. Contact: Cameron Goodwin, phone 401/874-9437; email <cgoodwin@rinsc. ri.gov>; Web <www.trtr.org>.

Oct. 29–31 **Thorium Energy Conference 2018 (ThEC18),** Brussels, Belgium. Organized by Thorium Energy World. Contact: Thorium Energy World, phone +0046 70 200 88 40; email <info@ thoriumenergyworld.com>; Web <www.thoriumenergyworld.com/ conference.html>.

Oct. 30–Nov. 2 **14th Specialists' Workshop on Shielding Aspects of Accelerators, Targets, and Irradiation Facilities (SATIF-14),** Gyeongju, South Korea. Hosted by the Korea Multipurpose Accelerator Complex (KOMAC) and the Pohang Accelerator Laboratory. Contact: Sung Kyun Park, KOMAC, email <skpark4309@ kaeri.re.kr>; Web ">http://pal.postech.ac.kr/satif14/>.

November

Nov. 4–8 **23rd Nuclear Inter Jura Congress,** Abu Dhabi, United Arab Emirates. Organized by the International Nuclear Law Association. Contact: INLA, phone +32 2 547 58 41; fax +32 2 503 04 40; email <info@aidn-inla.be>; Web <http://aidn-inla.be/event/ nuclear-inter-jura-2018-abu-dhabi/>.

Nov. 5–8 **Symposium on International Safeguards: Building Future Safeguards Capabilities,** Vienna, Austria. Sponsored by the International Atomic Energy Agency. Contact: IAEA, phone +43 1 2600 0; fax +43 1 2600 7; email form <www.iaea.org/ contact/official-mail>; Web <www.iaea.org>.

Nov. 6–7 **Managing Risk in the National Critical Infrastructure,** Rockville, Md. Sponsored by EXCEL Services Corporation. Contact: Celine Ryan, EXCEL Services, phone 301/984-4400; Web <https://excelservices.com/cip/>.

Nov. 6–8 **7th International Conference on Nuclear Decommissioning (ICOND 2018),** Aachen, Germany. Sponsored by the Aachen Institute for Nuclear Training GmbH. Contact: John Kettler, AINT, phone +49 2402 127505 111; email <contact@nucleartraining.de>; Web <www.icond.de/>.

Nov. 10–17 **2018 IEEE Nuclear Science Symposium and Medical Imaging Conference (NSS/MIC)**, co-located with the **25th International Symposium on Room-Temperature Semiconductor X-Ray and Gamma-Ray Detectors (RTSD)**, Sydney, Australia. Sponsored by the IEEE Nuclear & Plasma Sciences Society. Contact: Christina Sanders, email <nssmic.regchair@gmail.com>; Web <www.nssmic.org/2018/>.

Nov. 11–15 **2018 ANS Winter Meeting and Nuclear Technology Expo**, Orlando, Fla. Sponsored by the American Nuclear Society. Contact: email <meetings@ans.org>; Web <www.ans.org/ meetings/c_1>.

Nov. 11–15 **Embedded Topical: International Topical Meeting on Advances in Thermal Hydraulics—2018,** Orlando, Fla. Sponsored by the ANS Thermal Hydraulics Division. Contact: John Luxat, McMaster University, phone 905/525-9140; email <luxatj@mcmaster.ca>; Web <www.ans.org/meetings/c_1>.

Nov. 11–15 Advances in Nuclear Nonproliferation Technology and Policy Conference, Wilmington, N.C. Sponsored by the ANS Nuclear Nonproliferation Policy and Fuel Cycle and Waste Management Divisions. Contact: John Mattingly, North Carolina State University, phone 919/515-0224; email <jkmattin@ncsu.edu>; Web <http://nnp.ans.org>.

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Meetings listed in the Calendar that are not sponsored by ANS do not have the endorsement of ANS, nor does ANS have financial or legal responsibility for these meetings.

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ANS event.

[□] Non-ANS event cosponsored by ANS.

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Calendar

Continued from page 6

Nov. 12–15 **Embedded Topical: 23rd Topical Meeting on the Technology of Fusion Energy (TOFE),** Orlando, Fla. Sponsored by the ANS Fusion Energy Division. Contact: Leigh Winfrey, University of Florida, phone 352/273-0297; email <winfrey@mse.ufl. edu>; Web <www.ans.org/meetings/c_1>.

Nov. 14–15 **Division of Spent Fuel Management Regulato**ry Conference 2018 (DSFM REG CON), Rockville, Md. Hosted by the Nuclear Regulatory Commission's Office of Nuclear Material Safety and Safeguards, Division of Spent Fuel Management. Contact: Haile Lindsay, NRC, phone 301/415-0616; email <haile.lindsay@nrc.gov; Web <www.nrc.gov/public-involve/conference-symposia/dsfm.html>.

Nov. 19–21 **3rd International Conference on Fusion Neutron Sources and Subcritical Fission Systems (FUNFI3),** Hefei, Anhui, China. Sponsored by the Institute of Nuclear Energy Safety Technology at the Chinese Academy of Sciences. Contact: FUNFI3, email <funfi@fds.org.cn>; Web <www.ans.org/meetings/m_303>.

Nov. 28–29 **Nuclear Plant Digitalization Conference,** Charlotte, N.C. Organized by Nuclear Energy Insider. Contact: Charlotte Howlett, Nuclear Energy Insider, phone 800/814-3459, ext. 7182; email <chowlett@nuclearenergyinsider.com>; Web <https://analysis. nuclearenergyinsider.com/>.

Nov. 28–30 Ministerial Conference on Nuclear Science and Technology: Addressing Current and Emerging Development Challenges, Vienna, Austria. Sponsored by the International Atomic Energy Agency. Contact: Martina Neuhold, IAEA, phone +43 1 2600 21314; fax +43 1 2600 7; email <m.neuhold@iaea.org>; Web <www.iaea.org>.

December

Dec. 1–3 **4th International Conference on Radiation Effects and Radiation Protection (RERP 2018),** Sanya, China. Sponsored by the Engineering Information Institute, the Open Access Library, and others. Contact: Ms. Rolin, phone +86 155 27752170; email <phy.feb@engii.org>; Web <www.engii.org/conference/ rerp2018/>. •

Dec. 3–7 International Conference on the Security of Radioactive Material: The Way Forward for Prevention and Detection, Vienna, Austria. Sponsored by the International Atomic Energy Agency. Contact: Martina Khaelss, IAEA, phone +43 1 2600 21315; email <m.khaelss@iaea.org>; Web <www.iaea.org/events/ security-of-radioactive-material-conference-2018>.

Dec. 4–5 **Fusion Power Associates (FPA) 39th Annual Meeting and Symposium,** Washington, D.C. Sponsored by FPA. Contact: FPA, email <fusionpwrassoc@aol.com>; Web <https:// fusionpower.org/registrationform.html>.

January

Jan. 22–24 INMM Spent Fuel Management Seminar-XXXIV, Alexandria, Va. Sponsored by the Institute of Nuclear Materials Management. Contact: INMM, phone 856/380-6813; fax 856/439-0525; email <inmm@inmm.org>; Web <www.inmm.org>.

February

Feb. 5–7 **Conference on Nuclear Training and Edu**cation (CONTE 2019), St. Augustine, Fla. Sponsored by the ANS

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Education, Training and Workforce Development Division. Contact: Russ Godwin, Southern Company, email <frgodwin@southernco. com>; Web <http://conte.ans.org/>.

Feb. 9–14 IIth Nuclear Plant Instrumentation, Control and Human-Machine Interface Technologies (NPIC& HMIT) 2019, Orlando, Fla. Sponsored by the ANS Human Factors, Instrumentation & Controls Division. Contact: Daniel Churchman, Southern Nuclear Operating Company, phone 205/992-5236; email <dchurchm@southernco.com>; or Jason Remer, Nuclear Energy Institute, phone 202/431-8204; email <sjr@nei.org>; Web <http://npichmit.ans.org/>.

Feb. 12–14 **Nuclear Deterrence Summit,** Arlington, Va. Organized by ExchangeMonitor Publications & Forums. Contact: Sarah Plombon, ExchangeMonitor, phone 301/354-1520; email <splombon@exchangemonitor.com>; Web <www.deterrencesummit. com>.

Feb. 17–20 **HPS 52nd Midyear Meeting,** San Diego, Calif. Sponsored by the Health Physics Society. Contact: HPS, phone 703/790-1745; email <hps@burkinc.com>; Web <www.hps.org>.

Feb. 25–27 **Nuclear and Emerging Technologies for Space** (NETS) 2019, Richland, Wash. Sponsored by the ANS Aerospace Nuclear Science & Technology Division and the Eastern Washington local section. Contact: Andrew Klein, Oregon State University, phone 541/737-7061; email <andrew.klein@oregonstate.edu>; Web <www. ans.org/meetings/m_298>.

March

Mar. 3–7 **WM Symposia 2019,** Phoenix, Ariz. Organized by WM Symposia, Inc. Contact: Selly Soetarso, WM Symposia, phone 480/557-0263; email <selly@wmarizona.org>; Web <www.wmsym. org/>.

Mar. 10–14 **9th International Symposium on Supercritical-Water-Cooled Reactors (ISSCWR-9),** Vancouver, British Columbia, Canada. Hosted by the Canadian Nuclear Society. Contact: Lori Walters, Canadian Nuclear Laboratories, phone 613/584-3311, ext. 46057; email <lori.walters@cnl.ca>; Web <www.cns-snc.ca/ events/isscwr9/>.

Mar. 12–13 **Just Trust Me Workshop,** Albuquerque, N.M. Sponsored by the Institute of Nuclear Materials Management. Contact: INMM, phone 856/380-6813; fax 856/439-0525; email <inmm@ inmm.org>; Web <www.inmm.org/just-trust-me-workshop>.

Mar. 27–29 **I4th International Symposium—Conditioning** of Radioactive Operational and Decommissioning Wastes (KONTEC 2019), Dresden, Germany. Organized by atm. Contact: Andrea Weiss, atm, phone +49 40 228 13 77 90; fax +49 40 228 13 77 99; email <contact@kontec-mannheim.de>; Web <www.kontecsymposium.com/en/home>.

April

Apr. 2–3 International SMR and Advanced Reactor Summit 2019, Atlanta, Ga. Sponsored by Nuclear Energy Insider. Contact: Ben Moss, Nuclear Energy Insider, phone +44 0 20 7375 7537 or U.S. toll-free 800/814-3459, ext. 7537; email

emoss@fc-bi.com>;
Web <https://analysis.nuclearenergyinsider.com/>.

Apr. 4–6 **ANS Student Conference**, Richmond, Va. Sponsored by ANS. Contact: email form http://studentconf.ans.org/

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St. Lucie Nuclear Power Plant

Thursday, November 15 7:30 am - 4:30 pm

The St. Lucie Nuclear Power Plant, located on Hutchinson Island and operated by Florida Power & Light, operates two combustion engineering pressurized water reactors. With a combined output of 2,000 megawatts of electricity, the reactors can power over 1 million homes. Tour the turbine deck and power block, and the control room simulator. Learn about PSL's commitment to protecting the 180 species of birds and animals that inhabit the property in their wildlife preserve. Mitsubishi Hitachi Power Systems Orlando Service & Manufacturing Center Thursday, November 15 8:15 am - 12:00 pm

The Service Center provides repair services to extend the life of combustion and turbine components for mature and advanced frame gas turbines from multiple manufacturers. The Manufacturing Center utilizes highly automated machining operations, productivity-enhancing systems, and "lean" manufacturing techniques designed to ensure best-quality and rapid availability of both gas and steam turbine parts. Learn about the company and safety, visit the Remote Monitoring Center, and tour the shop.

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Calendar

April—continued

contact-us/>; Web <http://studentconf.ans.org/>.

Apr. 9–11 **World Nuclear Fuel Cycle**, Shanghai, China. Organized by the Nuclear Energy Institute and the World Nuclear Association. Contact: Michael Jordan, NEI, phone 202/739-8000; email <mjj@nei.org>; Web <www.wnfc.info/>.

Apr. 14–18 International High-Level Radioactive Waste Management 2019 (IHLRWM 2019), Knoxville, Tenn. Sponsored by the ANS Fuel Cycle & Waste Management Division and the ANS Oak Ridge/Knoxville local section. Contact: John Scaglione, Oak Ridge National Laboratory, phone 865/574-9284; email <scaglionejm@ornl. gov>; or Rob Howard, ORNL, phone 865/241-5750; email <howardrll@ ornl.gov>; Web <http://ihlrwm.ans.org/>.

Apr. 22–26 **12th International Conference on Tritium Science and Technology (Tritium 2019),** Busan, South Korea. Organized by the National Fusion Research Institute. Contact: Tritium 2019, email <tritium2019@nfri.re.kr>; Web http://tritium2019.

Apr. 23–26 **Electric Power Conference and Exhibition**, Las Vegas, Nev. Sponsored by Access Intelligence. Contact: Kim Arellano, Access Intelligence, phone 713/343-1879; email <karellano@accessintel. com>; Web <http://2019.electricpowerexpo.com/>.

Apr. 28–May 3 **2019** International Topical Meeting on **Probabilistic Safety Assessment and Analysis (PSA 2019),** Charleston, S.C. Sponsored by the ANS Nuclear Installations Safety Division and the ANS Savannah River and Columbia local sections. Contact: Kevin O'Kula, AECOM Technical Services, phone 803/502-9620; email <kevinokula@aecom.com>; Web <http://psa.ans.org/2019/>.

And coming up (ANS meetings) . . .

2019 ANS Annual Meeting, June 9–13, 2019, Minneapolis, Minn.

Utility Working Conference and Vendor Technology Expo, Aug. 4–7, 2019, Amelia Island, Fla.

19th International Conference on Environmental Degradation of Materials in Nuclear Power Systems—Water Reactors, Aug. 18–22, 2019, Boston, Mass.

18th International Topical Meeting on Nuclear Reactor Thermal Hydraulics, Aug. 18–22, 2019, Portland, Ore.

International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering (M&C 2019), Aug. 25–30, 2019, Portland, Ore.

Global/Top Fuel 2019, Sept. 22–27, 2019, Seattle, Wash.

Materials in Nuclear Energy Systems (MINES), Oct. 6–10, 2019, Baltimore, Md.

2019 ANS Winter Meeting and Nuclear Technology Expo, Nov. 17–21, 2019, Washington, D.C.

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Publications

Recently Published



Crossing Nuclear Thresholds: Leveraging Sociocultural Insights into Nuclear Decisionmaking, edited by Jeannie L. Johnson, Kerry M. Kartchner, and Marilyn J. Maines. This book applies the sociocultural model pioneered in the authors' earlier volume, *Strategic Culture and Weapons of Mass Destruction: Culturally Based Insights into Comparative National Security Policymaking* (Palgrave Macmillan, 2009), with an eye toward isolating those vectors of

nuclear decision-making on which the United States might exert influence within a foreign state. The case studies included in this volume tackle a number of the nuclear challenges-termed "nuclear thresholds"—likely to be faced by the United States and identify the most promising points of leverage available to American policymakers in dealing with a wide range of over-the-horizon nuclear challenges. Near- and medium-term nuclear thresholds are likely to involve both allies and adversaries, meaning that the U.S. response will require strategies tailored to the perception of a threat experienced by the actors in question, the value the actors place on their relationship with the United States, and the domestic context driving decisionmaking. This volume offers a nuanced look at each actor's identity, national norms, values, and perceptual lens in order to offer culturally focused insights into behavior and intentions. (227 pp., HB, \$119.99, ISBN 978-3-319-72669-4; eBook, \$89, ISBN 978-3-319-72670-0. Order from Springer International Publishing: phone 212/460-1500; fax 212/460-1700; email <customerservice@springernature.com>; Web <www.springer.com>.)



Geologic Disposal of High-Level Radioactive Waste, by Roland Pusch, Raymond N. Yong, and Masashi Nakano. This book presents the best practices for the disposal of spent nuclear fuel and compares the two leading methodologies, deep borehole disposal and mined repository. It assesses the waste isolation capacities in both the short and long term, along with the associated risks, and describes site selection principles and the economics of the construction of different types of repositories. An appen-

dix provides the latest international recommendations and guidelines concerning the disposal of high-level radioactive waste. (220 pp., HB, \$179.95, ISBN 978-0-8153-6766-6. Order from CRC Press: phone 800/634-7064; fax 800/374-3401; email <orders@crcpress.com>; Web <www.crcpress.com>.)



Review of Particle Physics, M. Tanabashi et al., Particle Data Group, published in the American Physical Society journal *Physical Review D*. Sometimes referred to as the "bible of particle physics," the *Review* is an evaluation of the properties of all the known elementary particles and of searches for new hypothetical ones. The 2018 edition marks the 60th anniversary of the founding of the international Par-

ticle Data Group (PDG), which produces the *Review*. It contains 118 review articles summarizing the latest information on particle physics and related areas such as cosmology. Since

its inception, the PDG has been based at the Department of Energy's Lawrence Berkeley National Laboratory. (1,898 pp., free download at <https://doi.org/10.1103/PhysRevD.98.030001>.)

ANS Technical Journals



Fusion Science and Technology October 2018

First-Principles Study of Helium Trapping in Carbide Precipitates (Cr₂₃C₆) in Ferritic-Martensitic Steels *J.-L. Cao et al.*

Recent EUROfusion Achievements in Support of Computationally Demanding Multiscale Fusion Physics Simulations

and Integrated Modeling I. Voitsekhovitch et al.

Necessary Extensions and Modification of Fluid Transport Theory for the Tokamak Plasma Edge W. M. Stacey

Effect of Cold Working and Aging Treatment on Mechanical Performance of SS316LN Tube *H. Jin et al.*

Neutrons from Muon-Catalyzed Fusion and Muon-Capture Processes in an Ultradense Hydrogen H(0) Generator L. Holmlid

Quench Detection Design for CFETR CSMC T. Wang et al.

Preliminary Comparison of Wet Bypass Accident Consequences Between ITER and a Helium-Cooled Fusion Power Plant S. Chen et al.

Thermal Release Behavior of Tritium from Tungsten After Implantation by Glow Discharge Z. Chen et al.

Simulation and Optimization of Hydrogen Displacement Adsorption Process for Hydrogen Isotope Enrichment/Separation Q.-H. Lei et al.



Nuclear Science and Engineering October 2018

Functionalization of the Discontinuity Factor in the Albedo-Corrected Parameterized Equivalence Constants (APEC) Method W. Kim et al.

The RAPID Fission Matrix Approach to Reactor Core Criticality Calculations

W. J. Walters et al.

A 2D/1D Algorithm for Effective Cross-Section Generation in Fast Reactor Neutronic Transport Calculations *B. Faure et al.*

Prediction of the Prompt Neutron Multiplicity Distribution v(A) for ²³⁵U(n,f) and ²³⁹Pu(n,f) in the Incident Energy Range of Multi-Chance Fission A. Tudora et al. Analytical Studies of Three-Dimensional Evaluation of Radionuclide Distribution in Zeolite Wastes Through Gamma Scanning of Adsorption Vessels *T. Matsumura et al.*

SENSMG: First-Order Sensitivities of Neutron Reaction Rates, Reaction-Rate Ratios, Leakage, $k_{\rm eff}$, and α Using PARTISN J. A. Favorite



Nuclear Technology October 2018

Potential Recovery Actions from a Severe Accident in a PWR: MELCOR Analysis of a Station Blackout Scenario J. Wang et al.

Transient Thermal-Hydraulic Analysis of Single Flow Channel Blockage in the JRR-3M 20-MW Research Reactor *Y. Guo et al.*

Comparison of Wall Treatments and Meshes in Large-Eddy Simulations of Mixing Tees A. Timperi

At the ANS Nuclear Cafe . . .

Hurricane Florence no problem for nuclear power plants

Posted on September 13, 2018 By James Conca

This excerpt is from a post in the ANS Nuclear Cafe the day prior to the anticipated landfall of Hurricane Florence.

Along with most everyone else, nuclear power plants in North and South Carolina, as well as Virginia, have been preparing for the natural onslaught.... "We anticipate Hurricane Florence to be an historic storm that will impact all customers," said Grace Rountree, a spokeswoman for Duke. These reactors provide power to about 4 million customers in the two Carolinas.

The Brunswick plant has withstood several hurricanes since the two reactors there began operation in the mid-1970s, including Category 3 Hurricane Diana in 1984 and Category 3 Hurricane Fran in 1996. Category 4 Hurricane Hugo—the most often compared with Florence—made landfall about 150 miles southwest of Brunswick in South Carolina in 1989....

The Carolinas have a heavy concentration of power reactors—12 of the country's 99 reactors. Four more reactors are in Virginia and five are in coastal Delaware and Maryland. These reactors provide enough electricity to power 30 cities the size of Raleigh.

Nuclear is the only energy source immune to all extreme weather events, by design. Plants have steel-reinforced concrete containments with over 4-foot-thick walls. The buildings housing the reactors, vital equipment, and used fuel have steel-reinforced concrete walls up to 7 feet thick, which Applications for Thorium in Multistage Fuel Cycles with Heavy Water Reactors T. Ault et al.

Ab Initio Calculation of Spectral Absorption Coefficients in Molten Fluoride Salts with Metal Impurities E. S. Chaleff et al.

Influence of Coolant ⁶Li Concentration on the Neutronic Parameters of Lithium-Cooled Reactor *B. Hong et al.*

Demonstration of Under Sodium Viewer in Monju K. Aizawa et al.

Evaluation of Nuclear Warhead Symmetry Detection by Compton Camera *Y. Zhang et al.*

Criticality Detection Method Based on Fission Product Gamma Radioactivity Measurement Y. Naito, K. Azekura

Estimation on Feeding Portions of Slitting Decladded Fuel Fragments to Electrolytic Reduction Process J.-W. Lee et al.

Postclosure Performance Assessment of a Hypothetical Canadian Deep Geological Repository for Thorium-Containing Advanced Heavy Water Reactor Fuels N. Chornoboy et al.



are built to withstand any category hurricane or tornado. They can even withstand a plane flying directly into them.

Not so for many other parts of our power systems. Weatherrelated disruptions of our electrical grid have become the dominant disturbances over the last 20 years, especially in the last several. This has resulted from an increase in extreme weather plus an increasingly aging energy infrastructure, most of which is over 40 years old. Some pipelines have passed 100 years.

The costs for these storms over the last 10 years have exceeded \$400 billion. Fortunately, the nuclear industry has kept up its infrastructure better than any other industry except perhaps high-speed communications.

Last year, when Hurricane Irma made landfall in Florida in early September, Florida Power & Light shut three of the four nuclear reactors at its Turkey Point and St. Lucie nuclear plants in southern Florida. Texas nuclear plants weathered Hurricane Harvey easily as well.

Last summer, a heat wave cooked America with extreme temperatures, affecting most energy production. . . . Fortunately, nuclear power didn't mind, scoring record capacity factors of 96 percent and up, with no increase in price. Other energy sources did not fare so well, and some gas plants gouged consumers just because they could.

In 2014, a Polar Vortex shut down natural gas and coal plants, and stopped wind turbines and solar generation. But nuclear performed wonderfully and provided more power to the hard-hit Northeast than any other source.

Whether it's hurricanes, floods, earthquakes, heat waves, or severe cold, nuclear performs more reliably than anything else. There's no better reason to retain our nuclear fleet, and even expand it, to give us a diverse energy mix that can handle any natural disaster that can occur.

This is an excerpt from an article posted at the ANS Nuclear Cafe. Read the complete article at: http://ansnuclearcafe.org/2018/09/13/hurricane-florence-no-problem-for-nuclear-power-plants/

WHEN A WORLD LEADER IN COMMERCIAL NUCLEAR R&D TEAMS UP WITH THE WORLD'S TOP EXPERT IN NUCLEAR REACTOR LIFE-EXTENSION, GREAT THINGS HAPPEN.

Canadian Nuclear Laboratories, Vice-President of Research & Development Dr. Kathryn McCarthy

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Late News



Vogtle: The plant co-owners have voted to continue the construction of Units 3 and 4. (Photo: Georgia Power)

Late News This Month

Construction of the new Vogtle units will continue
NuScale has selected BWXT to manufacture its SMR17
A nuclear bill aimed at getting advanced reactors
South Africa's nuclear new build plans are on hold
China's Sanmen-I began commercial operation
Zion's license will be transferred back to Exelon
ANO will load fuel with Framatome's ATF cladding18
INL's TREAT facility has resumed operations
The demolition of the Plutonium Finishing Plant83
A Senate hearing on accident-tolerant fuels
20-year license extensions for Olkiluoto-I and -2
Holtec's proposed spent fuel storage facility
President Trump released a National

ANS

► CONSTRUCTION OF THE NEW VOGTLE UNITS WILL CONTINUE, fol-

lowing the resolution of a disagreement between the plant co-owners over the project's costs. Two of Vogtle's three major owners, Southern Company subsidiary Georgia Power, the lead owner, with a 45.7 percent share, and the Municipal Electric Authority of Georgia (MEAG Power), a 22.7 percent owner, voted on September 24 to move forward with construction. The vote was triggered by a \$2.3-billion cost increase announced by Southern in August (*NN*, Sept. 2018, p. 20). The third major owner, however, Oglethorpe Power, a power supply cooperative that holds a 30 percent share of Vogtle, offered only "conditional" support, arguing that a cap on future project cost overruns was needed to protect its members. While Georgia Power termed Ogle-thorpe's position "unreasonable," the utilities agreed to further discussions and extended the deadline for a final vote to September 26. Late on the 26th, the co-owners jointly issued a press release announcing that all parties had voted to proceed with the project. "In connection with the votes to continue construction . . . the co-owners agreed to finalize and execute definitive agreements, which helps mitigate financial exposure for each of them," the press release stated.

Under the agreements, filed with the Securities and Exchange Commission on September 26, Georgia Power would pay 55.7 percent of costs that exceed the current "estimated cost at completion" (EAC) by \$800 million to \$1.6 billion. For costs exceeding the EAC by \$1.6 billion to \$2.1 billion, Georgia Power would be responsible for 65.7 percent. If EAC overages exceed \$2.1 billion, the SEC filing states, MEAG Power and Oglethorpe will have a one-time option to sell a portion of their ownership shares in Vogtle to Georgia Power "in exchange for Georgia Power's agreement to pay 100 percent of such Vogtle owner's remaining share of construction costs."

NUSCALE HAS SELECTED BWXT TO MANUFACTURE ITS SMR, with

engineering work to begin immediately. NuScale Power announced on September 25 that BWX Technologies has been contracted for the first phase of manufacturing for NuScale's small modular reactor. During this phase, which is expected to continue through June 2020, BWXT will refine NuScale's design for manufacturability, assembly, and transportability. NuScale plans to issue contracts for the remaining two phases of manufacturing—preparation for fabrication, and fabrication—at a later date.

BWXT was chosen after an 18-month selection process that NuScale said drew expressions of interest from 83 companies based in 10 countries. According to NuScale, BWXT plans to use Pennsylvania-based Precision Custom Components as a component manufacturing subcontractor for the project.

NuScale describes its SMR as "a safer, smaller, and scalable version of pressurized water reactor technology" that is capable of supplying energy for electricity generation, district heating, desalination, and process heat applications. A factory-fabricated NuScale Power Module could generate up to 60 MWe (gross), and up to 12 individual power modules could be housed at one power plant. NuScale submitted a design certification application to the Nuclear Regulatory Commission in January 2017, and the NRC staff's review of the application is currently targeted for completion in September 2020. NuScale expects the first plant to be deployed by Utah Associated Municipal Power Systems on a site at Idaho National Laboratory in the mid-2020s.

A NUCLEAR BILL AIMED AT GETTING ADVANCED REACTORS to market more quickly was signed into law by President Trump on September 28. The Nuclear Energy Innovation Capabilities Act (S. 97), sponsored by Sen. Mike Crapo (R., Idaho), was passed by a voice vote in the House of Representatives on September 13. The Senate passed the bill in March. The new law establishes an advanced nuclear energy licensing cost-share program between industry and the federal government to accelerate the deployment of small modular reactors and advanced reactor technologies. It also requires the Department of Energy to award grants to cover a portion of the fees the Nuclear Regulatory Commission charges for licensing activities for advanced nuclear reactor designs. Other provisions of the law direct the DOE to develop a reactor-based fast neutron source to test advanced reactor fuels and materials and to establish a high-performance computer modeling and simulation program to advance the development of new reactor technologies. "The passage of this legislation underscores the strong bipartisan commitment in Congress that nuclear energy must be maintained as a reliable, safe, clean, and efficient part of our national energy portfolio," Crapo said in a statement. "S. 97 will eliminate barriers to innovation within the private sector and strengthen collaboration with our national labs to maintain American preeminence in nuclear energy."

Continued



Sanmen: The Unit I reactor is the first Westinghouse AP1000 to enter commercial operation.

SOUTH AFRICA'S NUCLEAR NEW BUILD PLANS ARE ON HOLD

until after 2030, under the government's new Integrated Resource Plan (IRP 2018). The new plan updates IRP 2010, which projected power generation requirements for the period 2010–2030 and included 9.6 GWe of new nuclear capacity. Efforts to implement a nuclear program encountered many delays, however, including a high court ruling that in developing the plan, the government had made procedural errors that needed correcting before going forward (*NN*, June 2017, p. 18). The new plan, without any additional nuclear capacity, was approved by the cabinet on August 22 and released by South Africa's Department of Energy on August 27 for a 60-day public comment period.

At a media briefing, Minister of Energy Jeff Radebe explained that the electricity generation and distribution landscape in South Africa has changed substantially, and many of the assumptions used in developing IRP 2010 had not materialized. For example, electricity demand in the financial year ending in March was 30 percent below the 2018 level projected in IRP 2010, while the use of new generation technologies, such as solar and wind, has grown rapidly because of a significant decline in costs.

Radebe noted that most of the 18,000 MWe of new production capacity ordered under IRP 2010 by Eskom, the national electricity generator, involving coal-fired generation, pumped storage, and renewable energy, is already in production. The only new capacity to be added from now to 2030 under IRP 2018 is 1,000 MWe of coal generation, 2,500 MWe of hydro, 5,670 MWe of solar, 8,100 MWe of wind power, and 8,100 MWe of natural gas. As for nuclear, IRP 2018 calls for further studies to inform the future energy mix beyond 2030.

CHINA'S SANMEN-I BEGAN COMMERCIAL OPERATION on September 21, according to owner China National Nuclear Corporation (CNNC), following the completion of 168 hours of continuous operation at full power to demonstrate commercial readiness. Sanmen-1 is the lead of four Westinghouse Generation III AP1000 units being constructed in China; the others are CNNC'S Sanmen-2 and the two Hai-yang units owned by China Power Investment Corporation. The Sanmen plant is located in coastal Zhejiang Province, and Haiyang in east China's Shandong Province.

The construction of Sanmen-1 formally started on March 29, 2009, with the first pour of concrete for the reactor foundations. Fuel loading began on April 25 of this year, and the reactor reached first criticality on June 2. It was connected to the grid on June 30 and reached full power for the first time on August 14.

Regarding the status of the other AP1000 units, Sanmen-2 reached initial criticality on August 17 and was connected to the grid on August 24. Haiyang-1 went critical on August 8 and was connected to the grid on August 17, and fuel loading began at Haiyang-2 on August 8.

ZION'S LICENSE WILL BE TRANSFERRED BACK TO EXELON upon the

Nuclear Regulatory Commission's approval of a license transfer application submitted by ZionSolutions on July 24. A subsidiary of Utah-based EnergySolutions, Zion-Solutions acquired the operating license for the closed Zion nuclear power plant in Illinois from Exelon Generation in 2010 under a sale agreement whereby ZionSolutions would take possession of the plant for the purpose of expedited decommissioning. ZionSolutions expects to complete the decommissioning and remediation of the Zion site by December 30, 2019. The return of the license to Exelon, along with the transfer of the generally licensed independent spent fuel storage installation, would complete the sale agreement between the two companies. Any decommissioning trust funds remaining at the time of the license transfer will also be returned to Exelon, which will retain title to the Zion real estate and ownership of the spent nuclear fuel and Greaterthan-Class C waste. In the September 24 Federal Register, the NRC published notice of an opportunity to request a hearing and petition for leave to intervene in the license transfer proceeding, with a deadline of October 15, and a public comment period ending on October 24. Information is available on the federal rulemaking website, at <www.regulations.gov>, with a search for Docket ID NRC-2018-0189. Comments can be emailed to <hearingdocket@nrc.gov>.

ANO WILL LOAD FUEL WITH FRAMATOME'S ATF CLADDING in

the fall of 2019, Framatome announced on September 19 after signing a contract with Entergy for the delivery of accident-tolerant fuel rods. The chromium-coated fuel rods will be inserted at Arkansas Nuclear One-1, an 850-MWe pressurized water reactor located in Russellville, Ark. Chromium coating is a feature of the fuel design that Framatome (formerly Areva) has been developing for several years as part of the Department of Energy's Accident Tolerant Fuel program and in collaboration with its European partners, the Commissariat à l'Énergie Atomique et aux Énergies Alternatives, EDF, and the Gösgen nuclear power plant in Switzerland. The addition of a chromium *Continued on page 83*

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OYSTER CREEK

Permanent shutdown ends 49 years of operation

Exelon closed the 625-MWe BWR as part of an agreement with New Jersey.

t noon on September 17, operators at Exelon Generation's Oyster Creek nuclear power plant in Forked River, N.J., took the reactor off line for the final time, and the 625-MWe boiling water reactor became the seventh U.S. power reactor to be closed in this decade. At the time of its shutdown, Oyster Creek, which began commercial operation in 1969, was the oldest operating commercial nuclear power plant in the United States.

"Today we celebrate the proud legacy of Oyster Creek and the thousands of employees who worked here and shared our commitment to safety and operational excellence for almost 50 years," said Site Vice President Tim Moore. "Eventually these buildings will disappear, but the station's legacy of safe, reliable operations, community involvement, and environmental stewardship will never fade."

Exelon announced in February that Oyster Creek would be permanently shut down at the end of its current operating cycle. The utility was required to close



Oyster Creek: Decommissioning may be completed within eight years if work proceeds according to Holtec International's accelerated timeline.

the plant no later than December 2019, halfway through the 20-year term of a license renewal received in 2009, as part of an agreement with the state of New Jersey. Continued operation would have required the installation of natural-draft cooling towers, an expense that Exelon could not justify.

Even as Oyster Creek closes, New Jersey's other nuclear facilities, Hope Creek and Salem, may benefit from a bill to create a zero-emission certificate program that was signed into law in May. That program is estimated to be worth about \$300 million in annual subsidies to operator Public Service Enterprise Group (*NN*, June 2018, p. 17).

Immediate plans for the Oyster Creek plant include transferring the reactor's fuel supply to the spent fuel pool. Workers will then begin to prepare the plant for dismantlement and decommissioning. Exelon said that about 300 plant employees will stay on at Oyster Creek during the decommissioning process.

In July, Exelon announced a conditional sale of Oyster Creek to Holtec International. The transaction is expected to close in 2019, pending license transfer approval from the Nuclear Regulatory Commission. Once the sale is completed, Holtec will manage all site decommissioning and restoration activities, with a goal of full decommissioning within eight years (*NN*, Sept. 2018, p. 41).

Over its 49 years of operation, Oyster Creek has produced enough electricity to power about 600,000 homes and has offset over 140 million metric tons of carbon, the equivalent of nearly 31 million cars, according to Exelon. The utility estimates that the plant and its employees have contributed over \$3 billion to the local economy through wages, taxes, charitable contributions, and local purchasing since 1969.

Section continued



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EXELON

Illinois's ZEC program upheld by appeals court

The U.S. Court of Appeals for the Seventh Circuit on September 13 upheld the Zero Emission Credits (ZEC) program for nuclear power plants in Illinois. The ruling followed a lower court's decision in July 2017 (*NN*, Aug. 2017, p. 17) that dismissed a lawsuit challenging the state's ZEC program, which was signed into law on December 7, 2016, by Gov. Bruce Rauner (*NN*, Dec. 2016, p. 22). The law will help Exelon keep its financially struggling Clinton and Quad Cities nuclear plants open.

The Electric Power Supply Association, Dynegy, Eastern Generation, NRG Energy, and Calpine Corporation were the plaintiffs in the latest lawsuit, filed on February 14, 2017 (*NN*, Mar. 2017, p. 18). They argued that the credits unfairly interfered with wholesale power markets. The three-judge panel found, however, that states have the right to regulate electricity generation within their borders as they see fit. It is up to the Federal Energy Regulatory Commission (FERC) to monitor the auctions that determine the wholesale rates of electricity.

The plaintiffs reacted to the court's decision by stating that it is now up to FERC to make sure the credits don't distort the PJM Interconnection market. The appeals court did not rule out subsequent court rulings based on FERC's determinations.

Similar ZEC programs are in place in Connecticut, New Jersey, and New York. A comparable court case in New York was allowed to proceed on January 22 and is expected to use the Illinois ruling as a precedent (*NN*, Mar. 2018, p. 30).

Other clean power providers, including solar and wind generation companies, are also expected to rely on the Illinois ruling to make a case for ZEC programs elsewhere, according to several reports.

NEW JERSEY

State regulator moves to create ZEC program

The New Jersey Board of Public Utilities (BPU) on August 29 initiated a proceeding to create a program for the issuance of zero emission certificates (ZEC) to aid eligible nuclear power plants, as required by legislation signed into law in May by Gov. Phil Murphy (*NN*, June 2018, p. 17). According to the BPU, each ZEC is intended to represent the fuel diversity, air quality, and other environmental attributes of 1 megawatt-hour of electricity generated by an eligible nuclear plant. "Nuclear power is an important piece of the state's energy puzzle," said BPU Presi-



dent Joseph L. Fiordaliso in a press release. "The board and its staff take seriously the responsibility to analyze nuclear power plant financial information and applications and determine whether the credits are warranted."

Fiordaliso

The authorizing legislation charges the BPU with creating the ZEC program by November 19, including an application process for ZEC eligibility review and a mechanism for each of the state's electric companies to purchase ZECs from the selected nuclear plants. As part of the program, the board will also conduct a second proceeding, which must be completed by April 18, 2019, to certify which applicant nuclear units are eligible to receive ZECs and to establish a rankordered list of those facilities, based on the process the board creates. Both proceedings will include extensive public input, the BPU said.

"Nuclear generation is currently the state's largest source of carbon-free energy," the press release stated. "As such, eligible nuclear energy generators with the ability to feed into PJM Inc. [the regional transmission organization for New Jersey] power grid footprint could be approved to provide ZECs for the state's energy supply, which would then be purchased by the state's four electric companies."

New Jersey's ZEC program has been estimated to be worth about \$300 million in annual subsidies to Public Service Enterprise Group, owner of Hope Creek and co-owner, with Exelon, of Salem, which

Power Briefs

ARIZONANS WILL VOTE ON A RENEWABLE ENERGY STANDARD in November, pursuant to an August 29 order from the state Supreme Court denying an appeal from Arizonans for Affordable Energy (AAE) opposing the ballot measure. The Clean Energy for a Healthy Arizona initiative, or Proposition 127, would require utilities in the state to procure 50 percent of their electricity from renewable sources—mostly wind and solar—by 2030. The proposition was approved for the ballot by a Maricopa County Superior Court judge on August 27, despite challenges to its legality by AAE (*NN*, Sept. 2018, p. 18). AAE is supported in its opposition to Proposition 127 by Arizona Public Service, owner and operator of the three-unit Palo Verde nuclear plant in Wintersburg, Ariz., which has argued that enactment of the proposition could force the plant to shut down.

THE CONSOLIDATION OF EMERGENCY OPERATIONS FACILITIES

(EOF) for North Anna-I and -2 and Surry-I and -2, along with their respective independent spent fuel storage installations, was approved by the Nuclear Regulatory Commission on August 27. The commissioners unanimously approved the proposal by Dominion Energy Virginia to consolidate the local EOFs, the common backup EOF, and the headquarters support organization into the Corporate Emergency Response Center, to be located at Dominion's corporate office in Glen Allen, Va. In approving the consolidation, three of the commissioners cited a successful March 5 dual-site emergency drill that simulated emergency events at the North Anna and Surry plants.

THE RIVER BEND LICENSE RENEWAL APPLICATION moved forward with the issuance of the Nuclear Regulatory Commission's safety evaluation report (SER) on August 17. The NRC staff's safety review found that Entergy Operations has met the agency's requirements from a safety perspective. At the time of this writing, a September 20 Advisory Committee on Reactor Safeguards subcommittee meeting had been scheduled to review the SER. The 430-page document is available for download at the NRC website, at <www.nrc.gov>, via the ADAMS document retrieval system, with a search for accession number ML18212A151. The NRC accepted Entergy's license renewal application for River Bend on August 7, 2017 (*NN*, Sept. 2017, p. 44). If it is approved, the 967-MWe boiling water reactor, located near St. Francisville, La., will be authorized to operate for 20 years beyond its current expiration date of August 29, 2025.

THE NRC'S LATEST INFORMATION DIGEST IS NOW AVAILABLE, the Nuclear Regulatory Commission announced on August 20. The *Information Digest*, published annually since 1989, describes the NRC's responsibilities and activities and provides general information on nuclear-related topics. The 2018–2019 edition of the *Information Digest* (NUREG-1350, Volume 30) is available on the NRC's website,

are the state's only operating nuclear power plants, now that Oyster Creek has been permanently retired (see page 20).

PEACH BOTTOM

NRC to review subsequent license renewal application

The Nuclear Regulatory Commission on August 27 accepted for docketing the Peach Bottom nuclear plant's subsequent license renewal application, submitted by Exelon Generation in July (*NN*, Sept. 2018, p. 21). If the application is approved, the Delta, Pa., facility's two boiling water reactors will be licensed to operate into the 2050s.

Peach Bottom-2 (a 1,302-MWe BWR) and -3 (a 1,304-MWe BWR) first came on line in 1974, in July and December, respectively. An initial 20-year license renewal application for the reactors was submitted in July 2001, and the NRC issued the new license in May 2003, approving the operation of Unit 2 through August 8, 2033, and of Unit 3 through July 2, 2034.

In the September 6 Federal Register, the NRC published a notice of opportunity to request a hearing and to petition for leave to intervene in the matter, with a deadline of November 5. According to the notice, information related to the Peach Bottom application can be obtained by visiting the federal rulemaking website, at <www.regulations.gov>, and searching for Docket ID NRC-2018-0130. Questions regarding NRC dockets can be sent to Jennifer Borges at <Jennifer.BorgesRoman@ nrc.gov>, while technical questions can be sent to the Office of Nuclear Reactor Regulation's Bennett M. Brady at <Bennett. Brady@nrc.gov>.

The FR notice also states that petitions for NRC adjudicatory proceedings must

at <www.nrc.gov/reading-rm/doc-collections/nuregs/staff/sr1350/>. A print or CD copy is available upon request from the U.S. Nuclear Regulatory Commission, Office of Administration, Publications Branch, Washington, DC, 20555-0001. Requests can also be sent by email to <distribution.resource@nrc.gov>, or by fax to 301/415-2289.

DUKE ENERGY HAS NO PLANS FOR NEW NUCLEAR CAPACITY in the next 15 years, according to its Integrated Resource Plan for 2018, released on September 5. "Low natural gas prices, the absence of national carbon regulation, and other industry factors have collectively moved the need for new nuclear generation outside the current planning window," Duke states in the plan. Nuclear power will make up 19 percent of Duke Energy's installed capacity mix for 2019, but that share is predicted to decrease to 16 percent by 2033 as the utility adds more natural gas-fueled capacity. Calling nuclear "an essential component of the company's commitment to the provision of affordable, reliable, and increasingly clean power," Duke states that it is evaluating the potential for subsequent license renewals to keep its existing North Carolina nuclear units—Brunswick-1 and -2, Harris-1, and McGuire-1 and -2—in operation for an additional 20 years. Each plant is already licensed to operate for 60 years.

A STUCK CONTROL ROD AT A WESTINGHOUSE PLANT IN FRANCE

in 2017 was the subject of an information notice that the Nuclear Regulatory Commission issued on August 29. NRC licensees with Westinghouse pressurized water reactors that have thermal sleeves in control rod drive mechanism (CRDM) penetration tubes are advised that the thermal sleeve flange can experience wear resulting in a loose part becoming lodged in the path of the CRDM shaft. "Therefore, facilities that have similarly designed thermal sleeves may consider monitoring for thermal sleeve flange wear and if needed consider taking corrective action(s) to mitigate any potential safety consequences that can result from the noted wear," the notice states. NRC Information Notice 2018-10 is available on the NRC's website, at <www.nrc.gov>, through the agency's ADAMS document retrieval system, with a search for accession number ML18214A710.

COMMENTS ON PROTECTIVE ORDER TEMPLATES FOR ITAAC

hearings are being sought by the Nuclear Regulatory Commission, which issued two draft templates on September 4. The templates are intended to speed the development of case-specific protective orders for hearings associated with the closure of inspections, test, analyses, and acceptance criteria (ITAAC). The two templates would be available for use by parties seeking to obtain access to sensitive unclassified non-safeguards information or safeguards information. Such access would require a protective order and a signed nondisclosure declaration. Comments are requested by October 19 and can be submitted through the federal rulemaking website, at <www.regulations.gov>, with a search for Docket ID NRC-2018-0190. be filed in accordance with the agency's e-filing rule, which requires interested parties to submit all documents over the Internet. Guidance on making electronic submissions can be found on the NRC's website, at <www.nrc.gov/site-help/ e-submittals.html>.

DIABLO CANYON

Legislation approves funds to ease impact of closure

A bill developed in response to the planned shutdown of the Diablo Canyon nuclear power plant was signed into law by California Gov. Jerry Brown on September 19, having been overwhelmingly approved by the State Assembly on August 20. The bill, S.B. 1090, authorizes the California Public Utility Commission (PUC) to permit Pacific Gas and Electric Company (PG&E) to increase electricity rates to fund \$435 million in worker retention and local community benefits.

The bill also requires the PUC to ensure that future integrated resource plans are designed to avoid an increase in greenhouse gas emissions as a result of the reactor closures.

San Francisco-based PG&E plans to shut down Diablo Canyon-1 and -2, pressurized water reactors rated at 1,138 and 1,151 MWe, respectively, when their operating licenses expire in November 2024 and August 2025. In 2016, PG&E worked with several environmental groups and community stakeholders to develop a package of employee retention and community transition provisions called the "Joint Proposal to Retire and Replace Diablo Canyon" (*NN*, Jan. 2017, p. 20).

The agreement went to the PUC in June 2016, but it was modified after additional agreements were reached with community groups. A January 11 PUC decision approved a stripped-down version of the plan and authorized PG&E to shut down the plants when their original licenses expire (*NN*, Feb. 2018, p. 14). Following the PUC's ruling, PG&E announced that it would withdraw the license renewal applications for Diablo Canyon-1 and -2 that it had submitted in 2009 and later delayed. In April, the Nuclear Regulatory Commission approved the withdrawal of the applications.

In its January decision, the PUC authorized PG&E to recover \$241.2 million in costs associated with retiring the plant, significantly less than the utility had requested. The PUC asked the state legislature to weigh in on whether the PUC had the legal authority to approve the full community impact mitigation settlement submitted in the joint proposal. S.B. 1090, which was drafted to restore the provisions stripped away by the PUC, states that the joint proposal "is in the interest of utility customers."

Provisions include a total of \$85 million for San Luis Obispo County, nearby cities, and a local school district to ease the loss of taxes and other economic benefits provided by the plant, and a \$350-million employee retention program. The implementation of S.B. 1090 is expected to increase electricity rates for PG&E customers by about 0.2 percent through 2025, according to a PG&E spokesperson.

SUMMER

NRC approves transfer of licenses to Dominion

The Nuclear Regulatory Commission has approved the indirect transfer of the licenses for Summer-1, -2, and -3 from SCANA Corporation, the parent company of license holder South Carolina Electric & Gas Company (SCE&G), to Dominion Energy, as announced in a September 7 press release.

SCANA and Dominion announced their proposed merger on January 3 (*NN*, Feb. 2018, p. 12), and SCE&G and Dominion applied for the transfer of SCE&G's two-thirds interest in the reactors on January 25. The license transfer application for Summer-1, a 972.7-MWe pressurized water reactor and the sole operating reactor at the site in Fairfield County, S.C., was considered and approved separately from



Focus on Finance

By Linda C. Byus

Elections and energy policy

The upcoming November election in Arizona provides a snapshot of the complexity of establishing energy policy specifically regarding renewable energy standards. Arizona voters will find a "clean energy" measure on the ballot that could drastically alter the energy future of the state.

The Clean Energy for a Healthy Arizona measure would require utilities that sell electricity in Arizona to procure a certain percentage of electricity from renewable resources each year. Renewable resources include solar, wind, biomass, geothermal, and landfill gas. The amount would increase each year, from 12 percent in 2020 to 50 percent in 2030.

The current renewable energy standards in Arizona call for renewable sources to meet 15 percent of retail load by 2025. While the overall goal is clean energy (non-carbon producing), the mandate specifically addresses renewable sources such as wind and solar. Nuclear is not recognized as clean energy—even though it is not carbon producing—because it is not considered a "renewable" resource.

Arizona Public Service Company's Palo Verde nuclear station produces over 30 billion kWh per year and is the largest producer of low-carbon electricity in the United States. Palo Verde's three units generate 79 percent of Arizona's clean (non-carbon-producing) energy. Hydroelectric produces 13 percent, and solar and wind produce the balance of 8 percent.

Nuclear power provides approximately 36 percent of Arizona's electricity, with hydroelectric at about 6 percent and solar and wind combined at 4 percent. Coal generation provides about 30 percent, and natural gas provides the balance.

The proposed goal for renewables to provide 50 percent of Arizona's total electricity generation would be one of the most aggressive goals in the country. It would require a massive build out of wind and solar power over the next 12 years. The renewable generation would displace coal and nuclear, and the cost of electricity to customers would likely increase.

As the mandated generation from renewables increases, Palo Verde's market share will decrease significantly. It is possible that Palo Verde could be priced out of the market, given the mandate for renewable generation. Overall, the effect could be to replace the supply of baseload generation with less reliable alternatives.

The underlying goal of the clean energy initiative is to replace carbon-producing generation with non-carbon-producing generation. In Arizona, the proposed mandate could actually force the early shutdown of Palo Verde and create the need for new gas-fired power plants. The cost of new renewable resources, as well as new gas-fired generation, would create a complete shift in the generation profile in Arizona, which could increase the overall cost of electricity in the state. Ironically, the clean energy initiative could result in the early retirement of the largest nuclear power plant in the country.

The utilities in the state, led by Arizona Public Service, are aggressively opposing the initiative by appealing to the state political leadership, as well as making direct appeals to voters. In March, the Republican-led state legislature passed a bill that establishes the "exclusive remedy" for violating any constitutional provision dealing with the way electricity must be generated as a fine that could be as much as \$5,000 or as little as \$100. The legislation was signed into law by Arizona Gov. Doug Ducey. If Proposition 127 is indeed approved by voters in the November election, the effect of the law would be to minimize the impact of the proposition. Utilities could ignore the new renewable energy standard. Proponents of the clean energy initiative assert that the law is unconstitutional.

Since the new renewable energy standard was added to the ballot via petition, the submitted signatures required verification. A group called Arizonans for Affordable Electricity, supported financially by the parent company of Arizona Public Service, aggressively challenged the petition signatures (*NN*, Sept. 2018, p. 18). In late August, the Arizona Supreme Court determined that the renewable energy standard will be on the November ballot as Proposition 127.

Going into the November election, Arizona voters will be challenged to understand Proposition 127. The renewable energy standard is supported by an outside (not Arizona-based) environmental advocacy and political action committee. Their stated goal is "clean energy," which does not include nuclear generation. Opponents of Proposition 127 argue that the new standards would increase the price of electricity in the state primarily because it does not include nuclear generation as clean energy.

Both sides are investing time and money to educate and motivate voters. A spokesperson for opponents of the proposition summarized the issue: "Everyone supports clean energy. The question is whether Arizona voters are willing to double their electric bills in order to approve Proposition 127." The most significant outcome from the Arizona election may be the recognition that energy policy is too complex to be established by an initiative on a general election ballot. **FoF**

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the application to transfer the combined licenses for Summer-2 and -3, on which construction was officially halted in August 2017. The order approving the license transfer for Summer-1 also includes the transfer of the general license for the independent spent fuel storage installation at the site.

On September 4, Dominion and SCANA announced the "significant milestone" for the proposed merger and confirmed that Dominion has no plans to complete the Summer-2 and -3 construction project if the merger closes. The merger now needs approvals from the public service commissions of South Carolina and North Carolina. Approval was previously received from SCANA's shareholders, the Federal Energy Regulatory Commission, the Georgia Public Service Commission, and the Federal Trade Commission.

The license transfers are considered indirect because SCE&G will remain the licensed owner and operator at the site, even as SCANA becomes a wholly owned subsidiary of Dominion. The transfer does not involve Santee Cooper's one-third ownership interest in the reactors.

"The NRC staff review of the license transfer application concluded that the merger between Dominion and SCANA would not affect the financial and technical qualifications of SCE&G to conduct



Summer: The approval of Unit I's license transfer to Dominion also includes the transfer of the general license for the site's ISFSI.

the activities authorized by the licenses," the NRC's press release stated. "The NRC staff also concluded that SCE&G has satisfied the NRC decommissioning funding assurance requirements, and the facility is not owned, controlled, or dominated by a foreign entity."

■ Work to demobilize and maintain the Summer-2 and -3 construction site continues. The South Carolina Office of Regulatory Staff (ORS) in its latest update re-

port, dated September 4, describes work performed in August, including the consolidation of plant material and equipment at the site. All hazardous materials have been removed, according to the ORS, and Fluor personnel are on-site to support Santee Cooper's program for the maintenance, preservation, and documentation of high-value equipment—such as reactor coolant pumps, steam generators, pressurizers, reactor vessels, and integrated





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head packages—for potential resale. Santee Cooper plans to maintain the equipment through the end of 2018 (*NN*, Aug. 2018, p. 17).

VOGTLE

Construction project sparks dueling lawsuits

The Jacksonville Electric Authority (JEA) and the Municipal Electric Authority of Georgia (MEAG Power) filed lawsuits against each other on September 11 over a 2008 power purchase agreement between the two in connection with the newreactor construction project at the Vogtle site in Georgia. JEA filed its complaint in the Fourth Judicial Circuit Court of Florida, while MEAG Power filed in the U.S. District Court for the Northern District of Georgia. Joining JEA in its claim was the City of Jacksonville, Fla.

The JEA suit argues that the agreementunder which JEA is required to share construction costs and purchase Vogtlegenerated power for 20 years-should be declared void and unenforceable, in part because the Florida utility lacked the authority, under the Florida constitution, to enter into the contract in the first place. In addition, JEA's lawyers assert that the agreement contravened Florida public policy. "Under the [power purchase] agreement," they stated, "ratepayers are burdened for 20 years by the obligation to fund a project in which JEA retains no ownership interest, over which JEA has no management or budgetary control, and from which ratepayers may never receive any electricity or capacity notwithstanding the massive unconditional financial obligations incurred."

In its filing, MEAG Power charges JEA with breach of contract and seeks a court order that would hold JEA to the agreement. "These 'hell-or-high-water' contracts specifically provide that the buyer has no right, under any circumstances, to abandon the contract or be relieved of its contractual obligations," MEAG Power's attorneys stated. "JEA's actions in denying the enforceability of the [agreement] have already created uncertainty in MEAG's ability to fulfill its own obligations under the [agreement], as well as uncertainty in determining whether to proceed or cancel the Vogtle project." (Southern Company announced in early August an additional \$2.3-billion cost overrun for the project, triggering a requirement that Vogtle's owners hold a vote on whether to proceed with construction. At this writing, the vote was scheduled for mid- to late September.)

To those familiar with recent correspondence between the entities, the lit-



A STEAM GENERATOR HAS BEEN PLACED AT VOGTLE-4, marking another milestone at the project site near Waynesboro, Ga. According to an August 31 press release from Georgia Power, the four steam generators for Vogtle-3 and -4 were fabricated in South Korea and transported to the site via the Port of Savannah and then by rail. The final steam generator for the project is on-site and is expected to be placed in the coming months, Georgia Power said.

igation comes as something less than a surprise: On August 17, JEA Chief Executive Officer Aaron Zahn penned a sharply worded letter to MEAG Power (NN, Sept. 2018, p. 17), demanding that the Georgia agency walk away from the project, citing its ballooning costs and schedule delays. Responding in kind to Zahn on August 24, MEAG Power CEO James Fuller wrote, "While we very much hope we can work together harmoniously over the next 20-plus years, we assure you that we will not violate the principles we have laid out here because of baseless threats, and we, too, reserve the right to pursue all of the remedies available to us at law and equity."

MIT

Study finds nuclear power needed to reduce carbon

The Massachusetts Institute of Technology's Energy Initiative on September 3 released *The Future of Nuclear Energy in a Carbon-Constrained World*, a report on the role of nuclear power in reducing greenhouse gas emissions. The authors of the report analyze the reasons for the current stall of nuclear energy capacity—which currently accounts for only 5 percent of global primary energy production—and discuss measures that could be taken to arrest and reverse that trend.

This is the eighth in a series of MIT Energy Initiative studies that aim to shed light on a range of complex issues involving energy and the environment. The first in the series, published in 2003, was also on the topic of nuclear power. According to MIT, "Following a 2009 update to the original nuclear study, now is an appropriate time to take a fresh look at nuclear, given advances in inherently safer technologies, a sharpened focus on the need to reduce CO_2 emissions in the energy sector, and challenges of cost and public perceptions of safety." Other studies in the series have looked at the roles of CO_2 sequestration, natural gas, the electric grid, and solar power.

Jacopo Buongiorno, a study co-chair and professor and associate department head of MIT's Nuclear Science and Engineering Department, said, "Our analysis



demonstrates that realizing nuclear energy's potential is essential to achieving a deeply decarbonized energy future in many regions of the world. Incorporating new policy and business models, as well as innovations in construc-

Buongiorno

tion that may make deployment of costeffective nuclear power plants more affordable, could enable nuclear energy to help meet the growing global demand for energy generation while decreasing emissions to address climate change."

The report addresses the cost concerns and policy issues facing nuclear power and makes the following suggestions:

■ Construction costs need to be reined in, and newly constructed plants need to be delivered on time. One suggestion for achieving this objective is to give contractors a vested interest in the project.

■ A shift to standardized units that could be used at multiple nuclear power plants and relying on factory production as much as possible could also help reduce construction costs, as well as speed up the schedule. ■ Public safety concerns loom large over the nuclear power industry. Investments should be made in reactor designs that offer more passive safety features. Building nuclear power generators that minimize external intervention could also help reduce human errors and quell concerns among the populace.

■ Nuclear power and other low-carbon generation options need to be compensated for providing power with minimal CO₂ emissions. Altering power pricing through decarbonization policies would appropriately level the playing field.

■ Governments should provide specific sites where prototype nuclear reactors could be tested. Test reactors ought to share regulatory as well as research and development costs with the government. Successful milestones could then be used to achieve additional funding, and production credits might be offered to reward successful designs.

"The role of government will be critical if we are to take advantage of the economic opportunity and low-carbon potential that nuclear has to offer," said John Parsons, another co-chair of the study and a senior lecturer at MIT's Sloan School of Management.

The 275-page report can be downloaded from the MIT website, at <energy.mit.edu/ futureofnuclear>.

HURRICANE FLORENCE

Brunswick, other facilities prepared for storm

Duke Energy's two-unit Brunswick nuclear power plant, located near Southport, N.C.—about four miles inland from the Atlantic coast and about 40 miles south of Wilmington-began shutdown procedures on September 13 in anticipation of Hurricane Florence's landfall on September 14. The plant was put in hot shutdown mode, as the site was facing hurricane-force winds, major storm surges, and heavy rain. Other plants near the storm's path, including Surry in southeastern Virginia, Harris near Raleigh, N.C., and Robinson near Hartsville, S.C., also took precautions but did not shut down.

Additional Nuclear Regulatory Commission inspectors were on-site at the plants to verify that all pre-storm preparations were completed and that emergency diesel generators were available in the event of a loss of off-site power. The NRC also contacted officials at Global Nuclear Fuels-America near Wilmington, at North Carolina State University's research reactor in Raleigh, and other licensees in the area ahead of landfall to verify their emergency preparedness.

On September 15, Brunswick declared an unusual event—the lowest level of nuclear emergency—because of "site conditions sufficient to prohibit the plant staff from accessing the site via personal vehicles due to flooding of local roads," according to the event report provided to the NRC by plant personnel. About 300 personnel were on-site throughout the storm period, and when the flooding of roads blocked land access, Duke brought in supplies by helicopter.

Public safety was never at risk, and the site had grid power throughout the storm, allowing for the cooling of the reactors. The unusual event emergency notification at Brunswick was lifted on September 18. At that time, the plant was accessible and personnel were able to move to and from the site. Also, a gradual restart of the units began on September 20. According to the NRC's September 27 Power Reactor Status Report, Unit 1 was at 91 percent power and Unit 2 was at 94 percent power.

Section continued



INDIAN POINT

License renewals issued, but shutdown in sight

The Nuclear Regulatory Commission issued renewed operating licenses for Indian Point-2 and -3, located in Buchanan, N.Y., on September 17 after over 11 years of regulatory review. While the renewed licenses permit Entergy Nuclear Operations to operate the 1,035-MWe Unit 2 and 1,048-MWe Unit 3 through April 2024 and April 2025, respectively, Entergy has confirmed its plans to shut down the plants by April 2020 and April 2021.

"The issuance of these renewed licenses is the culmination of thousands of hours of work by hundreds of nuclear professionals at Indian Point and across our nuclear fleet and company," said Chris Bakken, Entergy's chief nuclear officer. "Indian Point is one of the most reliable electricity generating plants in New York State, and it repeatedly has been determined to be safely and securely operated. I congratulate our outstanding employees on achieving this milestone."

Entergy applied for license renewal for Indian Point in April 2007, seeking an additional 20 years of operation beyond the original expiration dates of 2013 and 2015. The NRC authorized the plants to operate past their license expiration dates because Entergy had met the requirement for "timely renewal" by submitting its renewal application more than five years prior to the expiration of the original licenses.

The receipt of the renewed operating licenses does not change Entergy's plans to retire the Indian Point units in accordance with a January 2017 settlement agreement between Entergy, the state of New York, and Riverkeeper, an intervenor in the license renewal proceeding. Citing sustained low wholesale power prices, Entergy agreed to shut down Unit 2 by April 30, 2020, and Unit 3 by April 30, 2021, and to amend its license renewal application to seek a shorter renewal term. An NRC Atomic Safety and Licensing Board then dismissed the remaining contentions and closed the adjudicatory hearing on the renewal.

The license renewal process generally takes about 22 months for an uncontested proceeding and about 30 months for one involving hearings. The Indian Point license renewal proceeding—at over 136 months—was the longest to date.

The decision to seek renewed licenses terminating in 2024 and 2025 was part of the 2017 settlement agreement and was intended to allow for limited continued operation of one or both units—if agreed to by both New York State and Entergy—in the event of unexpected and severe disruptions of the regional electric grid. "Entergy does not have any expectation that either unit will run beyond its scheduled shutdown in 2020 and 2021," the company stated in a September 17 press release.

Entergy concluded the final refueling and maintenance outage at Unit 2 in April of this year and has scheduled the final refueling and maintenance outage for Unit 3 in the spring of 2019.

ΤVΑ

NRC: SMRs can scale down emergency planning zones

The Nuclear Regulatory Commission has agreed with the Tennessee Valley Authority that small modular reactors can have smaller emergency planning zones (EPZ), reflecting their enhanced safety features. The NRC staff made the preliminary finding, based on its advanced safety review, that TVA's proposed dose-based, consequence-oriented methodology in its 2016 early site permit application for an SMR at the Clinch River site is a reasonable technical basis for determining EPZ size. The Nuclear Energy Institute, in a press release, called the finding "a potential regulatory breakthrough" that could

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help accelerate the licensing of advanced reactor technologies.

TVA's early site permit application calls for two or more SMR modules (up to 800 MWe) to be located at the Clinch River site near Oak Ridge, Tenn. A reactor design for the SMRs was not specified in the application, but information about BWXT's mPower, Holtec International's SMR-160, NuScale Power's SMR, and Westinghouse's SMR was used to provide the technical basis for the request for an exemption to the 10-mile EPZ requirement that is mandated for all existing light-water reactors in the United States.

NEI also believes that reducing the necessary physical footprint for SMRs, as well as easing other regulatory standards meant for larger reactors—such as requiring armed security guards (see page 38)—will help speed up the development and deployment of advanced reactor technologies.

WATTS BAR

Chilled work environment persists, NRC says

While improvements continue to be made in the safety-conscious work environment at the Watts Bar plant, near Spring City, Tenn., a chilled work environment still exists, the Nuclear Regulatory Commission stated in an August 17 follow-up inspection report to the Tennessee Valley Authority. The report specifically points to concerns in regard to the Radiation Protection Department. "The indications of a chilled work environment within the RP Department suggest continued challenges to Watts Bar's ability to proactively detect and prevent chilled work environments," the report states.

Questions about the Watts Bar work environment date back to 2009, when a confirmatory order was issued for work culture-related concerns. The NRC followed up in 2015 by initiating a review of the safety environment at Watts Bar and found that employees in the Operations Department feared retaliation if they voiced safety concerns. This was blamed on stress tied to pressure to improve performance across TVA's nuclear fleet and preparations for the Watts Bar-2 startup (*NN*, Apr. 2016, p. 21).

Similar issues have kept Watts Bar on the NRC's radar, including the findings of a follow-up inspection on October 26, 2016, which found that a chilled work environment remained (*NN*, Dec. 2016, p. 57). Similar concerns were raised in a second NRC confirmatory order issued on July 27, 2017 (*NN*, Sept. 2017, p. 23). The latest findings at the two-unit plant were the result of 35 individual interviews of personnel from the Radiation Protection Department, including supervisors and managers.

"The vast majority of individuals interviewed (97 percent) reported being willing to raise nuclear and radiological safety concerns," the report states. "However, approximately 25 percent of the personnel interviewed from the RP Department felt like they may be retaliated against if they raise certain concerns. The types of concerns personnel would be hesitant to raise for fear of retaliation included concerns that challenge management decisions, concerns that would slow down or delay critical or time-sensitive activities, concerns that may reflect badly on the department by revealing procedural violations or mistakes, or concerns that implicate managers in procedural violations or mistakes."

Other findings included employees being reluctant to report safety concerns for fear of how a particular supervisor or manager might respond, fear of retaliation, concern over being labeled a troublemaker, being cast as for or against management, not being treated equally, being denied special projects or overtime, and being given lower performance ratings as a result of voicing a safety issue.





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UWC GOLF TOURNAMENT

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Before the work of the conference began, nearly 80 attendees representing 52 different utilities, vendors, and nuclear organizations participated in the 25th Annual UWC Golf Tournament. The networking and collaboration that took place during the event aligned with the theme of this year's conference, "Nuclear Rising to the Challenge."

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WINNING TEAMS





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Photo bomb by Jeff Mosses, Nuclear News/ Golf Chair.



Lewis Wetzel from Framatome (2nd from left) presents the trophy to the 1st place team.



NUCLEAR THREAT INITIATIVE

Security

2018 Nuclear Security Index released

The NTI index offers recommendations to improve nuclear security and to keep attention focused on the threat of nuclear terrorism. Risk environment factors—including political instability, corruption, and terrorism—have deteriorated in 54 countries since 2016, and cybersecurity threats to nuclear facilities continue to increase worldwide, according to the 2018 *NTI Nuclear Security Index.* The fourth edition of the Nuclear Threat Initiative's biennial assessment, produced in cooperation with the Economist Intelligence Unit, the research and analysis division of the Economist Group, was released on September 5 in Washington, D.C.

"The good news is that progress on security has accelerated since 2016; the bad news is that much of that progress is now at risk," said Ernest Moniz, cochair and chief executive officer of NTI.

The latest NTI index credits most of the early gains to the biennial Nuclear Security Summit, which took place from 2010 to 2016. More than 935 actions to strengthen nuclear security were taken



Answering questions about the 2018 NTI Nuclear Security Index, which was released on September 5 in Washington, D.C., are, from left, Joan Rohlfing, president and chief operating officer of the Nuclear Threat Initiative; Page Stoutland, NTI's vice president for scientific and technical affairs; Hilary Steiner, director of public policy, economics, and politics for the Economist Intelligence Unit; and Erin Dumbacher, NTI's program officer for scientific and technical affairs.

by the countries participating in the four summits, according to a July report by the Arms Control Association and the Fissile Materials Working Group (*NN*, Aug. 2018, p. 124). No comparable global effort, however, has emerged to replace the summits, according to the report, which recommends a renewed commitment to collaboration, including creating a global nuclear security system with a common set of international standards and best practices, a mechanism for holding states accountable to achieve such standards, and a comprehensive international legal foundation.

The report outlines the global threat of a cyberattack and recommends mandated cybersecurity prevention and response plans for nuclear facilities across the globe. It also warns of a potential combined cyber-physical attack and recommends that "physical and cybersecurity programs be integrated and dynamic."

One-third of the countries that have weapons-usable nuclear materials or nuclear facilities lack all of the basic cybersecurity regulations measured by the NTI index, the report states. Also, since 2016, only 12 countries have improved their cybersecurity regulations.

The NTI index recommends that countries with nuclear materials participate in peer reviews, which currently are voluntary. The reviews typically involve another country or organization, such as the International Atomic Energy Agency, analyzing the country's nuclear policies and procedures and sharing its findings. The report recommends that countries with nuclear facilities request such a review at least once every five years.

Only four countries in the NTI's latest index have participated in a peer review over the past two years, and six countries have never hosted a review. China and Germany saw their scores improve in the latest index after participating in the IAEA's International Physical Protection Advisory Service review in 2017.

The report further recommends that countries possessing nuclear material fi-

Country highlights

The 2018 NTI Nuclear Security Index ranked 22 countries with 1 kilogram or more of weapons-usable nuclear materials, 154 countries with less than 1 kilogram of such materials or no nuclear material at all, and 44 countries and Taiwan with nuclear facilities where an act of sabotage could result in a dangerous release of radiation. Highlights include the following:

■ Australia and Switzerland were tied as having the most favorable nuclear materials security conditions in NTI's theft ranking category. Australia has held the top spot since the ranking began in 2012.

■ Japan improved its theft score more than any other country since 2012 by decreasing quantities of nuclear material and improving insider threat-prevention measures, as well as adding physical and cybersecurity regulations.

■ China, Belgium, and Germany made notable improvements to their theft scores by taking important steps in areas such as insider threat prevention, cybersecurity, and physical security during transport and at facilities.

■ Among countries with less than 1 kilogram of weapons-usable nuclear materials, Finland, New Zealand, and Sweden tied for top ranking in the theft category. ■ Finland has the most favorable nuclear materials security conditions in NTI's sabotage ranking among countries with nuclear facilities, which includes power plants and research reactors. As in 2016, Australia, Canada, Japan, and the United Kingdom round out the top five countries in NTI's sabotage ranking.

nancially support the IAEA and follow its suggested guidelines.

"It is clear that governments struggle to stay ahead of—even keep pace with evolving and escalating threats, so it is more important than ever that countries stay focused on improving security within their own borders and on developing an effective global security system to protect the world's deadliest materials," Moniz said.

NTI Nuclear Security Index—Threat/ Sabotage: Building a Framework for Assurance, Accountability, and Action is available for download at <https://ntiindex.org>.

CONGRESS

Cybersecurity subject of Senate committee hearing

The Senate Judiciary Committee's Subcommittee on Crime and Terrorism on August 21 heard testimony on cybersecurity issues from a number of witnesses, including Thomas Fanning, chairman, president, and chief executive officer of Southern Company, and James Lewis, senior vice president at the Center for Strategic and International Studies. Fanning's and Lewis's comments focused on cyber threats facing the U.S. electrical grid.

Fanning, a co-chair of the Electricity Subsector Coordinating Council, outlined several steps that he and others throughout the industry have taken to collectively thwart hackers as well as to prepare for an incident that would take down a portion of the grid. Southern Company has 9 million customers and operates 200,000 miles of electric transmission and distribution lines. It also operates the Farley nuclear plant in Alabama and the Hatch and Vogtle plants in Georgia.

"The threat to our way of life is growing," Fanning said. "But so is the work that is under way to prepare our systems, to prevent attacks, to detect intrusions, to

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respond to issues, and to recover quickly."

Fanning said that while threats to nuclear power plants are often the cause of greatest concern when it comes to cyberattacks, "the real crown jewel" for hackers is the electrical infrastructure management system. He admitted to some concern about a coordinated attack that would involve both a physical and a cyber incursion. He also briefly mentioned an initiative called the "MacGyver Project," which aims to teach grid operators how to run the nation's electrical system without the use of digital technology.

While Sen. Lindsey Graham (R., S.C.) commended Fanning and other electrical operators for fending off any major disruptions up to this point, the consensus of the senators on the panel was that a successful cyberattack was inevitable. Graham then sought Fanning's counsel on incentivizing the electrical industry to continue to implement cutting-edge cybersecurity protections.

"How about some carrots on the table," Graham said to Fanning. "Because I don't think the Department of Homeland Security can regulate this. You know more about your area than DHS can ever hope to know."

Graham suggested that one legislative incentive could be protecting utilities that invest heavily in cybersecurity from lawsuits. Fanning stopped short of calling such a move a "game changer," but he agreed that it would likely spur those in the electrical industry to implement cybersecurity measures more quickly.

Lewis spoke specifically about Russia, Iran, and other nations with organized hacking groups that take aim at U.S. infrastructure. He urged legislators to spell out sanctions for such groups and rigidly enforce penalties that might include indictments and diplomatic actions.

"Potential hackers need to believe the U.S. will punish them," Lewis said. "As long as our opponents think they can attack us and get away with it, the cyber risk to the nation will continue to grow."

NONPROLIFERATION

Top U.S., Indian officials hold talks in New Delhi

The Indo-U.S. 2+2 Dialogue took place on September 6 in New Delhi, India, with talks focusing on shared counterterrorism efforts between the United States and India, joint military operations, trade agreements, and India's entry into the Nuclear Suppliers Group (NSG). India's Minister of External Affairs Sushma Swaraj and Minister of Defense Nirmala Sitharaman hosted U.S. Secretary of State Mike Pompeo and Secretary of Defense James



At the Indo-U.S. 2+2 Dialogue (from left): India's Minister of External Affairs Sushma Swaraj, U.S. Secretary of State Mike Pompeo, India's Prime Minister Narendra Modi, U.S. Secretary of Defense James Mattis, and India's Minister of Defense Nirmala Sitharaman.

Mattis for the daylong meeting.

"Ten years ago today, the Nuclear Suppliers Group voted to allow India to engage in trades of civilian nuclear materials and technologies," Pompeo said. "We now look forward to what we can achieve over the next 10 years. In particular, we look forward to finalizing the Westinghouse civil nuclear project that will provide clean and reliable power to millions of Indians." Westinghouse and the Nuclear Power Corporation of India Limited began engineering and site design work for six AP1000 reactors in mid-2016 (*NN*, July 2016, p. 41).

The NSG is an international organization of nuclear supplier states that have voluntarily agreed to coordinate their controls governing the export of civilian nuclear material and nuclear-related technology to nonnuclear weapon state. The United States is among a number of NSG members-including Australia, France, the Netherlands, Russia, and the United Kingdom-that have supported India's entry into the 48-member group, which was formed in 1975 in reaction to a nuclear test in India a year earlier. China, a key member of the NSG, has been staunchly opposed to India's bid to become a member of the group, based primarily on India's refusal to sign the Nuclear Non-Proliferation Treaty.

India is a member of the three other export control regimes that deal with weapons of mass destruction: the Missile Technology Control Regime, the Wassenaar Arrangement, and the Australia Group.

The groundwork for the Indo-U.S. 2+2 Dialogue was laid during a meeting between President Donald Trump and India's Prime Minister Narendra Modi in the United States in June 2017.

"Today's fruitful discussion illustrated the value of continued collaboration between these two coequal democracies," Mattis said. "It's a strong relationship between the world's two largest democracies, and it did not begin with those of us sitting here before you. We inherited it, and now we ensure it is even stronger when we pass it to our successors on a higher trajectory than we received it."

OVERSIGHT

DNFSB planning major staff reorganization

The Defense Nuclear Facilities Safety Board, the independent federal agency responsible for safety oversight of the Department of Energy's defense nuclear facilities, is reducing the staff at its Washington, D.C., headquarters by 46 percent, under a staff restructuring plan announced on August 15 by acting DNFSB Chairman Bruce Hamilton. Under the plan, the DNFSB will also increase by 80 percent the number of resident inspectors located at DOE defense facilities.

According to the DNFSB, the changes are in response to a number of studies and critiques of the board's effectiveness over the past several years. In a statement, Hamilton said, "In recent years, the Department of Energy has changed its processes, procedures, and organization, and we have been slow to adapt. This restructuring will improve our safety focus and independent oversight priorities in the field, while making our headquarters organization leaner to make us more responsive in the execution of our mission."

The restructuring plan also creates two new field offices in Albuquerque, N.M., and Las Vegas, Nev., that will provide fulltime coverage of Sandia National Laboratories, the Waste Isolation Pilot Plant, the Nevada National Security Site, Lawrence Livermore National Laboratory, and Idaho National Laboratory. It also provides for the establishment of a new executive director of operations, who will lead the entire agency. The majority of the headquarters staff reduction will be accomplished through the strategic management of currently vacant positions and the new positions in the field offices, the DNFSB said.

Sens. Tom Udall and Martin Heinrich, both Democrats from New Mexico, issued a joint statement, praising the addition of the new inspectors while criticizing the board for using the new additions to justify cuts elsewhere. "A sweeping reorganization proposal for the DNFSB—which would likely result in staff reductions—should at the bare minimum include an in-depth consultation process with stakeholders, the public, board membership, and Congress," the senators said in a statement published in the *Albuquerque Journal*.

Former DNFSB Chairman John Sullivan introduced the restructuring plan as a secondary proposal in a June 29, 2017, letter to John Mulvaney, director of the Office of Management and Budget. Sullivan's primary proposal was to eliminate the DNFSB, calling it a "relic of the Cold War-era defense establishment." The proposal to eliminate the board received political pushback, including from Udall and Heinrich. Congressional approval would be needed to terminate the board.

The new structure was to become effective on October 1 and is expected to be fully implemented during fiscal year 2019. Christopher Roscetti, the current DNFSB technical director, will serve as acting executive director of operations until the board permanently fills the position.

Order 140.1

During a public hearing held on August 28, the four sitting DNFSB board members voiced concerns about DOE Order 140.1, *Interface with the Defense Nuclear Facilities Safety Board*, which the DOE adopted in May and which clarifies how it cooperates with the DNFSB, including how and when the DOE provides information to the board. Along with Hamilton, the other board members are Jessie Hill Roberson, Daniel Santos, and Joyce Connery (one position on the board is vacant).

During the hearing, the board members expressed concerns to DOE leadership about DNFSB's ability to access information, facilities, and personnel following the adoption of the order. "Now is not the time to be limiting interactions with the board," Santos said. Roberson noted that the DOE implemented the order without consulting the DNFSB, which she said makes the DOE's intent toward independent oversight open to speculation.

In a September 17 letter summarizing the board's primary concerns with DOE Order 140.1, DNFSB Chairman Hamilton informed Energy Secretary Rick Perry that the board planned to hold two additional public hearings to solicit feedback on the order. In the letter, which was also sent to the House and Senate Appropriations and Armed Services Committees, Hamilton stated, "In the event you are willing to suspend the order pending revisions, we will collaborate with you on what revisions would be appropriate."

Outside groups have also criticized DOE Order 140.1. In a letter to Perry dated August 27, Beatrice Brailsford, president of the Alliance for Nuclear Accountability, asked that the order be rescinded, claiming that it was issued without the opportunity for public review or comment. "Since the order was approved on May 14, 2018, it has already limited the flow of information from the nuclear security sites to the board, workers, and the public, creating a chilling effect and endangering worker and public health and safety," Brailsford



Security

stated.

The Energy Communities Alliance (ECA) asked the DOE to suspend the order until a formal review process can be completed. In an August 28 letter to Perry, ECA Chair Ronald Woody said that many of the order's requirements appear to limit DNFSB access to information about DOE activities or DOE personnel. "ECA asks DOE to take immediate action to involve the DNFSB, local communities, state regulators, tribes, and other stakeholders in the development of an improved policy that corrects the errors of the new Order 140.1," he stated.

■ On September 11, Udall and Heinrich secured two provisions related to the planned DNFSB reorganization and Order 140.1 in the FY 2019 Energy and Water Development Appropriations bill. The first prohibits any appropriated DNFSB funds from being used to carry out the board's reorganization, including the reduction of staff, unless Congress has vetted and authorized such a move. The second provision directs the DOE to brief Congress on Order 140.1 within 30 days and expresses Congress's concerns about the potential impacts of the order.

NNSA

Down-blended HEU to be used for tritium production

The National Nuclear Security Administration announced on August 23 that it intends to enter into an agreement with the Tennessee Valley Authority to down-blend high-enriched uranium to low-enriched uranium for the production of tritium.

A key component of the U.S. nuclear stockpile, tritium enables weapons to produce a larger yield while reducing the overall size and weight of a warhead in a process known as "boosting," according to the Department of Energy. It occurs naturally but in small quantities and must be manufactured to be used in weapons. Tritium also decays at a rate of 5.5 percent annually, and thus must be replaced periodically.

"Without this down-blending campaign, we would need to accelerate the development and execution of a strategy to provide LEU fuel for tritium production by nearly a decade," said Phil Calbos, the NNSA's acting deputy administrator for defense programs.

The NNSA is forced to down-blend its unobligated HEU inventory to provide LEU for tritium production because there is no source of unobligated enriched uranium available through the open market. ("Unobligated" refers to uranium not subject to peaceful-use obligations under civil nuclear trade agreements between

Security Briefs

THE U.S.-SOUTH KOREA HIGH LEVEL BILATERAL COMMISSION

(HLBC) held its second plenary meeting on August 16 in Washington, D.C. U.S. Deputy Secretary of Energy Dan Brouillette hosted South Korea's Vice Foreign Minister Cho Hyun for discussions about the management of spent nuclear fuel, reliability in the nuclear fuel market, exports and export control cooperation, and nuclear security and nonproliferation, and agreements were reached on future joint technical activities in each of those areas. Among the outcomes of the meeting, which was attended by about 50 senior officials, was an agreement that the two countries will work toward minimizing the use of high-enriched uranium in research reactors. Established in 2016, the HLBC serves as a formal mechanism to address issues pertaining to the peaceful uses of nuclear energy. A third plenary meeting is scheduled for 2019 in Seoul.

THREE ELECTRIC UTILITY TRADE ASSOCIATIONS RESPONDED

to an August 13 letter by Sen. Edward Markey (D., Mass.) in which he expressed his concerns about electric grid cybersecurity. The letter was sent to a number of electric utilities, power marketing organizations, and federal agencies. In their September 4 response, the heads of the American Public Power Association, the Edison Electric Institute, and the National Rural Electric Cooperative Association—which were not direct recipients of the letter—addressed some of the statements made in Markey's letter and asked that Congress consider how the electric sector and the federal government can more effectively share the responsibility for protecting the nation's energy grid. They also asked Markey to consider legislation that would allow electric companies access to federal databases to counter insider threats, increase security clearances for key electric company staff, and update the Support Anti-Terrorism by Fostering Effective Technologies (SAFETY) Act of 2002 (part of the Homeland Security Act) to include cyberattacks.

ABU DHABI POLICE HAVE CREATED A NUCLEAR SECURITY UNIT

to respond to potential nuclear emergencies, the United Arab Emirates' state news agency WAM reported on August 31. According to Mohammed AI Rashdi, acting director of the criminal security sector, "The new unit will cooperate with local and federal departments to review emergency nuclear response plans, coordinate with local and foreign partners to conduct training and exercises to upgrade readiness for emergencies, conclude partnership and coordination agreements, and assess the role of partners in nuclear security response." The unit will consist of four branches: planning and development, training and exercises, follow-up and license issuance, and partner coordination and readiness. A four-unit nuclear power plant is under construction at the Barakah site in Abu Dhabi.

PREVENTING RADIOACTIVE MATERIAL SMUGGLING IN MACEDONIA

is the objective of a memorandum of cooperation between the U.S. Department of Energy and Macedonia's Ministry of Interior Affairs. U.S. Ambassador Jess Baily and Interior Minister Oliver Spasovski signed the agreement on August 29 in Skopje, Macedonia's capital. The agreement includes the National Nuclear Security Administration's donation to Macedonia, by the end of the year, of two vehicle-based radiation detection systems worth \$550,000 for use by customs and radiation safety personnel. The NNSA's Office of Nuclear Smuggling Detection and Deterrence will provide training and maintenance for the mobile systems.

the United States and other nations.) The United States lost its only supplier of unobligated enrichment services in 2013.

The announcement of the agreement followed an August 21 "secretarial determination" by Secretary of Energy Rick Perry that authorizes the NNSA to continue the transfer of unobligated HEU from the DOE's inventory at the Y-12 National Security Complex in Oak Ridge, Tenn., to TVA for use as fuel in Watts Bar-1. Tritium is produced at the Spring City, Tenn., plant by irradiating lithium-aluminate pellets with neutrons in rods known as tritium-producing burnable absorber rods (TPBAR). The irradiated rods are then shipped to the NNSA's Savannah River Site, near Aiken, S.C., where the tritium is extracted, purified, and added to the nuclear stockpile. The first extraction of tritium at SRS from TPBARs irradiated at Watts Bar was successfully completed in January 2007, according to a 2015 DOE report.

The down-blending campaign will run from 2019 through 2025, with TVA providing material management and storage logistics through 2040, the NNSA said.

Section continued

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Nuclear News 2018 World List of Nuclear Power Plants

The World List of Nuclear Power Plants, a reprint from the March 2018 issue of Nuclear News, provides data on nuclear plants worldwide that are operable, under construction, or on order as of December 31, 2017, Plant listings are arranged alphabetically by country and by utility, with information on net MWe, reactor type, reactor model, initial criticality, commercial start, reactor supplier, and major participants. The 36-page reprint, available either as a PDF download or print copy, includes the entire Reference Section from the March issue: the updated World List (and notes), the maps showing the location of each plant site, and the tables.





A U.S.-RUSSIA WORKSHOP ON NONPROLIFERATION and disarmament was held July 30–31 in Monterey, Calif. The event was co-hosted by the James Martin Center for Nonproliferation Studies (CNS) and Moscow's Center for Energy and Security Studies. Participants in the workshop, held at the Middlebury Institute of International Studies, included California Gov. Jerry Brown (above, at front center), who delivered the keynote address; former U.S. Secretary of State William Perry; former Russian Ambassador Sergey Batsanov; and deputy of the Russian State Duma Inga Yumasheva (above, at right). One topic on which all parties seemed to agree, according to a press release from CNS, was the current lack of communication between top leaders of the two countries. "Even during the depth of the Cold War, we did not lack the dialogue we lack today," Perry said. However, noted CNS Director William Potter, "This workshop meeting represented an important step toward reestablishing regular interactions between American and Russian experts on nuclear issues."

ADVANCED REACTORS

NRC considers alternatives to physical security regs

Nuclear Regulatory Commission staff on August 1 sent a paper to the commissioners providing four options and a recommendation on possible revisions to physical security regulations and guidelines for advanced reactors, including small modular reactors and non-lightwater reactors. According to the staff, with design features such as smaller cores and passive safety systems, advanced reactors may warrant different physical security requirements commensurate with the risks posed by the technology.

The staff's recommendation was that the commission should pursue a limitedscope rulemaking that retains the current overall framework for security requirements in 10 CFR Part 73, Physical Protection of Plants and Materials, but provides alternatives to specific regulations and guidance related to physical security for advanced reactors. For example, the design attributes of advanced reactors may justify less reliance on human actions such as those provided by armed responders during an attempt to sabotage a plant. Alternative requirements could eliminate the need for armed responders or could establish a performance-based approach

for determining an appropriate number of armed responders. The paper cites a survey conducted by the Nuclear Energy Institute that found that the current requirement adds at least \$5 million per year to the operating costs of a nuclear power plant.

The other three options the staff considered were the following:

■ Maintaining the status quo.

■ Keeping the current regulations, but having staff prepare guidance for processing requests for proposed alternatives or exemptions related to physical security. Alternatively, staff could review and approve guidance prepared by reactor developers and could work with stakeholders to develop and issue a standalone guidance document.

■ A broad-scope rulemaking to assess and define physical security requirements for advanced reactor designs.

In their interactions with NRC staff, NEI, NuScale Power, and the Tennessee Valley Authority identified the limitedscope rulemaking approach as their preferred option. They all cited as reasons for their support the goals of reducing regulatory uncertainties and providing a process for reactor developers to incorporate security into their designs—many of which are still in the conceptual phase—to reduce reliance on human actions, as well as the timely resolution (about 44 months from the NRC's authorization) of the issue. **N**

Policy & Legislation

SENATE

Bipartisan bill aims to boost U.S. nuclear industry

The Nuclear Energy Leadership Act calls for more action from the DOE in support of advanced nuclear energy goals.

n September 6, Sens. Lisa Murkowski (R., Alaska) and Cory Booker (D., N.J.) introduced S. 3422, the Nuclear Energy Leadership Act (NELA), bipartisan legislation intended to reestablish U.S. leadership in nuclear energy by launching public-private partnerships between the federal government, research institutions, and industry innovators. It will also promote education initiatives, workforce development, and nuclear science training. Cosponsors of the bill include Sens. Shelley Moore Capito (R., W.Va.), Chris Coons (D., Del.), Mike Crapo (R., Idaho), Dick Durbin (D., Ill.), Joe Manchin (D., W.Va.), James Risch (R., Idaho), and Sheldon Whitehouse (D., R.I.). The bill has been referred to the Senate Committee on Energy and Natural Resources, which Murkowski chairs.



Murkowski

Booker

"Nuclear power provides clean, safe, efficient, flexible, and reliable power to American families and businesses, but we have only scratched the surface of its immense potential," Murkowski said in a press release. "Our bipartisan bill will help rejuvenate the U.S. nuclear industry by providing the tools, resources, and partnerships necessary to drive innovation in advanced reactors. I thank my colleagues for joining me in sponsoring this timely measure to create American jobs and restore our global leadership on nuclear technologies."

Among other directives, NELA would create a pilot program for at least one longterm power purchase agreement between the Department of Energy and a utility to buy electricity generated by a commercial nuclear reactor. According to the bill's text, the secretary of energy "shall give special consideration to power purchase agreements for first-of-a-kind or early deployment nuclear technologies that can provide reliable and resilient power to high-value assets for national security purposes... especially in remote off-grid scenarios or grid-connected scenarios." The deadline for the DOE to enter into such an agreement is December 31, 2023.

The new legislation would also extend the maximum length of federal power purchase agreements from 10 to 40 years, a change that the Nuclear Energy Institute considers crucial. "This is important because the larger upfront investments in nuclear reactors generally mean they need more than 10 years before they can begin to realize a profit," NEI stated in a press release on the bill's introduction. "The shorter timespan effectively locks nuclear power out of power purchase agreements with the federal government."

In addition, NELA would direct the DOE to establish specific advanced reactor research and development goals, a 10-year strategic plan that supports those goals, a fast neutron-capable research facility, a program to provide a minimum amount of high-assay low-enriched uranium to U.S. advanced reactor developers from DOE stockpiles until a long-term domestic supply is developed, and a university nuclear leadership program to meet the workforce needs of the industry, as well as those of the Nuclear Regulatory Commission and the National Nuclear Security Administration.

ANS President John Kelly said in a statement, "The American Nuclear Society applauds Senator Murkowski and Senator Booker on their introduction of the Nuclear Energy Leadership Act. NELA is an important step forward in supporting development of the U.S. advanced reactor technology portfolio and the nuclear engineering workforce."

CLEAN POWER PLAN

EPA defends abeyance as ACE Rule moves forward

On September 14, the Environmental Protection Agency filed a motion and re-



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Policy & Legislation Briefs

CONGRESS PASSED THE ENERGY AND WATER SPENDING BILL

for fiscal year 2019, part of a "minibus" package that includes Military Construction and Veterans Affairs and Legislative Branch appropriations bills. This is the first time in over a decade that Congress has sent more than one appropriations bill to the White House prior to the end of the fiscal year. The Senate approved the \$147.5-billion package on September 12 in a 95–5 vote, with the House giving its endorsement the following day in a 377–20 vote. At the time of this writing, President Trump was expected to sign the bill.

The Energy and Water portion of the measure provides \$44.64 billion in funding, a \$1.44-billion increase from the FY 2018 enacted level. The National Nuclear Security Administration receives a total of \$15.23 billion—a \$560-million increase from 2018—for the maintenance of the nuclear stockpile, defense nuclear nonproliferation, and naval nuclear reactors. Research and development activities to strengthen the security of the electric grid are funded at \$120 million, a hike of \$24 million. Energy programs will receive \$13.5 billion, a \$554-million increase, including \$1.2 billion for nuclear energy R&D and demonstration activities, a \$108-million increase.

In addition, the bill provides \$132 million for the ITER project in France, a \$10-million dollar boost from 2018 and the largest U.S. contribution since FY 2015. It also denies funds for Yucca Mountain and gives the Advanced Research Projects Agency–Energy a 3.7 percent boost, to \$366 million, after the Trump administration called for its elimination in its FY 2019 budget request.

A BILL TO AID COMMUNITIES AFFECTED BY PLANT CLOSURES— H.R. 6814, the Troubled Nuclear Power Plants Communities Assistance Act—was introduced in the House of Representatives on September 13 by Rep. Marcy Kaptur (D., Ohio). "The impact on local economies due to the potential loss of jobs and the tax base when nuclear power plants close can be severe," Kaptur noted during her introduction of the bill. "In my district, if the Davis-Besse nuclear power plant closes, it will mean the loss of 700 highly paid, skilled nuclear industry workers. And for every 100 nuclear power plant jobs, 66 related jobs are created in the local community."

H.R. 6814 would require the secretary of energy to establish and carry out a program to provide financial assistance to units of local government affected by the reduction in tax revenue from nuclear power plants. Over an eight-year period, the funding would provide 80 percent of lost revenues during the first year and would drop by 10 percent each following year.

sponse in the U.S. Court of Appeals for the District of Columbia Circuit asking the court to continue to hold in abeyance litigation on the Obama-era Clean Power Plan (CPP) as the agency moves forward with the Affordable Clean Energy (ACE) Rule.

The court had issued an order in April 2017 granting the EPA's motion to hold litigation on the CPP in abeyance for 60 days, and the order has subsequently been extended. On September 4, a coalition of 17 states, along with several cities, counties, and environmental groups, asked the U.S. Court of Appeals for the District of Columbia to end the abeyance period and move ahead with a decision on the CPP, which would impose restrictions on greenhouse gas emissions from power plants. The Supreme Court had granted a stay of the CPP in February 2016.

Supporters of the CPP argued in court documents that the EPA's motions for abeyance were a tactic meant to stall the regulation. The EPA, however, contends that it has been reviewing the CPP as directed while the issue has been in abeyance, even filing mandatory status reports every 30 days.

The ACE Rule was proposed by the EPA as a replacement for the CPP on August 21 under the agency's acting administrator, Andrew Wheeler, and comments have been requested through October 31 (*NN*, Sept. 2018, p. 47). The ACE Rule would do away with many of the CPP guidelines, giving states the authority to set their own emissions standards. The new plan, promised by President Donald Trump on the campaign trail, focuses on coal-fired plants and is expected to face its own legal challenges.

In court papers, the EPA states, "There is no sound reason for the court to change course. EPA's final rulemaking—now expected within a period of months—could moot this case and render any further proceedings unnecessary." The EPA has indicated that a final ruling can be expected "by the first part of 2019" and that no emission reductions would be required from power plants through the CPP until 2022 at the earliest.

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The Davis-Besse nuclear power plant, with Lake Erie in the background

Davis-Besse's 20th outage: The "Drive For 25"

As a result of detailed planning, improved communications, and a united effort, Davis-Besse and its contractors achieved their 25-day outage goal—a plant record.

By Mark Kanz

usiness as usual" could no longer be the standard at FirstEnergy's Davis-Besse nuclear power plant. The 908-MWe pressurized water reactor in northwest Ohio, about 25 miles east of Toledo near Oak Harbor, had performed successful refueling and maintenance outages in the past, achieving its outage goals, but market forces required the next set of Davis-Besse outage goals to be much more challenging than in the past. The plant's 20th refueling outage in the spring of 2018 would be planned for 25 days-or less. Davis-Besse's "Drive For 25" was under way.

All photos on pp. 44 through 56 are from FirstEnergy, except for the exterior shot (above), which is from the NRC.



Members of the Outage Management team gather at the conference table in the Outage Control Center. From left, Alvin Dawson, John Cunnings, Trent Henline, Brian Matty, Lucas Ring, Bob Howard, and Pat McCloskey.

Mark Kanz (<mkanz@firstenergycorp.com>) is the Senior Communications Representative for FirstEnergy Solutions.

When Davis-Besse closed the breaker on its previous outage, all major projects required for a 20-year life extension had been completed. The station had previously replaced the reactor vessel head, steam generators, reactor coolant pump motors, and several other components. Major license renewal work was done. Modifications required to implement its FLEX strategies-ordered by the Nuclear Regulatory Commission after the Fukushima Daiichi accident in 2011-were complete, and many other station improvement projects were checked off the "to-do" list. The station objectively was in the best material condition it had been in since its initial construction, and the plant was ready for the prolonged operational life granted by a 20-year license renewal from the NRC—only it wouldn't be that simple.

Market forces were not the only obstacle facing the Davis-Besse team. Three months before the outage was to begin, FirstEnergy made a decision to spin off FirstEnergy Solutions and FirstEnergy Nuclear Operating Company (FENOC) into stand-alone companies. Rumors began to circulate about the company and the plant's future. "When we started planning this outage two years ago," said Doug Huey, performance improvement and day shift outage director, "economics was a major factor, but it became essential that we achieve our outage goals."

With economic uncertainty surrounding the future of the plant, employees were encouraged to focus on the things they could control. "The only thing we can control is safe, error-free, reliable generation," Site Vice President Mark Bezilla told outage workers.



Reactor Operator Chris Hotz monitors plant conditions during shutdown prior to the 2018 spring outage.

The Outage Management team realized that it couldn't do what it had done in the past because it wouldn't achieve the desired result. Employees were challenged to think creatively and to a different level of detail. Contingency plans were also a major focus. The organizational challenge was, "What's the most likely thing that can go wrong and are we prepared for it?"

The outage team was tasked with leading an effort to improve every aspect of Davis-Besse's outage performance. The first challenge was to determine where the greatest gains could be achieved. DavisBesse outages are broken down into 10 work windows. "We looked at the best times in the industry for Babcock & Wilcox-designed units, how those outage windows were executed, and our previous best performances," said Outage Manager Bob Howard. "The other two FENOC stations—Perry and Beaver Valley—were also leveraged for improvements."

Howard's team needed to find room for nearly 1,250 work orders and more than 7,500 specific activities, from surveillances to preventive and corrective work to a handful of project work orders. He wanted



Crews wait outside the containment hatch to begin inspections at the start of the outage. A 360-degree camera with a fisheye lens was used to take the photo.



Members of the air-operated valve (AOV) maintenance team conduct work on a valve on the turbine deck. The AOV team conducted overhauls, calibrations, packing consolidations and adjustments, and diagnostic testing on 39 different valves during the outage.

control room operators to be able to focus on running the plant without distractions post-outage. Some of the major work scope items included condensate polisher tube replacements, circulating water pipe repairs, steam generator inspections, and the main transformer low-voltage bushing replacements.

"We wanted to make sure we were going after the right work to address plant reliability issues, health report concerns, and operational impacts," Howard noted. One of the biggest challenges was convincing employees that they were capable of executing an outage in 25 days or less because the plant's previous best was almost two weeks longer. "Station personnel had a positive attitude about 1R20 [Unit 1 refueling outage no. 20], but they didn't fully understand the outage improvement initiatives early on," he said. "Supervisors were charged with explaining the 'why' behind the 'what' in the outage schedule."

Despite a lot of moving parts and emergent issues in the first few days of the outage, the Operations department manipulated the plant flawlessly and without incident. "Crews went through a great deal of training, and it really paid off," said Dan Hartnett, assistant operations manager. Part of the secret to success was the just-in-time training the Operations staff received leading up to the outage. Plant operators had the opportunity to practice crucial plant maneuvers in the simulator for several weeks before making the moves for real. "We established plant conditions in the simulator, and it's exactly what they were seeing in the control room," Hartnett said.

Communication and discovery

An industry best practice that Davis-Besse borrowed from the Perry plant was the creation of a Joint Work Execution Center (JWEC). "The purpose of the JWEC is to take the three-day schedule and track what the major work groups are doing, including start and stop times," said JWEC Team Lead Chris Chisholm. "We control and track all maintenance activities." The Outage Control Center remains responsible for driving the "big-ticket items" in the outage, focusing on critical path tasks and the 24-hour look ahead.

JWEC staff included representatives from Maintenance, Operations, and Radiation Protection working side by side to improve the handoffs between groups, enhance communication, and ultimately improve schedule adherence by streamlining work, dealing with minor issues, and eliminating delays in the schedule. Equipment clearance orders and Radiation Protection briefings had delayed outage work in the past. The JWEC gave Maintenance direct contact with the two groups that control those areas, providing a clear path for success.

The JWEC's focus was on secondary system restoration, taking the burden off the Operations staff and allowing them to focus on the primary system. "We've seen it work well at top-performing plants and felt it could be the key to trimming a week and a half or more off the typical Davis-Besse outage duration," Chisholm said.

The first 100 hours of every outage are important for discovery, as issues arise and must be dealt with. Some are anticipated and others are not, but they are all emergent and can test an unprepared organization. "We schedule outage activities to get possible discovery items on the table as soon as possible," Howard said.

The Engineering department took great care in laying out the in-service inspection schedule and added some additional manpower to accommodate the compressed outage schedule. "We highlighted some of our discovery items, the high-risk exams that would cause a delay in the outage if an issue were discovered," said Alan Scheanwald, team lead. They conducted



In the Outage Control Center, engineer Dennis Schreiner consults with valve experts on an emergent equipment issue.

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The Steam Generator team from BWXT is congratulated by Assistant Dayshift Outage Director Trent Henline, at far right. Team members are, from left, Ted Mitchell, Jimmy Morgan, John O'Neil, and David Howard, who along with the rest of their team set a record for steam generator eddy current inspections safely and under dose estimates.

visual inspections, walked down containment, and tried to identify any problem areas as early as possible.

Issues identified in the first few days of the outage included a valve socket weld leak, malfunctions on two cranes, and a broken throttle on a diesel fire pump. "These types of mechanical issues are going to happen," said Ken Byrd, Engineering director and night shift outage director. "We just turned these challenges into one more work activity, incorporated them into the outage work schedule, and got them done like every other outage activity. The focus was to get out of the analysis phase and get to work to resolving them."

SG team sets record

The consensus opinion at Davis-Besse following steam generator inspection and maintenance activities during 1R19 was, "We can't keep doing what we're doing and expect different results." Numerous challenges caused delays in completing steam generator primary work on time during past outages. The plant had taken a full week to perform steam generator tube inspections, while industry peers were regularly completing similar inspections in about three days.

BWX Technologies (BWXT), the original equipment manufacturer for the plant's current once-through steam generators, was brought in for the outage for the first time. This was viewed as an opportunity to start with a clean slate and dramatically change how steam generator maintenance and inspection activities were handled at Davis-Besse.

BWXT had several years of experience in performing successful outages at plants similar to Davis-Besse, so plant representatives did some benchmarking to see how the vendor coordinated work processes with plant personnel. The lessons learned were incorporated into Davis-Besse's pre-outage planning process, culminating in a three-day meeting with representatives from all affected organizations. An "outage project script" was developed that listed the sequence of events to a far greater level of detail than the outage schedule, handoffs, and the required coordination across the entire work scope. All work groups were on the same page, even during the preliminary equipment mobilization stage.

All of the preparation and planning paid off, as the first outage with BWXT's participation at Davis-Besse was recordsetting. The team set an industry record for B&W full-scope steam generator eddy current testing, coming in at just under 62 hours. In addition, the BWXT crew used less than half of the radiation dose it had originally budgeted. All activities were completed ahead of schedule, allowing the rest of the outage to proceed without interruption.

Numerous post-outage lessons learned were documented and will be rolled into planning for the next inspection outage as the BWXT team looks to break its own record. BWXT's steam generator team made a great first impression on Davis-Besse. "They were a first-time vendor here, and they knocked it out of the park," said Trent Henline, site projects manager.

Other scheduled work

Electrical Maintenance Superintendent Brian Walleman's team faced the challenge of fitting 50 pounds of work into a 25-pound bag. "We had multiple motor control centers [MCC] to service, and we had a very narrow window to fit them in," Walleman said.

The MCC team got creative. Environmental qualification testing is required every eight years. This outage required that all 105 MCC enclosures-known as buckets, or cubicles-be tested, a process that had taken a week last time. "Right at the start, we asked which cubicles could be tested on line," Walleman said. They found that the answer was 40. Then they looked for additional efficiency gains and formulated an effective plan for the other 65 cubicles. "We laid these out physically to maximize resource capabilities," he said. "It strategically kept us from bumping into each other or trying to work in the same location at the same time."

The MCC team also looked at upcoming preventive maintenance tasks and incorporated them into the work scope. "We prepared at a level that we've never done before, and the execution was flawless," Walleman proudly said of his team.



A Conco employee conducts feedwater eddy current testing during the outage.



Workers prepare to reinstall the cover on one of the plant feedwater heaters during the outage.

■ Work scheduled on a low-pressure feedwater heater was not only planned to bring this piece of equipment back to life, but also to restore plant efficiency. A water leak in the heater had caused plant operators to bypass it, resulting in a 7-MW production loss during the operating cycle.

"In the past, we would just plug tubes that were leaking," said Project Manager Mark Wymer. "If it got too bad, we'd have to retube the entire heater, and that's a big deal."

A new process brought to Davis-Besse by Framatome (formerly Areva) had technicians identify problem tubes through eddy current testing and then insert sleeves in them. "The sleeves are then expanded for a tight fit," Wymer said. "These eliminate tube flaws and extend the life of the feedwater heaters well into the future." In this effort, several tubes that had been plugged for years were recovered.

■ Davis-Besse's cooling tower suffered the effects of many brutal winters along the shores of Lake Erie. Ice had been falling from the tower and onto the circulating water piping below for four decades, and this problem needed to be corrected.

Project Manager Stevie Darr developed a two-phase plan to protect and refurbish the two concrete pipes that each carry 225,000 gallons of water from the plant to the tower every minute. The first step involved fabricating a rubber and metal *Continued on page 52*



Technicians apply carbon fiber wrap to the inside of one of the two 108-inch circulating water pipes near the Davis-Besse cooling tower to help mitigate years of damage caused by falling snow and ice.

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Project Manager Mark Wymer uncovers a tube bundle staged for replacement in one of the Davis-Besse condensate polishers.



One activity not accounted for in the original outage scope was cleaning and refurbishing the bolts that hold the condensate polishers together. More than 400 bolts had to be blasted and cleaned, and any burrs or irregularities removed. Creative scheduling got this key task included in the outage work.

Continued from page 49

bumper to fit over pipe sections that are aboveground. The second phase had crews from Structural Technologies apply a carbon fiber wrap to the inside of the 108-inch-diameter pipes. "It's essentially a new pipe," Darr said.

■ It had been more than 15 years since Davis-Besse's condensate polishers got the kind of attention they received during 1R20. Polishers function like a water softener to filter water and limit the wear on key pieces of plant equipment. As the outage was being planned, questions were raised as to whether work on all four polishers could fit into a 25-day schedule.

"We bought two new frames and tubed them before the outage," Wymer said. "We removed the first two tube bundles and replaced them with the new ones." Then, the two bundles that were removed were refurbished and put into the last two polishers. Maintaining the secondary water chemistry at optimum levels helps ensure the long-term reliability of plant components. Another example of a long-term investment made in the plant and its equipment was the main transformer low-voltage bushing replacement. Six new bushings installed in the outage will have a longer life (20 years) than the previous ones and will perform better under the extreme heat conditions in which they need to operate.

While the transformer was disassembled, a full battery of tests was conducted to ensure its long-term viability and to improve its health. Focused project challenges resulted in the completion of this work in less than nine days, compared to a previous best of 13 days. "The transformer is now in really good shape," said Jim Whitwright, project manager, upon completion of the work.

■ Davis-Besse had 100 integrated control system (ICS) circuit cards in need of replacement grommets at the testing jacks, but the grommets are no longer manufactured for sale. As a result, the plant turned to FENOC's BETA Laboratory to help find a solution. In partnership with Pennsylvania State University, BETA Lab created updated ICS modules using 3-D printing technology.

"Purchasing reverse-engineered cards is costly, averaging \$6,800 per card," said Mike Yeager, director of technical and lab services at BETA Laboratory. "We created the grommets in-house at a fraction of the cost. More than \$500,000 in savings was achieved."

Penn State students gained experience from working on a real-life challenge for a large company, and in return the company benefited from their skills and hard work, as well as the university's institutional knowledge and resources. BETA Lab has already used 3-D printing technology for other applications within the company. ■ The Reactor Engineering group knew that it needed to do its part if the plant was to complete 1R20 in record time. Reactor engineer Shane Rafferty was determined to better the time needed to verify the reactor core, an activity that previously took an entire day and delayed key work required to bring the unit back on line. He benchmarked other plants that use a similar system and trained other staff members on the use of the Newton core verification system. The job was completed in a third of the usual time, helping to push the outage closer to completion.

Involving student interns

Davis-Besse believes in fully immersing its Engineering student interns in outage work. Quinton LeSage, a mechanical engineering student from the University of Wisconsin at Milwaukee, was a boric acid corrosion control (BACC) inspector during the outage. He used a 360-degree camera to create a new virtual tour of the Davis-Besse containment. "I had seen some 360-degree work on the Internet, and it sounded like a cool project," he said. "Pretty much anytime I went out for a BACC inspection, I had that camera with me."

LeSage compiled almost 275 different views of the containment with a dual fisheye lens camera on a tripod. The actual photo takes less than three seconds, pro-



This view inside Davis-Besse's incore tank was taken using a fisheye lens on a 360-degree camera. Workers are making final preparations for the plant's restart.

ducing a view in all directions. The camera combines the views of the two lenses into a single image. Maps of the four main elevations of containment have been posted on the plant's SharePoint site, with dots linked to the panoramic photo shot at that spot. Clicking on the dot opens the photo in an Internet browser. Employees can click, hold, and drag the mouse on the photo to look up, down, right, and left and all around the area.

The virtual tour will increase job safety and efficiency. Workers are better prepared for entry into infrequently accessed spaces, which allows them to work more safely and to complete tasks in less time. Because the photos are plotted on a map, workers can see how to reach the work area and view possible impediments. Radiation Protection staff have used it to show possible problem spots and help workers see exactly what they will be dealing with in the field.

In July, following the outage, an entry into containment was required for online maintenance activities, and the virtual tour proved to be an invaluable asset. Maintenance personnel were able to fully immerse themselves in the work environment prior to doing the actual work. The result was more thorough planning and efficient conduct of the maintenance, saving both radiation exposure and overall cost.

LeSage acknowledged that the nuclear industry is currently going through "a rough patch." However, he added, "These plants are going to be around for years to come regardless, and I want to be a part of the industry." He is thankful for the lessons he learned. "If I gain experience now, I can be ready for a nuclear industry revival."

Reflections on IR20

The "Drive For 25" mission was accomplished with more than nine hours to spare. The official time was 24 days, 14 hours, and 52 minutes. Many plant improvements were completed in three-anda-half weeks-from March 3 to 27-and, most important, the performance of the outage was safe and event-free. Although the outage got off to a rather inauspicious start with the malfunction of both containment cranes and some issues with fuel handling equipment, the site rallied around those problems and figured out solutions. "We started 18 hours in the hole on day one, and we clawed that back," Huey noted. "I think the staff started to see that this [25-day outage] was possible."

Besides making the duration milestone, a number of other goals were achieved. The plant finished significantly under budget and came in 5.7 rem under its radiation exposure budget. There were no Occupational Safety and Health Administration recordable injuries, no environmental exceedances, no changes in shutdown



Plant electricians rack-in the exciter field breaker as Davis-Besse prepares to return to service following its IR20 outage.

defense-in-depth, and no site clock resets. The plant has run at 100 percent power since the breaker closed on the outage, further proving that the right work was done and was done correctly. All of these improvements have given the operators a quality plant to run.

A substantial amount of time was spent planning the 1R20 outage and selecting the projects that would provide the biggest benefit to the plant. Barry Blair, general plant manager, credited candid work readiness discussions during Outage Fridays for aiding the process. "We built in a lot of contingencies and held a lot of challenge meetings," he said. "We spent a lot of time digging deep into the schedules."

It worked, as the Davis-Besse team set station best-ever times in six of the 10 outage work windows. Blair's assessment is that pre-outage preparation and emergent issue management made the difference. As planning for 1R21 begins to hit its stride, the Outage Management team is focused on the four windows that did not meet expectations. "There's still room for improvement," he noted. "I think we left some things on the table, but in no way should that diminish the accomplishments of our team."

In previous outages, operators would find themselves trying to start the secondary and primary systems at the same time. The outage team held firm to its schedule, and there was no overlap this time around.

Looking to the future

With the plant arguably in the best material condition it has been in for many years, Davis-Besse now finds itself in a unique situation. While plans for the next outage are well under way, a decommissioning team has also been formed. Just after 1R20 concluded, employees' fears were realized as FirstEnergy Solutions announced plans to deactivate its nuclear

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A General Electric technician cleans parts as his group begins to reassemble the Davis-Besse turbine.

fleet unless some type of legislative relief from a flawed market design and weak power prices can be found. Failing that, Davis-Besse will shut down no later than May 31, 2020. On March 31, 2018, First-Energy Solutions declared bankruptcy in an effort to restructure its finances under Chapter 11 of the federal bankruptcy code, further adding to employees' concerns.

Weak power demand forecasts and insufficient capacity auction results make it difficult for a single-unit plant like Davis-Besse to compete in today's competitive market. Davis-Besse and Perry, Ohio-based FENOC nuclear plants, contribute more than \$540 million to the Ohio economy annually, and that doesn't include all of the dedicated employees' expenditures on housing, gas, food, and other necessities. Davis-Besse is Ottawa County's largest employer.

Employees try to remain confident that some sort of policy solution will be developed in the Ohio legislature to avoid the deactivation or sale of Davis-Besse, recognizing the importance of nuclear plants and their unique role in providing consumers with reliable, zero-emissions electric power. In the meantime, Davis-Besse continues down the parallel paths of outage planning and preparing for decommissioning, always focusing on the job at hand: to continue safe, secure, and reliable plant operations.



Operator Chris Simpson closes the control cabinet on the DB-34561 output breaker after switchyard work was completed.

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Trends in maintenance and work management

The 25th ANS Utility Working Conference focused on improving industry performance and managing operational risk. he 25th ANS Utility Working Conference, held August 5–8 at the Omni Amelia Island Plantation Resort in Florida, drew more than 650 professionals from the power generation side of the industry—more than three times the number at the inaugural event in 1994.

This year's UWC featured 55 educational sessions and workshops, including six sessions dealing with maintenance and work management issues organized by Jon Anderson, chief executive officer of Anderson, Chavet & Anderson; Pete Arthur, work management lead evaluator at the Institute of Nuclear Power Operations; Gwen Bookheimer, department manager of transportation at Duquesne Light Company; and Bryant Hearne, maintenance lead evaluator at INPO.

UWC fixtures Arthur and Hearne conducted the first such session, "INPO Review of 2017 and 2018 Trends in Work Management and Maintenance." Hearne began the discussion with a review of the 2017–2018 IPSR (INPO Performance Summary Report) ratings for maintenance. According to Hearne, U.S. nucle-



Bryant Hearne and Pete Arthur lead an INPO work management and maintenance session.

ar plant maintenance in 2017 and 2018 breaks down as follows:

Exemplary and improving: 6 plants in 2017; 14 in 2018.

Exemplary and stable: 13 in 2017; 13 in 2018.

Exemplary and declining: 1 in 2017; 0 in 2018.

Strong and improving: 15 in 2017; 15 in 2018.

Strong and stable: 17 in 2017; 9 in 2018.

Strong and declining: 1 in 2017; 1 in 2018.

■ Acceptable and improving: 3 in 2017; 6 in 2018.

Acceptable and stable: 4 in 2017; 1 in 2018.

■ Marginal and declining: 0 in 2017; 1 in 2018.

Hearne said that the numbers of "areas for improvement" this year in the categories of mechanical component assembly practices, mechanical joint/tubing assembly practices, written instruction deviation/errors, and supervisory oversight are all on track to either match or surpass 2017's totals, while the numbers for control of wiring, test leads, and terminations may come in below last year's.

On the topic of consequential events, Hearne noted that just two reactor fleets are responsible for 52 percent of consequential events recorded so far in 2018, with all other fleets accounting for 12 percent or less. When these events are broken down by work group, he added, supplemental is responsible for 44 percent, instrumentation and controls for 24 percent, electrical for 16 percent, and mechanical for 12 percent (4 percent is designated as "others").

One of INPO's major goals, Hearne said, is to reduce the average number of monthly consequential events attributed to maintenance performance to five by the end of 2018, four by the end of 2019, and three by the end of 2023. At the end of the second quarter of 2016, he said, that number stood at just under 10, whereas by the end of the first quarter of this year, INPO registered a total of just under seven. Hearne also covered 2018 maintenance areas of positive recognition, including

Trends in Maintenance and Work Management

craft ownership, industrial safety, electrical safety, and training.

A number of documents are being revised as part of INPO's key issue action plan, Hearne said, including INPO 05-004, Guidelines for Conduct of Maintenance; INPO 12-001, Maintenance Fundamentals; INPO 12-007, Craftsmanship; INPO 10-05, Principles for Maintaining an Effective Technical Conscience; and ACAD 92-008, Guidelines for Training and Qualification of Maintenance Personnel.

"The Electric Power Research Institute is part of this as well," Hearne said. "They're evaluating their Standard Task Evaluations to look for gaps. We've also got industry working groups involved in identifying best practices for sustainability, improving performance in electrical safety, and improving performance in mechanical assembly and leak paths."

Newly released INPO event reports (IER), Hearne continued, include L4-18-7, Adverse Trend in Primary Pump Seal Failures, and a revised L4-16-5, Adverse Trend in Debris-Related Nuclear Fuel Failures. "We've got five stations operating with failed fuel in 2018, and only five in all of 2017," Hearne said. "Effectiveness of station and supplemental leadership to develop and reinforce foreign material prevention behaviors has declined." IERs in development, he said, include one regarding adverse trends with operations and maintenance personnel with mis-positioning events. That IER, he said, was expected to be released in the third quarter of 2018.

INPO's major focus areas in 2018, Hearne said, are maintenance technical fundamentals, improvement of industry monitoring and performance, alignment and empowerment of leadership, craftsmanship and proficiency, optimum use of resources, and improvement of foreign material exclusion controls.

Arthur's presentation on work management trends also began with a look at the 2017–2018 IPSR ratings:

Exemplary and improving: 3 plants in 2017; 12 in 2018.

Exemplary and stable: 37 in 2017; 33 in 2018.

Exemplary and declining: 3 in 2017; 2 in 2018.

Strong and improving: 10 in 2017; 6 in 2018.

Strong and stable: 2 in 2017; 5 in 2018.

Strong and declining: 1 in 2017; 0 in 2018.

Acceptable and improving: 2 in 2017; 1 in 2018.

Acceptable and stable: 1 in 2017; 0 in 2018.

■ Marginal and improving: 1 in 2017; 1 in 2018.

"All in all, we're pretty pleased with work management," Arthur said. "Here's what I'd tell you: Proceed with caution. Don't take this information and sit back and go, 'OK, things are running smoothly.' Be cautiously optimistic about your work management performance."

INPO identified what Arthur described as a "handful" of areas for improvement in 2017—with a prominent theme being safety system outage preparation and performance-while in 2018, it has so far identified two, in safety system outage preparation and execution. "Organization shortfalls exist in preparation and execution of safety-significant and importantto-safety system outage performance, lowcritical scope survival, and high backlogs," he said. "And workers involved in work preparation and planning inconsistently understand and prepare for contingencies when preparing plans for work important to safe and reliable plant operation."

Regarding work management areas of positive recognition in 2018, Arthur highlighted the categories of work progress, online work management, risk reduction,

outage readiness, and overall work management process. "The maintenance department has effectively collaborated with work management and operations per-

sonnel to improve work preparation and execution," he said. "Managers and risk assessment engineers have taken actions to achieve low probabilistic risk assessment risk management action levels for both online scheduled work and refueling outages." Arthur also noted that "strong teamwork among senior leaders and sitewide engagement in the work management process have driven a rapid recovery in equipment performance."

In closing, Arthur summarized INPO's 2018 focus areas, which include identifying, communicating, and managing operational risk, preparing and executing safety system work windows, effectively allocating maintenance resources, improving fix-it-now team effectiveness and productivity, and identifying areas of inefficiencies that are affecting station performance.

Change agents

One of the more significant initiatives being taken on by the nuclear industry is the transformation of plant maintenance organizations, with the goal of improving efficiency and effectiveness and reducing costs. At the start of a session on that topic, "How We Are Transforming Our Maintenance Organizations," John Boesch, maintenance manager for Xcel Energy's Prairie Island plant, did not mince words. "To stay in business," he said, "we are going to have to change... During my last stint at corporate, our chief nuclear officer, Tim O'Connor, and David Goldsmith and I put together an organization that we feel is going to transform maintenance and keep us viable in the long term. We started out just trying to fix what we have but came to the



realization that we need to break the mold, see how other businesses are doing it, how they're being efficient, and then apply those efficiencies to our business. So we did a lot of benchmarking. We benchmarked nonnuclear plants, the

Boesch

airline industry, the automotive industry. What we saw was pretty eye-opening."

According to Boesch, what the team saw was workers with advanced technical skills who took ownership of, and pride in, their work. "They don't depend on layers of processes and procedures, they don't depend on layers of supervision and management,"

"We have to drive costs down and at the same time keep our standards up. One without the other is not a recipe for success."

he said. "They truly own their work."

Noting the current threats to the industry's continued viability-cheap natural gas and renewables, flat demand, nuclear plant closures, and high costs-Boesch said, "We have to drive costs down and at the same time keep our standards up. One without the other is not a recipe for success." The typical repair of an airoperated valve in the radiological control area of a nuclear plant, he said, involves 36 man-hours of field time, 41 worker touch points, eight supervisor touch points, and 11 handoffs, all of which cause delays. The typical total cost for that repair, he said, is about \$36,000. "That's just the way it is right now with our processes," he added. "It doesn't have to be that way."

To help transform the maintenance organization, some key NEI efficiency bulletins have been implemented, Boesch said, including EBs that have reduced the maintenance workload by 25 percent and empowered front-line supervision and craft workers. "There are a lot of jobs out there that we put two, three, four people on, when in reality, if there isn't a risk to the schedule, if there isn't a risk to the plant, you could probably put far fewer people out there," he said. Boesch also called for "breaking down the barriers between the different silos. Let's just get rid of silos. . . . We're going to combine maintenance, a good portion of engineering, and work management all under one organization. Continued

By doing that, we could have far fewer handoffs."

Returning to the subject of benchmarking, Boesch said that maintenance organizations outside of nuclear tend to share the following characteristics: They are self-sufficient, with fewer handoffs or external support groups; they have the expertise to be self-reliant for all aspects of maintaining equipment; they are accountable for the cost-effective use of resources with the right skill sets; they hold accountability for the safe execution of work and adherence to standards at the worker level; and they utilize workers who are engaged, with strong ownership and accountability, have a broad range of capabilities, and are empowered to make decisions. "In our benchmarking, what we saw is that the focus of the company was on investment in their workers," he said. "To give them the right skills, the right standards, and the right ownership, you have to invest in them. If you're going to turn them loose, you've got to make them good."

Value judgments

The UWC business and engineering tracks merged with the maintenance and work management track for a session titled "Is the Nuclear Promise Delivering on Value Based Maintenance?" The session examined the reduction in critical plant components, as well as the reduction in the cost of preventive maintenance (PM) programs, and the total cost of maintenance.

The Delivering the Nuclear Promise (DNP) initiative, as most in the industry are aware, is the multiyear effort coordinated by the Nuclear Energy Institute, in collaboration with electric utili-

The goal of value-based maintenance is to change the culture of "reliability at any cost" and "more is better" to one in which maintenance is treated as a highly valued and limited resource.

ties, INPO, and EPRI—to improve operational efficiencies at nuclear plants while maintaining safety. According to the DNP, the goal of value-based maintenance is to change the culture of "reliability at any cost" and "more is better" to one in which maintenance is treated as a highly valued and limited resource. The DNP considers this change necessary to advancing safety and reliability in a cost-effective manner.

Kicking off the session, via telephone, was Joshua Hinson, Southern Nuclear's fleet equipment reliability manager, who led the company's effort to reduce the number of critical components at its three nuclear plants—Farley, Hatch, and Vogtle. At Southern, Hinson explained, a component is now defined as "critical" based on NEI's EB 16-25, *Critical Component Reduction*, which labels a component as critical only when a credible single active component failure will directly result in any of the following unacceptable consequences: 1. A reactor trip/scram.

2. A power transient of more than 20 percent.

3. A Mitigating Systems Performance Index component failure.

4. A single failure that causes a complete loss of any of the following critical safety functions: (a) core, reactor coolant system, or spent fuel pool heat removal; (b) containment isolation, temperature, or pressure; (c) reactivity control; or (d) vital AC electrical power.

5. A single equipment failure that results in the loss of a Maintenance Rule high-safety-significant or risk-significant function.

To review components using the revised definition, Hinson said, Southern employed "cross-functional reclassification teams" from engineering and operations that evaluated the components requiring review and developed a spreadsheet showing the classification basis for the affected components. In the end, according to Hinson, the Southern fleet's pre-change critical component total of 46,976 components was reduced to a post-change total of 10,360, a reduction of 36,616, or 78 percent.

"EB 16-25 is really an enabler to valuebased maintenance," Hinson said. "Of course, the equipment is going to behave

the same way it did before you called it something different, so what are you going to do differently to save money? Our next steps are to develop and implement value-based maintenance white papers. The industry put out a value-based maintenance white paper template that was

endorsed at the last [EPRI] Equipment Reliability Working Group meeting, and there are active industry efforts to develop white papers and to roll them out. Specifically for Southern Nuclear, our business plan states that we will complete 10 white papers by the end of 2018, with five implemented at each site, and we will continue and potentially expand the value-based maintenance effort in 2019."

An update on Duke Energy's efforts toward value-based maintenance was provided by Nally Osburn, head of Duke's critical component reduction program. According to Osburn, Duke reclassified all legacy critical equipment to align with revision five of INPO's AP-913, *Equipment Reliability Process Description*, which includes a notable change enabling a reduction in the number of critical components, and with EB 16-25. Procedural guidance and work instructions at the utility's six nuclear sites—Brunswick, Catawba, Harris, McGuire, Oconee, and Robinson were established in January 2017, he said, while equipment reclassification efforts were begun in February 2017 and completed at the end of June 2017.

"We established the classification criteria and basis . . . for what we were going to decide was critical and noncritical," Osburn said. "Excel spreadsheets with legacy 'high' and 'low' critical equipment were created from our equipment database. Each site's equipment reliability lead coordinated the efforts between the system engineers. New classification results, including basis, were captured in the spreadsheets. Spreadsheets were used to update the equipment database via a configuration management engineering change by design and IT." According to Osburn, this resulted in changes to more than 100,000 equipment records.

The review also identified a gap in Duke's previous classification efforts, Osburn said. "We had 32,000 equipment records that had no classification. We took this opportunity to clean that up, because we definitely wanted to know if there was any critical equipment hiding out there." In addition, he said, more than 550 new critical components and 3,100 single point vulnerabilities were identified.

This latest classification effort, Osburn pointed out, has resulted in an overall fleet critical component reduction of 49,465 from 75,535 components to 26,070, a 65 percent decrease. Specifically, Brunswick dropped from 10,321 to 5,531, a 46 percent reduction; Catawba, from 20,621 to 6,451, 69 percent; Harris, from 10,492 to 1,979, 81 percent; McGuire, from 17,380 to 5,914, 66 percent; Oconee, from 12,961 to 4,050, 69 percent; and Robinson, from 3,760 to 2,145, 43 percent.

In parallel with this effort, Osburn continued, Duke worked on EB 16-16, *High Cost, Non-Critical Preventive Maintenance Reduction*, which calls for identifying high-cost, high-frequency, and resourceintensive PMs that are performed on noncritical equipment but don't return value in equipment reliability. The desired outcome of EB 16-16, according to the document, is a reduction in maintenance labor, parts, and planning costs due to a reduction in PM frequency, content optimization, or the elimination of PM tasks. Duke's efforts on this score, Osburn said, resulted in a total "material savings" of \$352,332, as of the



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first quarter of 2017. "We did actually take that money out of the budget, so those were hard dollar savings," he said.

Further, Osburn said, Duke is working on EB 17-03a, the specific bulletin on value-based maintenance. Phase one of this work was to be completed by the end of the third quarter of this year, he said, with phase two being initiated by the fourth quarter. Duke's efforts on this subject in the first quarter of this year, Osburn said, have resulted in on line savings of \$1,278,204 and outage savings of \$781,776. The majority of the savings, he said, came from PM reductions on noncritical equipment. To date, reducing the critical equipment population has not resulted in PM cost savings, he added.

At the close of the session, Jon Anderson, one of the session's organizers, so-



licited input from the audience and cited encouraging statistics from NEI: The DNP initiative has led to a reduction in plant operating costs of 19 percent since 2012 and has saved the industry \$1.6 billion. Also, the NRC's annu-

Anderson

al fees for licensees have been reduced by approximately \$130 million. "In 2018, the DNP is transitioning to focus on the most significant savings opportunities in the most efficient manner," Anderson said.

Pursuing excellence

Fortified by a Sunday of golfing, beach strolling, and other Amelia Island diversions, attendees at this year's UWC got down to business on Monday morning at the conference's opening plenary session, "Continuing the Pursuit of Excellence."

In his introductory remarks, ANS President John Kelly, recently retired from the Department of Energy as chief technology officer in the Office of Nuclear Energy, emphasized the continuing importance of the ANS Nuclear Grand Challenges initiative, announced by ANS past president Andy Klein (2016-2017) the previous year (NN, Aug. 2017, p. 99), and of efforts by ANS immediate past president Bob Coward (2017-2018) to increase the value of ANS membership. "Bob's views really resonated with me," Kelly said. "He said that nuclear professionals should join ANS because they want to, because of the value that ANS gives to them, and not because they feel obligated to do so. That is the kind of spirit we need to invigorate us in all of the things we do."

Kelly also lauded ANS's recently revised strategic plan (available at <www.ans.org/ about/plan>), which, he said, includes specific, action-oriented objectives in the areas of members' professional develop-

ment, nuclear tech-

nology innovation

promotion, student

and public engage-

ment, and nuclear

technology advoca-

cy. "These objectives

will play a vital role

society and making

it more relevant as

and

our

in directing

strengthening



Kelly

the world continues to evolve," he said. Regarding the student and public engagement objective, Kelly noted that ANS's Center for Nuclear Science and Technology Information has launched a new K-12 education program called Navigating Nuclear: Energizing Our World, which is intended to provide science content to approximately 30 million students and 1.3 million teachers across the United States using Discovery Education's digital

platform. (For more information about the program, go to <www. navigatingnuclear. com>.) "This is going to be very important for the long-term future of nuclear energy in the country," Kelly said. "We believe that by providing this credible and objective

information on nuclear science and technology, we will pave long-term benefits and returns to the nuclear community."

The session's first featured speaker was Adm. (Ret.) Kirkland H. Donald, former director of the Naval Nuclear Propulsion Program, who led the Defense Department's initial technical response to the March 2011 accident

at Fukushima Dai-

ichi. Donald began

his talk with a story of his unnerving

first interview with

the "father" of the

an encounter that



views with Admiral Rickover are somewhat of a legend . . . but I believe there was a certain method to his madness," Donald said. "I think he saw more in me than what I thought I was capable of and challenged me in that regard. I also think he was testing me in a tense situation to see how I would respond. But more importantly, I believe he was conveying to me, 'Listen, Midshipman Donald, I'm responsible for this program for the safe and effective operation of these reactors. You will share that responsibility with me, and it is a solemn, great responsibility, and don't you ever forget it. It was important enough for me to spend time in my day to be with you to make that point.""

Donald also made reference to a Rickover quote on responsibility that Donald kept on his desk during his tenure as nuclear propulsion director: "Responsibility is a unique concept. You may share it with others, but your portion is not diminished. You may delegate it, but it is still with you. If responsibility is rightfully yours, no evasion or ignorance or passing of blame can shift the burden to someone else. Unless you can point your finger at the man who is responsible when something goes wrong, then you have never had anyone really responsible."

According to Donald, in virtually every case in which an organization exhibits systemic performance issues, you will find a misalignment of responsibility, authority, and accountability. "My advice is

In virtually every case in which an organization exhibits systemic performance issues, you will find a misalignment of responsibility, authority, and accountability.

> look at how you have assigned the responsibility, how you are giving people the authority to do the job for which you are holding them responsible, and then how you hold them accountable for the performance of that job," he said. "It takes the right people and the right circumstances, and if you get those pieces right, success will normally follow."

> Donald said that Rickover's successor as director of the Naval Nuclear Propulsion Program, Adm. Kinnaird McKee, proved to be a role model for him as well. McKee would hand out to all graduates of the nuclear training program a 3×5 card featuring a triangle with the words "technical competence," "stamina," and "integrity" written at the triangle's points. "They used to say about Admiral McKee's triangle that you can't have one out of three legs or two out of three legs," Donald said. "You have to have all three. If you have integrity and you have technical competence but you don't have stamina, you have good intentions but you don't get much done. If you have integrity and stamina but you don't have technical competence, you get a lot done, but it's just not the right things. If you have technical competence and stamina but no integrity, well, that's Bernie Madoff. You have to have all three."

Nuclear Navy, Adm. Hyman Rickoverincluded a lot of Donald yelling. "The inter-

Trends in Maintenance and Work Management

In his concluding remarks, Donald expressed concern regarding the implications of a declining U.S. commercial nuclear industry for national security. In his view, energy resilience, which includes having a diverse base of energy providers, is of critical importance from a security perspective. In addition, "The gold standard for nuclear regulation clearly resides in the United States," he said. "How long can we maintain that internationally if we are seeing a declining nuclear industry? . . . And whether it be nuclear energy, nuclear weapons, nonproliferation-if we are not seen on the forefront as a nuclear nation and an advocate for nuclear energy and its proper use of regulation, how do we ever have a seat at the international table where nuclear matters are discussed?"

Speaking next was Craig Amadeo, general manager of programs and predictive



Amadeo

maintenance engineering at Delta Air Lines, whose talk, "Pursuit of Excellence through Innovation," stressed the importance of predictive maintenance and the use of prop-"You cannot manage what you don't measure,"

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he said. "So we decided to innovate in that regard. One of the things that Delta measures is D-zero [departing exactly at the scheduled time]. The Federal Aviation Administration requires operators to report D-15s [departing within 15 minutes of the

scheduled time]. We said, 'Look, our customers don't care about departure within 15 minutes. Our customers care about departure within D-zero.' So we started measuring that metric and began setting our goals to that and to live to that." In 2017, Amadeo said, Delta achieved a D-zero percentage of 97.02.

The Atlanta-based airline also measures maintenance cancellation-free days, Amadeo noted, as well as the maintenance completion factor (how often flights are completed as scheduled). According to Amadeo, Delta had 324 maintenance cancellation-free days in 2017, whereas its competitors in the United States failed to reach a collective 40. Further, its maintenance completion factor in 2017 reached 99.9 percent. "How do we make that next step?" he asked. "How do we get better than this? Once we get to 100, what are

we going to do? We need to try to think outside the box on how to continue that trend upward."

To enable innovation, Amadeo said, an organization must be able to clearly identify cutting-edge technologies and

To enable innovation, an organization must be able to clearly identify cuttingedge technologies and secure a commitment to those technologies from its leadership.

secure a commitment to those technologies from its leadership. "There have been technologies and items that we tried to roll out from the lower levels of the organization," he said, "but ultimately, if we did not get leadership buy-in, we did not make ground in deploying that technology."

Also important to innovation is organizational structure, Amadeo said, and in Delta's case, a dedicated department focused solely on predictive maintenance engineering was created. "This was the group that was responsible for deploying the technology, reacting to the technology,



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innovating processes, and ensuring that we have a good feedback loop to prove the technology effective," he said. "And with that came process innovation. We made sure we had a very profound feedback loop to make sure we were effective, to make sure that we could communicate up and show senior leadership that they're getting value for the money they were spending. Continuous improvement is another part of that, along with feedback. It's very important to make sure that you keep moving the bar."

Predictive maintenance engineering, Amadeo said, has a singular goal: to move unscheduled maintenance to scheduled maintenance. "If an aircraft is in operation and a component fails, we have to react to it," he said. "In 2015, we dipped our toes in 'big data' and quickly found that the system alerts, the component alerts that we were getting from doing a data deep dive, were not very tactical. The alerts said, 'Within the next couple of weeks on this aircraft, you may have a delay or cancellation on the aircraft air-conditioning system.' That's not very tactical. The system is very complicated. There are lots of components. If we went and attacked that alert, inevitably all we did was drive up cost in the operation because we didn't necessarily find the problem that was there. In late 2015, we engaged Boeing with its aircraft health management system, which actually takes physical measurements of components and/or the system itself and looks for degradation in that parameter to hopefully be indicative of a pending failure. We found a lot of effectiveness right off the bat with that."

The session's final speaker was Scott Greenlee, senior vice president of engineering and technical services at Exelon, who called for the nuclear industry to undergo a "risk-informed transformation." Greenlee pointed out that while the NRC's adoption of risk-informed thinking-first with individual plant examination of external events, and later with the maintenance rule-has contributed to dramatic improvements in nuclear plant safety and performance since the 1990s, progress has slowed since the Fukushima Daiichi accident. "When Fukushima happened," he



said, "we all went after Fukushima, including the NRC, and we kind of lost our focus. My message to you today is that if we get back on the risk bandwagon, we can start moving that needle once again and continue the pursuit of

Greenlee excellence in our industry."

As an example of where transformation needs to take place, Greenlee cited the NRC's reactor oversight process (ROP). "We spend \$1 million every time we get a 'white' finding [an NRC finding of low to moderate significance, often associated with a violation], and it's just a waste of resources," he said. "We ought to be devoting our resources to what is risk-beneficial to this industry and not playing around at these low levels. . . . And we need to put together a method to close low-risk compliance issues."

Greenlee offered a number of other suggestions to help transform the industry, including tying security and emergency preparedness to large early-release frequency rather than to core-damage frequency. "That would be a game changer," he said. "I'm just going to guess that we could probably reduce

security resources by two-thirds. If you think about how many security resources we have, that is huge. For emergency preparedness, I would guess that we could probably get the five-hour response time for all of the supplemental staff, which means quality of life comes back, because now you've gotten rid of all of your fitnessfor-duty requirements for all of your responders. The future generation would really appreciate that.'

Greenlee also argued for operationalizing the focus on safety through broad riskinformed initiatives, including driving for probabilistic risk assessment methods to work in accordance with Regulatory Guide 1.200, An Approach for Determining the Technical Adequacy of Probabilistic Risk Assessment Results for Risk-Informed Activities; fixing the National Fire Protection Association's 805 standard; reducing conservatisms in the surveillance frequency control program; risk-informing Technical Specification 3.0.3; and simplifying the implementation of 10 CFR 50.69, Risk-informed categorization and treatment of structures, systems, and components for nuclear power reactors. "50.69 has the potential to be a real game-changer, but it's just way too difficult to implement," Greenlee said. "And it's way too conservative. We just finished scoping the radiation monitoring systems at Limerick. Thirty percent of the stuff in the radiation monitoring system is of high safety significance? No, it's not. It's because we threw in a bunch of deterministic stuff on top of the risk stuff, and now we're not risk-informed anymore. So we have to fix that."

Taking advantage of recent wins on digital modifications and value-based maintenance is also important, Greenlee said, as are embracing technology to improve performance and reduce costs and continuing work on accident-tolerant fuel. "Unfortunately, the future is not as bright as I thought it was two years ago for accident-tolerant fuel," he said. "We were looking to get 72-hour coping times. We're not really getting more than five or six hours at the moment. We may be able to get more if we combine it with some sort

"We spend \$1 million every time we get a 'white' finding, and it's just a waste of resources. We ought to be devoting our resources to what is risk-beneficial to this industry and not playing around at these low levels."

> of passive cooling technology. But I will tell you that coated cladding is absolutely where we want to go.... Once we get coated cladding into our plants, we'll almost assuredly be able to go to higher burnups very quickly, and that will be a big fuel cost savings."

Challenging times

The plenary session "Proceeding in the Face of Uncertainty" focused on the challenges facing the nuclear industryspecifically, challenges in the areas of policy, regulation, and the economy. First up to the lectern was Bill Pitesa, chief nuclear officer of the Nuclear Energy Institute, who began with a brief review of nuclear energy's well-known selling points (well known within the industry, at least), in-



Pitesa

cluding that it supplies about 20 percent of the electricity generated in the United States and more than half of the carbon-free generation, contributes more than \$12 billion a year in federal and state taxes, and has maintained a

90-plus percent capacity factor since 1999.

"After hearing all of this, you might think that life is rosy and things are good," Pitesa said. "But the reality we face is around declining electricity prices. When you look at those prices over time, nuclear was incredibly competitive 15 to 20 years ago. We were, quite frankly, the cash cow for many utilities, because we were pro-

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ducing the cheapest source of electricity for most of the utilities involved. But that is not true today, and when you look at the downward spiral of electricity prices, it's made it very, very difficult for nuclear to stay competitive in every market in which it's involved."

Pitesa noted that of the 15 U.S. nuclear plants that either have been prematurely shuttered in recent years or are scheduled for early retirement, 10 have closed or will close solely as a result of market conditions. "Once you cross that line and move into decommissioning, it's a oneway trip," he said. "There is no round-trip ticket associated with that. Our goal has to be to prevent plants from getting into that position. That is what we face collectively as an industry. The solutions are varied, but at the same time, the realities are right there, particularly in a world where most companies are very focused on quarterly numbers associated with the stock market. But nuclear is a long-term asset that needs to be viewed from a very long-term point of view."

Pitesa summed up NEI's national strategy for nuclear energy in four words: "preserve," by appropriately valuing nuclear generation and advancing federal- and state-level policy actions; "sustain," by modernizing NRC regulatory requirements and oversight, reducing the financial burden on nuclear operators, and advancing new and used fuel regulations; "innovate," by developing, commercializing, and deploying new nuclear; and "thrive," by successfully competing on a global scale.

Pitesa noted that at both the federal and state levels, there is activity in the various markets. States, he said, are looking at carbon legislation and at ways to preserve fleets. Illinois, New York, Connecticut, and New Jersey have taken actions to support their nuclear plants, but there are others where work is still needed to help them understand the value that nuclear provides. Pitesa used the example of New York Gov. Andrew Cuomo, who he said is "not necessarily a strong advocate for nuclear" but stood in front of the FitzPatrick plant and declared that the plant should be saved. "We convinced him," Pitesa said. "He had a lot of motives that weren't nuclear specific. But it's incredibly important to make sure that at the state level and at the federal level, we're doing everything we can to recognize how important nuclear is as a supplier of energy within the United States.'

On the subject of sustainability, Pitesa stressed the critical importance of safe operation. "If we ever let that slide, then we have no negotiations in any forum whatsoever," he warned. "We have to operate our plants very, very safely. Today, all 99 reactors in the United States are operating

at power. It shows how good a fleet we have collectively across the United States."

Pitesa also pointed out that the fees utilities pay to the NRC have gone down in recent years. "Over the last five years," he said, "the direct-fee billing to the utilities has been reduced by \$150 million. That's real money in any world. There will probably be some diminishing returns over time, but we are pushing the NRC in every way, saying that with the changes that are going on in the industry, there need to be commensurate changes within the regu-

lations and the regulatory viewpoint." In addition, according to Pitesa, the NRC staff has been reduced by about 1,000 since its peak of 4,018 in 2010. "I know it might not always feel that way, but ultimately, I think the NRC is doing many things to recognize the changes in the industry and stay in tune with those changes," he said.

Following Pitesa was Anthony Pugliese, chief of staff for the Federal Energy Regulatory Commission, who centered his

comments on nucle-

ar's value from a se-

curity perspective.

"It is incredibly im-

portant to U.S. na-

tional security that

we ensure that some

of these critical as-

sets, such as these

nuclear plants, do

not go the way of the

dodo bird," he said.



Pugliese

"There are a number of attributes that nuclear provides that are in the best interest of our country. We are continuing to see more and more adversarial nations and players looking to gain access to our grid. . . . Nuclear has an on-site fuel supply, which I think is very valuable. Look at that from a military perspective-there is a reason why every military base has onsite fuel. In addition, nuclear is essentially impervious to [electromagnetic pulse] and cyberattacks, whereas you have a number of other assets that are part of the bulk power system that are incredibly vulnerable. I think more and more you have adversarial countries that see, for example, pipelines as an area of great opportunity."

Pugliese added that FERC is working on pipeline security with the Transportation Security Administration, which oversees the physical security and cybersecurity of pipelines, as well as with various other "three-letter agencies" to ensure that "we are protecting the bulk power system and that we are working with our outside stakeholders and companies and others to insure that people are focused on cybersecurity, physical security, and the vulnerabilities of the bulk power system."

Pugliese generated a few headlines for the energy media during the questionand-answer portion of the session. In response to a query regarding the potential vulnerability of California's military sites if the Diablo Canyon nuclear plant

"If you look at the attributes that are going to be important going forward resiliency, energy density, land use, national security, energy security—you start to realize that nothing stacks up to nuclear."

> is closed prematurely, Pugliese seemedto some, at least-to suggest that FERC, an independent agency, was assisting the Trump administration in its efforts to assist nuclear and coal plants at risk of early retirement. He said that FERC is working with the Department of Defense, the Department of Energy, and the National Security Council to identify which plants are essential for ensuring that not only military bases but hospitals and other critical infrastructure are able to be maintained, "regardless of what natural or man-made disasters might occur." (For more on the reaction to those remarks, see NN, Sept. 2018, pp. 17 and 36.)

> The session's final speaker, Bob Coward, principal officer at MPR Associates and immediate ANS past president (2017-2018), addressed the challenges facing the nuclear industry from a supplier's perspective. The future, Coward declared,



Coward

important going forward-resiliency, energy density, land use, national security, energy securityyou start to realize that nothing stacks up to nuclear," he said. "I think the world is going to start to realize that, and I think they are already slowly coming back to us, and I think it's going to come back harder.

Our goal is to be there when it does."

Trends in Maintenance and Work Management

Coward cautioned, however, that to bring about a bright nuclear future, the current fleet of reactors has to be maintained. "We need to preserve them so that when this ball comes back at us, we've got a realistic chance to hit it," he said. "But we need to recognize-all of us in this room, all of the people who work back at our plants and offices-we need to realize that it's not going to be handed to us. We're going to have to earn it. And, because it's different, we're going to have to be different. We'll have to use words more effectively, like 'adapt,' 'evolve,' 'innovate.' We do that, and it's coming. We're going to hit that pitch. But if we don't, we're going to swing and miss."

According to Coward, the nuclear industry going forward will need to adapt by moving from custom engineering to modular/standard design, from specialized construction to localized assembly, from complex to simple, from 500-plus MW to 500-plus kW, from light-water reactors to multiple reactor technologies, from full power to scalable power, from waste issues to waste minimization, from proliferation concerns to proliferation resistance, and from operational safety to inherent safety.

In order to solidify the industry's foundation and "build a bridge to the future," Coward recommended a number of actions, including fixing dysfunctional energy markets, transforming the NRC's culture and processes, overcoming knowledge transfer challenges, aggressively implementing key enablers of long life and reduced costs for existing plants, and advancing small modular reactor programs through broad implementation. Also, to "shape and create the nuclear future," Coward called for shifting the development culture from "safest and niftiest" to "most attractive to customers and very safe"; shifting the culture surrounding advanced reactors from research and development to implementation; establishing needed codes, standards, and regulations; empowering the next generation of industry leaders; and solving financing challenges and enabling early and sustained investment.

"[Utilities and suppliers] only capture this opportunity if we do it arm-in-arm, in lock-step as partners," Coward said. "The utilities cannot do it alone. The suppliers cannot do it alone. It's easy to talk about the need to be partners. I believe we have to be better partners. I personally believe that the current state—not in every single instance, but generally speaking—of the utility/supplier relationship is about as poor as it's been in a long time.... I think we can fix it, but we need to work together."

To strengthen this partnership, Coward offered suggestions for both groups. Utilities, he said, should (1) focus on enabling suppliers to deliver value and avoid a focus on cutting costs; (2) understand that the primary factor defining supplier performance is the utility's performance as a customer; (3) remember that more paper and more onerous [terms and conditions] don't ensure high quality; and (4) hold suppliers accountable, but also give them the chance to learn, improve, and impress.

Suppliers, Coward said, should realize that (1) customers simply can't continue spending more—either they become more efficient or they dissolve—and suppliers need to help them be successful; (2) a "new normal" is being defined, and while it can't be stopped, suppliers can help shape it; (3) there is plenty of opportunity to provide products and services to the nuclear industry, as long as the supplier delivers value to the customer, meets its commitments (schedule and cost), has high quality, and "owns" its performance; and (4) the future is "screaming" for supplier-led innovation.

"This is important for the people in this room," Coward said. "This is important for the country and for everybody we represent. We absolutely have no choice. We have to make the nuclear program in this country successful. And I know we can. It's going to be on all of us. We just need to accept where we are, go from where we are, forget the past, and go do good stuff."—*Michael McQueen*



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International

RUSSIA

Gen III+ unit ready for commercial operation

The new VVER-1200 reactors at the Leningrad site are the first Russiandesigned reactors with a 60-year design lifetime. eningrad-II-1, the second Generation III+ VVER-1200 reactor to start operating in Russia, has successfully completed its final 15-day performance test at full power and is ready for commercial operation. According to the August 22 announcement by operator Rosenergoatom, the commissioning was completed two months ahead of schedule.

The unit was connected to the grid for the first time on March 9, and the plant began supplying electricity to northwest Russia. This also marked the start of the power-raising procedure, during which time the plant undergoes a sequence of commissioning tests and system inspections to confirm its safety and reliability. The next major milestone will be the certification of the unit's readiness for commercial operation by Rostechnadzor, the regulatory agency. Rosenergoatom will then undertake a final review before an acceptance for commercial operation is issued.

The new VVER-1200 reactors, explained Leningrad plant manager Vladimir Pereguda, are the first Russian reactors with a 60-year design lifetime. "We hope it will be followed by another, and then we might be entrusted to build the third and the fourth ones," he said.

According to the Rosenergoatom announcement, the new units meet all post-



Leningrad: Unit II-I has successfully passed its final performance test and is ready for commercial operation.

Fukushima safety requirements. The design incorporates a number of advantages that significantly increase its safety and economic performance, including a combination of active and passive safety systems that ensure that the plant can withstand extreme external and internal accident events. The features include the core catcher, which is designed to contain a core melt, and passive heat removal systems that are designed to ensure long-term cooling of the reactor core without human intervention in case of a loss of power.

The first VVER-1200 reactor to begin commercial operation was Novovoronezh-II-1 in early 2017 (*NN*, Apr. 2017, p. 42). The first units constructed at the Novovoronezh station all had VVER reactors, two of which continue to operate. The Leningrad station, which is located at Sosnovyy Bor, 40 kilometers west of St. Petersburg on the shore of the Gulf of Finland, includes four RBMK-1000 reactors, all of which are operational.

SLOVAKIA

Cold hydraulic test at Mochovce-3 completed

Slovenské Elektrárne, the owneroperator of the Mochovce nuclear power plant in Slovakia, has successfully completed Unit 3's cold hydraulic test (CHT), a crucial part of the commissioning process. According to an August 23 announcement from the utility, the CHT is the first comprehensive plant test of the reactor systems operating together with the auxiliary systems. The CHT program, which started in mid-July, was carried out over 38 days.

The company described Mochovce-3 and its sister Unit-4 as an evolutionary design based on the Russian VVER-440 V-213 reactor with safety upgrades to ensure that the power plant complies with current national and international nuclear safety requirements. Each of the units is rated at 440 MWe.

The main objective of the CHT is to demonstrate leak-tightness of plant systems and components, including pressure vessels, pipelines, and valves of both the nuclear and conventional islands and to clean the main circulation pipes. The primary circuit was pressurized to 13.7 MPa, which is over 111 percent of the normal operating pressure, at temperatures of up to 120 °C. The steam generators, as well as the feedwater and live steam pipelines were tested at a pressure of up to 7.65 MPa (166 percent of operating pressure).

Among the components tested were all of the reactor coolant pumps of the primary circuit, the main feedwater pumps of the secondary circuit, the steam generators, and other components of the primary and secondary circuits, including a number of auxiliary systems. Components such as pipelines, valves, welds, and flange joints had to be inspected at exactly defined pressures. A tightness test of the nuclear island containment, which has reinforced concrete walls up to 1.5 m-thick, was also carried out.

Branislav Strýček, director general of Slovenské Elektrárne, said that this key milestone "confirmed functioning of all tested components and took us closer to commissioning of the nuclear plant." Fuel loading of the reactor is scheduled for the first quarter of 2019.

UNITED ARAB EMIRATES

FANR, Khalifa University sign research agreement

The United Arab Emirates' Federal Authority for Nuclear Regulation (FANR) and Khalifa University of Science and Technology have signed a collaborative research agreement focused on advancing nuclear safety research and educating the next generation of nuclear professionals, according to a September 2 press release from FANR.

Under the agreement, FANR and Khalifa University will continue their joint work on the Advanced Thermal-hydraulic Test Loop for Accident Simulation Project Phase 2 (ATLAS-2), an international project organized by the OECD Nuclear Energy Agency and carried out by the Korea Atomic Energy Research Institute. The work by FANR and Khalifa University concerns thermal-hydraulic safety and accident management issues relevant to the APR1400 reactor, a Generation III pressurized water reactor, four of which are being built at the UAE's Barakah site. The collaborative agreement is designed to familiarize UAE students and researchers with the reactor and to build local human capacities in nuclear safety through intensive research activities.

Christer Viktorsson, director general of FANR, said, "Since FANR's establishment in 2009, we have prioritized human capacity development in nuclear safety. Through this research agreement, Emirati students and researchers will learn about the critical safety features of nuclear systems utilizing various [computer] coding systems, including how to generate and modify plant inputs and study test results. Likewise, the training material produced by our work on the ATLAS-2 project will serve as a valuable resource to postgraduate students and researchers for years to come."

Arif Sultan Al Hammadi, executive vice president of Khalifa University, said that this collaboration is in line with Abu Dhabi's Economic Vision 2030, which emphasizes the importance of energy and water sustainability. "Through this agreement," he added, "we believe we will be contributing effectively to fostering local expertise on nuclear safety in the UAE."

FANR and Khalifa University will present their collective research findings on one of the relevant tests during the ATLAS-2 project review meeting scheduled for October in South Korea.

Youth council created for future UAE nuclear leaders

The Barakah Youth Council has been established "to inspire, support, and empower" future Emirati nuclear energy leaders, according to an August 12 announcement by the Emirates Nuclear Energy Corporation (ENEC). The council will serve as a direct channel of communication between the senior leadership of the ENEC and its subsidiaries, Nawah Energy Company and Barakah One Company, and the organizations' young Emirati employees. The ENEC noted that over 63 percent of the 1,400 United Arab Emirates nationals employed across all three companies are under the age of 30. "The council provides these young employees with a voice to champion change and drive continuous improvement while also being involved in the decision-making for ongoing evolution of the UAE Peaceful Nuclear Energy Program," the ENEC said.

Mohamed Al Hammadi, ENEC's chief executive officer, said, "The launch of the Barakah Youth Council forms a part of our commitment to developing our youth and providing them with the skills, expertise, and experience to become the future leaders of our nation and the growing local nuclear energy sector. This council operates within the framework of the UAE Centennial 2071 vision and UAE Vision 2021, which aim to ensure that the UAE has the human capital necessary to sustain a world-leading, knowledge-based economy.

"The Barakah Youth Council is led by a dynamic and diverse group of young UAE nationals from across ENEC, Nawah, and Barakah One Company," Al Hammadi said. "I am proud of their commitment and dedication to our nation and the UAE Peaceful Nuclear Energy Program and look forward to working closely with them."

UNITED KINGDOM

NuGen advances Moorside as site of new nuclear plant

In response to the U.K. government's request for input as it updates its nuclear power program policy, NuGeneration Limited submitted information in sup-



Moorside: NuGen submitted supporting information for a new nuclear plant at the site.

port of its Moorside location, in west Cumbria, as the site of a potential new nuclear power plant.

The U.K. Department for Business, Energy and Industrial Strategy sent the request to all new nuclear developers in the United Kingdom so that sites listed in the current *National Policy Statement for Nuclear Power Generation* can be included in a new statement that will define government policy for developing new sources of energy from 2026 to 2035. All of the United Kingdom's current National Policy Statements for energy were approved in July 2011.

According to an August 17 announcement from NuGen, "The renewal of the National Policy Statements . . . will enable an important part of the planning process, which is necessary for new nuclear developers such as NuGen to bring forward their plans."

Chief Executive Officer Tom Samson said, "NuGen remains committed to delivering a nuclear power station at Moorside. Support for the policy process to carry forward the Moorside site is another opportunity for the community of west Cumbria to restate its desire to host this critical national infrastructure and bring a transformational stimulus to the local economy, including jobs and prosperity for thousands of people throughout the county."

In noting the local community's continuing support, Samson said, "NuGen has conducted two stages of public consultation about its plans, and thousands of Cumbrians have come forward to have their say. I'm happy to report that there is real, sustained support in the community." He also noted that the Copeland Borough Council, the local authority covering the Moorside site, is supportive of the project "but resolute in their ambition for Moorside to benefit all and for NuGen to deliver it in the right way for west Cumbria."

The U.K. government has also reaffirmed its long-standing commitment to develop new nuclear power as a vital part of the country's energy mix through its new nuclear sector deal, on which it reached an agreement with industry at the end of June (*NN*, Aug. 2018, p. 42).

IAEA

Trends show decline in world nuclear capacity

Nuclear power may struggle to maintain its current share of the world's energy mix, according to the 38th edition of *Energy, Electricity and Nuclear Power Estimates for the Period up to 2050*, issued by the International Atomic Energy Agency. A press announcement about the September 10 release of the report notes that the world's nuclear generating capacity is at risk of shrinking in the coming decades as aging reactors are retired and the industry faces reduced competitiveness.

Nuclear power produced about 10 percent of the world's electricity in 2017, accounting for about one-third of total low-carbon electricity. The 150-page report provides detailed global trends in nuclear power.

For the period to 2030, the low-case projections show nuclear capacity falling by more than 10 percent from a net installed capacity of 392 GWe at the end of 2017. For the longer term, the report shows generating capacity continuing to decline through 2040 in the low case, before rebounding to 2030 levels by 2050, when nuclear is anticipated to provide only 2.8 percent of global generating capacity. That compares with 5.7 percent today.

"The declining trend in our low projection for installed capacity up to 2050 suggests that without significant progress on using the full potential of nuclear power, it will be difficult for the world to secure sufficient energy to achieve sustainable development and to mitigate climate change," according to a statement from IAEA Director General Yukiya Amano.

A different situation would exist if the ambitious high case were to be achieved, whereby nuclear generating capacity increases 30 percent to 511 GWe by 2030, 45 GWe lower than last year's high case projection. Looking at the period to 2050, nuclear capacity is projected to rise to 748 GWe, which represents a 90 percent increase over 2017 and accounts for 5.8 percent of the total projected electrical generating capacity, slightly higher than the 2017 percentage.

According to the IAEA, "The low and high estimates reflect contrasting, but not extreme, underlying assumptions on the different driving factors that have an impact on nuclear power deployment." The wide range in the projections is also due to the considerable number of reactors scheduled to be retired around 2030 and beyond, particularly in North America and Europe, and whether they will be replaced by new nuclear capacity.

Over the short term, the low price of natural gas, the impact of subsidized intermittent renewable energy sources on electricity prices, and national nuclear policies in several countries following the 2011 accident at Japan's Fukushima Daiichi plant are expected to continue to

World Total and Nuclear Electrical Generating Capacity

		2030 ^ª		2040 ^a		2050 ^a	
Electrical Capacity	2017	Low	High	Low	High	Low	High
Total (GWe)	6,922	9,826		11,518		12,908	
Nuclear (GWe)	392	352	511	323	641	356	748
% of total	5.7	3.6	5.2	2.8	5.6	2.8	5.8

^aNuclear capacity estimates take into account the scheduled retirement of older units at the end of their lifetime. (Source: IAEA)

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weigh on nuclear power's growth prospects, according to the report. In addition, the nuclear power industry faces increased construction times and costs due to heightened safety requirements and challenges in deploying advanced technologies, as well as other factors.

Still, interest in nuclear power remains strong in the developing world, particularly in Asia, where countries such as China and India need huge amounts of electricity and also want to reduce greenhouse gas emissions. Commitments made under the Paris Agreement on climate change could also produce a positive impact on nuclear energy development in the future, the report states.

Rooppur design safety documentation assessed

The International Atomic Energy Agency has completed, through its Technical Safety Review (TSR) services, a review of selected parts of the design safety documentation for Bangladesh's Rooppur nuclear power plant. The plant has two Rosatom-supplied VVER-1200 reactor units under construction and is to be commissioned by 2023.

According to a July 31 press release, the TSR-Design Safety peer review was conducted in June as part of an IAEA Technical Cooperation Project focused on achieving effective regulatory oversight during Rooppur's construction phase. Also included was the training of Bangladesh's regulatory staff on reviewing safety assessment documentation. Preceding the hands-on training, the review team, comprising IAEA staff members and international senior experts, examined selected sub-chapters of the Rooppur Preliminary Safety Analysis Report (PSAR). The review focused on the methodology of accident analysis, based on IAEA safety standards, and its application to a selected design basis accident. Upon completion of the review, the team provided recommendations for improving the PSAR documentation.

The IAEA's TSR services offer support to national authorities in carrying out their responsibilities in safety assessment and design safety, addressing the various stages of the development and deployment of a country's nuclear power program. Typically, a review provides an independent evaluation of safety documentation but can also address specific technical or regulatory issues. TSR services are focused on assisting plant operators and vendors, technical safety organizations, and regulatory bodies in their technical evaluations and in the development of requirements, as well as in enhancing nuclear safety for specific facilities.

INTERIM STORAGE FACILITY

NRC resumes review of Waste Control Specialists' application

The application for a license to build a spent fuel storage facility at WCS's West Texas site has been revised and resubmitted. he Nuclear Regulatory Commission has resumed its review of the application for a license to construct and operate a consolidated interim storage facility for spent nuclear fuel at Waste Control Specialists' low-level radioactive waste facility in Andrews County, Texas. The license application was originally submitted in April 2016 (*NN*, June 2016, p. 60) and was docketed for review by the NRC in January 2017. In April 2017, WCS asked the NRC to suspend its review of the application, claiming that it did not have the financial resources to continue the licensing process. WCS had hoped to restart the licensing process following its proposed sale to Utah-based EnergySolutions. The federal government, however, blocked that deal on antitrust grounds. WCS was later sold to an affiliate of J.F. Lehman & Company.

In June, a revised application was sub-



aphic: WCS

Conceptual drawing of Waste Control Specialists' proposed consolidated interim storage facility for spent nuclear fuel at its site in Andrews County, Texas.

mitted to the NRC through Interim Storage Partners (ISP), a joint venture formed by WCS and Orano USA (*NN*, July 2018, p. 59). According to ISP, while the application reflects the organization and new leadership of the joint venture, it remains unchanged in its original proposal to receive, store, and manage spent fuel from U.S. reactors at a facility to be built on WCS's 14,900-acre site in West Texas. ISP is seeking an initial 40-year license to store an eventual total of 40,000 metric tons of spent fuel.

In the August 29 *Federal Register*, the NRC published a notice of opportunity to request a hearing and to petition for

leave to intervene in the licensing process. Requests will be accepted through October 29.

The NRC is also requesting public comments on the scope of its environmental impact statement for the WCS storage facility. As published in the September 4 *FR*, the NRC is reopening the comment period that had closed on April 28, 2017. Comments can be submitted until October 19.

Information regarding both *FR* notices, including instructions for submitting comments, can be found on the federal rulemaking website, at <www.regulations.gov>, with a search for Docket ID NRC-2016-0231.



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DECOMMISSIONING

Group petitions NRC over FirstEnergy's D&D funds

The Environmental Law and Policy Center (ELPC) has petitioned the Nuclear Regulatory Commission to take enforcement action against FirstEnergy Corporation and its subsidiaries, including FirstEnergy Solutions (FES) and FirstEnergy Nuclear Operating Company (FENOC), claiming that the company lacks sufficient funds to decommission its nuclear power plants. The NRC published notice of the 10 CFR 2.206 petition request in the August 31 *Federal Register*.

FES announced on March 28 that it would close the Davis-Besse and Perry plants in Ohio and the Beaver Valley plant in Pennsylvania over the next three years (*NN*, Apr. 2018, p. 18). Under the company's current schedule, Davis-Besse is to close in May 2020, followed by Beaver Valley-1 and Perry in May 2021, and Beaver Valley-2 in October 2021. In August, FES submitted to the NRC its certified fuel handler training and retraining program, as required under the NRC's decommissioning process. FES filed for bankruptcy protection on March 31.

ELPC claims that decommissioning fund estimates from March 2017 indicate a \$350-million shortfall in external trust funds for the plants and that the trusts are insufficient on their own to provide reasonable assurance of decommissioning funding. ELPC also said that if the plants close in 2020 and 2021 as planned, the trust funds will be unable to grow to levels that will pay for their complete decommissioning.

ELPC is asking the NRC to promptly issue a demand for information to First-Energy and its subsidiaries requesting site-specific decommissioning funding plans for the three plants, along with information regarding the company's reliance on external trust funds and parental guarantees to satisfy its decommissioning financial obligations. The group is also petitioning the NRC to issue a notice of violation against FirstEnergy and its subsidiaries for operating nuclear facilities without sufficient decommissioning funds and to issue civil penalties against the company for the violation.

ELPC, which is urging the NRC to prohibit FENOC from placing the plants into SAFSTOR condition for purely financial reasons, also asked that its petition be given immediate emergency consideration in light of FES's "rapidly deteriorating financial situation." The petition request has been referred to the director of the NRC's Office of Nuclear Reactor Regulation for consideration.
Waste Management

HANFORD SITE

New water pipeline to be installed; other news

The Department of Energy announced on September 6 that its Richland Operations Office and Hanford contractor Mission Support Alliance have begun work on a \$7.8-million water system improvement project intended to support the long-term cleanup of the Hanford Site near Richland, Wash.

According to the DOE, the bulk of the work will involve the installation of a new water pipeline connecting the separate water grids of central Hanford's east and west areas. The installation of approximately four miles of 30-inch pipe is expected to be completed by spring 2019. Once the construction of the water pipeline is complete, the disturbed areas will be revegetated with native grasses and shrubs, and wild bee habitats will be installed to encourage pollination of the revegetated areas.

Nearly 400 gallons of water are used annually at the Hanford Site, primarily for operations, construction, waste processing, and fire prevention, the DOE said. In addition to the pipeline installation, other upgrades will include the installation of a backup water supply line to a groundwater treatment facility.

■ The activist group Hanford Challenge announced on September 4 that it has released a report analyzing the off-site spread of radiological contamination from Hanford's Plutonium Finishing Plant (PFP) following releases to the air in 2017 (*NN*, Feb. 2018, p. 67). The report, *Radioactive Microparticles in Hanford Plutonium Finishing Plant Workers' Vehicle and House Dusts*, was prepared by Marco Kaltofen, of Boston Chemical Data Corporation.

According to Hanford Challenge, the report confirms the presence of americium, uranium, and thorium in multiple dust samples from personal vehicles driven out of the radiation protection zones at the PFP. The report indicates that metallic radioactive microparticles found in the vehicle samples are "fairly unique" to the Hanford Site.

Using information provided by Hanford contractor Washington River Protection Solutions, Kaltofen claims that biologically significant plutonium particles were found on-site at the PFP, including an example particle with a calculated internal dose of 94.8 millirem.

Tom Carpenter, executive director of Hanford Challenge, said in a statement, "These findings point to an urgent need for a deeper, broader look by an independent entity at the threats that Hanford's



A new water pipeline will connect the east and west water grids at the DOE's Hanford Site in Washington state.

past and present contamination might pose to surrounding communities."

■ In a September 6 letter to Anne White, assistant secretary for environmental management at the Department of Energy, U.S. Sens. Patty Murray (D., Wash.) and Maria Cantwell (D., Wash.) and U.S. Rep. Adam Smith (D., Wash.) asked that the DOE consider holding additional public meetings in the Pacific Northwest on the department's proposal for completing the cleanup and closure of the C Tank Farm at the Hanford Site.

Noting that the DOE has held only one public meeting on the *Draft Waste Incidental to Reprocessing Evaluation for Closure of Waste Management Area C at the Hanford Site* (Draft WIR Evaluation), the legislators said that they have heard from stakeholders who stressed the importance of holding additional public hearings at times and locations that allow for full participation.

"While we understand the Draft WIR Evaluation is the natural next step from DOE's perspective," the letter states, "we also recognize this is a complex decision that involves managing waste differently, reclassifying waste, and has the potential to set precedent for the 17 other tank farms at Hanford. A decision of this magnitude should be made in an open and transparent manner with multiple avenues for public engagement."

The DOE held a public hearing on the Draft WIR Evaluation, which evaluates whether Hanford's emptied waste tanks can be managed and disposed of

Waste Management

as low-level radioactive waste, on June 18 in Richland, Wash. The comment period on the Draft WIR Evaluation has been extended by 60 days to November 7 (*NN*, Sept. 2018, p. 48).

LOW-LEVEL WASTE

Finnish firms to provide LLW services to China

The Finnish companies Fortum and AINS Group announced on August 21 that they have signed a memorandum of understanding to jointly provide low-level radioactive waste management services to China. The agreement will also enhance cooperation among other Finnish companies and organizations such as VTT and Posiva Solutions, the companies said.

The press release from Fortum and AINS Group stated that Finnish expertise has an important role in disposing of Chinese radioactive waste as the country works to expand its nuclear infrastructure. China is in the process of building 20 new reactors, which it plans to have in service by 2020, adding to its existing fleet of 38 reactors.

Fortum owns and operates the Loviisa nuclear power plant, which has its own underground disposal facility for radioactive waste from the plant. Eventually, this facility will also hold all the decommissioned waste from the power plant when it is dismantled after final shutdown. Fortum designed and constructed the facility, and AINS Group participated in its design.

AINS Group Nuclear Waste Management (formerly Saanio & Riekkola) said that it first became involved in the design of low- and intermediate-level radioactive waste facilities for a project requested by Finnish nuclear power utility Teollisuuden Voima Oyj in the late 1970s. That repository has been in operation since 1992. The company also designed a larger facility in Wolsong, South Korea, that began operation in 2015, and it has provided consulting engineering services for radioactive waste projects in 20 countries.

SAN ONOFRE

NRC issues spent nuclear fuel inspection report

Southern California Edison (SCE) has completed all licensing requirements for transferring San Onofre's spent nuclear fuel into dry storage, according to an inspection report issued by the Nuclear Regulatory Commission on August 24. The NRC, however, found one low-level violation of its requirements related to

Waste Management Briefs

TERMINATION OF THE BUFFALO MATERIALS RESEARCH CENTER'S

reactor license was announced by the Nuclear Regulatory Commission in the August 14 Federal Register. Owned by the State University of New York at Buffalo (UB), the BMRC was a research and test reactor facility with a pool-type reactor that operated from 1961 to 1994. The reactor's used fuel was shipped to Idaho National Laboratory in 2005, and the decommissioning of the facility was completed in 2014. Based on its inspections and review of UB's final status survey report, NRC staff concluded that the decommissioning of the BMRC reactor was done in accordance with the approved decommissioning plan and that the facility and site are suitable for unrestricted release.

RANCHO SECO'S OPERATING LICENSE HAS BEEN TERMINATED

by the Nuclear Regulatory Commission, which published notice of the termination in the September 11 Federal Register. The Rancho Seco nuclear power plant, located near Sacramento, Calif., operated from 1975 to 1989. The decommissioning of the facility was completed in 2009. The NRC has approved the Rancho Seco site for unrestricted use and has terminated an indemnity agreement with the licensee, Sacramento Municipal Utility District (SMUD), which maintains an independent spent fuel storage installation (ISFSI) on the site.

In March, SMUD applied to the NRC to renew its site-specific ISFSI license for an additional 40 years. The current ISFSI license expires in June 2020. The NRC published a notice of opportunity to request a hearing and to petition for leave to intervene in the license renewal proceeding, with a deadline of October 22, in the August 22 *FR*. Further information is available on the federal rulemaking website, at <www.regulations.gov>, with a search for Docket ID NRC-2018-0147.

NEVADA IS SEEKING THE RECUSAL OF COMMISSIONER WRIGHT from the Nuclear Regulatory Commission's licensing proceedings for the Yucca Mountain repository. The *Las Vegas Review-Journal* reported on August 29 that Nevada officials have petitioned the U.S. District Court of Appeals for the District of Columbia Circuit to review the state's request that Commissioner David Wright recuse himself from decisions involving Yucca Mountain because of his previous statements and advocacy work related to the repository for high-level radioactive waste. Wright had earlier declined Nevada's request that he recuse himself from Yucca Mountain licensing proceedings. The court, which has scheduled a hearing in the case, instructed Nevada and the NRC to prepare motions by October 15, according to a follow-up report by the newspaper.

changes made to safety equipment. The inspection report is unrelated to the current special inspection the NRC is conducting at the San Onofre nuclear power plant, which was prompted by a fuel-loading incident on August 3 (*NN*, Sept. 2018, p. 17).

Between June 2017 and January 2018, the NRC conducted six separate on-site inspections of SCE's program for transferring spent fuel from wet storage to the independent spent fuel storage installation (ISFSI) at the closed plant. According to the NRC, inspection teams observed five dry-run preoperational training demonstrations and the loading of the first spent fuel canister for the dry cask system, which is being provided by Holtec International.

The NRC determined through the inspection that SCE has completed all of the required activities to demonstrate that the spent fuel transfer can be performed safely. The first cask was placed in the San Onofre ISFSI on January 31, 2018.

The Severity Level IV violation, the

lowest of the NRC's severity levels, stemmed from modifications SCE made to a system used to restrain spent fuel transfer casks in the event of an earthquake. The NRC found that SCE failed to ensure that the modifications it made were subjected to stringent design control measures. Because the modifications made to the original design were found to be acceptable and the changes did not affect the restraint system's safety design function or bases, the NRC determined that the violation was of low safety significance and the agency is treating it as a non-cited violation.

The NRC also found a change from previous safety analyses in how SCE evaluates the potential effects of a hypothetical transfer cask drop within San Onofre's spent fuel pool during a seismic event. The NRC said that it has opened an unresolved item related to SCE's methodology for evaluating such an event and will need additional information to determine whether the change could be approved through the regulatory process.

GLOBAL SUPPLY

Orano launches U conversion plant

The Philippe Coste conversion plant, constructed as part of a modernization program at the Tricastin site in France, is expected to reach a capacity of 15,000 tons of UF₆ by 2021. The Philippe Coste uranium conversion plant at Orano's Tricastin site in Drôme, France, was inaugurated on September 10 by Delphine Gény-Stephann, secretary of state to the French minister for the economy and finance, who was accompanied by Philippe Varin, chairman of Orano's board of directors, and Philippe Knoche, Orano's chief executive officer. The inauguration ceremony was attended by 60 international customers, French and European government representatives, and local stakeholders.

Conversion produces uranium hexafluoride (UF₆) from yellowcake (U₃O₈). Orano (formerly Areva) carries out its conversion process in separate stages at two sites in southern France located about 145 miles apart. The first stage takes place at Orano's Malvési plant in Aude, and the second stage will occur at the new Philippe Coste plant. The resulting UF₆ will be enriched at the Georges Besse 2 uranium enrichment plant, also located at the Tricastin site, and used to manufacture nuclear fuel.

The Philippe Coste plant replaces the Comurhex I plant, also at Tricastin, which was shut down in December 2017 after over 55 years of operation during which it produced more than 450,000 tons of UF₆. The project to replace Orano's aging conversion infrastructure, named Comurhex II, was launched in 2006. "Orano is the first manufacturer to renew its conversion plants," Varin said, "and that is a decisive competitive advantage."

The Philippe Coste plant features technological innovations that will improve safety and industrial performance while reducing impacts on the environment, according to Orano. Those improvements permit a reduction in the use of chemical reagents, including 75 percent less ammonia, 50 percent less nitric acid, and 60 percent less potash. The new plant also uses 90 percent less water and will have lower greenhouse gas emissions. The construction of the plant involved more than 240 companies, most of them from the local region.

Following its initial commissioning at a capacity of 7,500 tons, the plant's capacity is expected to double to 15,000 tons by 2021 after a new fluorine production facility is completed.

The new plant is part of a broader industrial modernization program at the Tricastin site, in which Orano has invested more than \notin 5 billion (about \$5.8 billion) over the past decade. The Comurhex II project cost \notin 1.15 billion (about \$1.3 billion).

LICENSING

Hearing scheduled for Crow Butte; other news

An Atomic Safety and Licensing Board will hold an evidentiary hearing on October 30 regarding a contention raised by the Oglala Sioux Tribe in the licensing proceeding for Crow Butte Resources' Marsland Expansion Area near Crawford, Neb. The Nuclear Regulatory Commission announced the hearing in a press release on August 15.

The NRC on May 23 approved Crow Butte's request for a license amendment allowing the construction and operation of an *in situ* recovery mining operation at the Marsland Expansion Area as part of the Crow Butte project. The company had applied for the amendment in May 2012.

The Oglala Sioux Tribe had submitted six contentions in January 2013. The only

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remaining contention—known as Contention 2—argues that Crow Butte's application and the NRC staff's environmental assessment did not provide sufficient information regarding the effects of the proposed expansion on adjacent surface and groundwater resources, according to the NRC.

Uranium was first produced at the Crow Butte deposit in 1991, and Crow Butte Resources, which is owned by Cameco, has sought regulatory approval to mine nearby deposits, as the ore body at Crow Butte has been depleted and annual production has declined. The Marsland Expansion Area covers over 4,622 acres and is located about 11 miles south-southeast of the Crow Butte facility. Uranium extracted from the wellfields at the expansion area would first go through an ion-exchange process at Marsland and would then be transported to Crow Butte's central processing facility for yellowcake production.

A final environmental assessment and finding of no significant impact was issued on April 30, following a draft EA issued in December 2017. The Oglala Sioux tribe submitted Contention 2 as a contention "migrated" from the draft EA to the final EA on May 30, and at the same time submitted 14 contentions it identified as new or renewed contentions. The 14 contentions were dismissed, and Contention 2 is the sole subject of the planned evidentiary hearing.

Crow Butte filed an initial statement of position with the ASLB on August 11, asserting that the ASLB should resolve the environmental and technical aspects of the contention in favor of Crow Butte and the NRC staff, because Crow Butte's application and the NRC staff's EA meet the requirements of the Atomic Energy Act and the National Environmental Policy Act.

While the evidentiary hearing involves only the three parties in the proceeding the Oglala Sioux Tribe, the NRC staff, and Crow Butte Resources—the ASLB has invited members of the public to register to make oral statements to the judges during a "limited appearance" session on October 28. The NRC's press release is avail-



AN INTERACTIVE DIGITAL MAP OF URANIUM DEPOSITS worldwide has been released by the International Atomic Energy Agency. First published in printed form in 1995, this second edition presents new information, such as additional deposits (2,831, compared to 582 in 1995), a revised classification system that distinguishes between 15 different types of deposits, and improved geological visualization. "The aim was to create a complex map that is very simple to use," said Martin Fairclough, a uranium production specialist at the IAEA and one of the map's developers. The map is a downloadable PDF with bookmarks arranged in three groups—Map Views, Deposit Types, and Map Peripherals—that allow the user to view specific map features. It also includes subdivided layers that can be toggled on and off to display a customized map.

The map is based on data from the IAEA's World Distribution of Uranium Deposits (UDEPO) database and on the publication *Geological Classification of Uranium Deposits and Description of Selected Examples*. It was developed with contributions from the Saskatchewan Geological Survey, the Geological Survey of South Australia, and the United States Geological Survey. *World Distribution of Uranium Deposits, Second Edition,* can be downloaded at <www-pub.iaea.org/books/IAEABooks/12314/World-Distribution-of-Uranium-Deposits-Second-Edition>.

able at <www.nrc.gov/reading-rm/doccollections/news/2018/18-036.pdf>.

■ Uranium One was notified by the NRC on August 24 that its request for an amendment to its source material license for the Willow Creek *in situ* recovery mining project has been approved. The license amendment allows the company to construct, operate, and perform aquifer restoration and decommissioning activities at a site known as the Ludeman Satellite (*NN*, Sept. 2018, p. 48) in Wyoming. Uranium One applied for the license amendment in December 2011.

BUSINESS DEVELOPMENTS

Denison to increase stake in Wheeler River project

Denison Mines Corporation announced on September 4 that it has entered into an agreement with Cameco Corporation to increase its ownership in the Wheeler River uranium project. Under the terms of the agreement, Denison would acquire 100 percent of Cameco's interest in the Wheeler River Joint Venture in exchange for the issuance of 24,615,000 common shares of Denison at a deemed price of \$0.65 per share, for a total value of approximately Can\$16 million (about \$12.3 million). Denison's interest in the project would increase to 90 percent.

JCU (Canada) Exploration Company owns 10 percent of the joint venture, and under its right of first refusal, JCU could choose to purchase its proportional interest of Cameco's share. If JCU exercises that right, it would hold about 13.16 percent of the joint venture, and Denison would hold about 86.84 percent.

"Denison, Cameco, and JCU have worked together since 2004 to advance Wheeler River to the point of being the largest undeveloped uranium project in the eastern Athabasca Basin," said Denison's president and chief executive officer, David Cates. "We are eager to continue advancing the project towards a development decision, with the next step being the planned completion of a prefeasibility study before the end of the third quarter."

The project has combined indicated mineral resources of 132.1 million lb U_3O_8 (*NN*, Mar. 2018, p. 92).

MINING

Resource estimate for Charlie Project announced

Anfield Energy announced on September 5 that a resource estimate for the Charlie Project, located in the Pumpkin Buttes uranium district in Johnson County, Wyo., has identified an indicated mineral resource equivalent to 3.1 million lb U_3O_8 . Anfield announced in March that it had entered into a transaction with Cotter Corporation to acquire the Charlie Project (*NN*, Apr. 2018, p. 60).

BRS Engineering, the engineering and geology consulting firm contracted by Anfield to develop the resource estimate, also found an inferred mineral resource equivalent to 1.4 million lb U_3O_8 . An exploration target may hold from 500,000 to 1.3 million lb U_3O_8 .

Anfield Chief Executive Officer Corey Dias said, "We view Charlie as an extremely strategic asset, due not only to its advanced nature but also to its close proximity to two of Uranium One's currently producing mines and its uranium satellite processing plant. We are aiming to close the ongoing Cotter transaction in the next 60 to 90 days, which will allow us to move the Charlie Project forward."

The resource estimate was derived from a database of over 1,300 drill holes and several hydrological, analytical, and mineralogical reports. Deposits similar to Charlie are mined using *in situ* recovery methods at Uranium One's Christensen Ranch site (part of the Willow Creek Project) and Cameco Resources' Smith Ranch-Highland site, according to Anfield.

Section continued

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RESEARCH

Radionuclide transfer studied in South Australia

Flinders University, located in Adelaide, South Australia, and National Energy Resources Australia (NERA) are collaborating on research at uranium mine sites in South Australia. The two-year project— Improving the Relevance of International Radiological Risk Assessment Tools to Australian Arid Environments—is funded at Aus\$417,000 (about \$298,000).

The aim of the project is to enhance the understanding of radionuclide transfer in arid environments and the potential radiological impacts of uranium mining in South Australia by analyzing the radioactivity of flora, fauna, and soils representative of those environments. The data generated will be added to a national database for comparison with existing datasets for other Australian species, habitats, and climates. The project builds on existing environmental research being undertaken by Flinders University and mining company BHP at the Olympic Dam mine.

While the level of radiation in the environment at the research sites is very low, with little or no impact on people and



Student researchers from Flinders University at BHP's Olympic Dam mine.

the environment, the researchers believe their work will lead to improved methods for monitoring background radiation in arid environments that can help the industry in several ways, including by improving current environmental impact assessment tools.

The project is being led by Flinders radioanalytical chemist and associate professor Rachel Popelka-Filcoff, with support from other Flinders professors and from students. "By analysis of comprehensive data sets, we will be able to better understand radiation in the arid Australian environment," Popelka-Filcoff said.

The Flinders team will work in partnership with mine operators BHP and Heathgate Resources, NERA, the Australian Nuclear Science and Technology Organization, the Australian Radiation Protection and Nuclear Safety Agency, and the consulting firm JRHC Enterprises.



RADIATION DETECTION

Purdue researchers to patent yeast-based dosimeters

A simple radiation detection badge intended for hospital workers uses the metabolic activity of yeast cells to detect ionizing radiation. Purdue University researchers have developed a yeast-based radiation badge that they say could provide a faster, less expensive alternative to current radiation dosimeters used by hospital lab workers to track their daily radiation exposure, according to an August 9 press release.

The wearable, disposable badges are made from freezer paper, tape, and aluminum. The yeast, which is contained within the paper substrate between two electrodes, acts as a smart material. Adding a drop of water activates the yeast to show ionizing radiation exposure as read by an electronic device for an instant reading. On a commercial level, the readout device could one day be a computer tablet or phone, according to the press release. The badge could also be adapted in the future for nuclear power plant workers and victims of nuclear disasters.

The technology relies on the quick and measurable response of yeast to radiation: The higher the radiation dose, the higher the percentage of yeast cells that die. Wetting the badge activates the cells that are still alive to eat glucose and release carbon dioxide—the same fermentation process



Disposable yeast-based radiation badges may allow workers in nuclear facilities and hospitals to check their daily radiation exposure instantly.

responsible for brewing beer and making bread rise.

When carbon dioxide bubbles at the surface, ions also form. The concentration of these ions increases the electrical conductivity of yeast, which can be measured by hooking up the badge to a readout system. According to the researchers, unlike other detectors that need to be sent to an outside laboratory for testing, a process that can take weeks, the badges can provide an instant reading at a much lower cost.

"We use the change in electrical properties of the yeast to tell us how much radiation damage it incurred," said Rahim Rahimi, a postdoctoral researcher in Purdue's School of Electrical and Computer Engineering. "A slow decrease in electrical conductivity over time indicates more damage."

According to the researchers, the badges are capable of detecting a radiation dose as little as 1 millirad, which is comparable to current commercial badges.

Yeast is known to be genetically similar to human tissue. Data from the badges can, therefore, inform future work on how human DNA and proteins are damaged by radiation.

Manuel Ochoa, an electrical and computer engineering postdoctoral researcher, said, "For yeast, it seems that radiation primarily affects the cell walls of the membrane and mitochondria. Since biologists are already familiar with yeast, then we're more likely to understand what's causing the biological effects of radiation in organic matter."

Currently, the badges are produced by hand, but the researchers say they could be easily produced on a large commercial scale. A patent is pending for the radiation detection technology via the Purdue Research Foundation.

A report on the researchers' findings, Yeast Metabolic Response as an Indicator of Radiation Damage in Biological Tissue, was published in the journal Advanced Biosystems and is available in the Wiley Online Library at https://onlinelibrary.wiley.com/doi/pdf/10.1002/ adbi.201800126>.

Section continued

ANS

HYDROGEN

SRNL licenses H isotope separation technology

Savannah River National Laboratory announced on August 28 that it has licensed its hydrogen isotope separation technology to Greenway Energy, a hydrogen technologies company based in Aiken, S.C.

The license is for a system known as the Thermal Cycling Absorption Process (TCAP), which is used to separate hydrogen isotopes—protium, deuterium, and tritium—using a continuous method based on palladium gas chromatography. The TCAP system was developed by SRNL in 1980 to support its national security mission. According to SRNL, since its introduction, the TCAP system has been refined to feature a significantly smaller size, consume less energy, and improve environmental safety.

Through the license agreement, Greenway will be able to economically manufacture a TCAP system for commercial laboratory use in a nucleotide radiography system. This type of radiography is used for the nondestructive testing of manufactured components in the aerospace, energy, and defense sectors.

"Licensing TCAP technologies opens a variety of unique solutions for imaging, as well as purification of hydrogen isotopes used in commercial processes," said Scott Greenway, president of Greenway Energy. "We are actively working with clients and industry to develop solutions around this technology. Greenway Energy sees SRNL as a partner for further technology development that will drive innovation in this area and allow for more advanced application in the future."

NEUTRON IMAGING

Phoenix to open neutron imaging services center

Phoenix LLC, a Madison, Wis.-based manufacturer of neutron generators, announced on August 28 that it plans to build a state-of-the-art neutron imaging center in Fitchburg, Wis., with its opening anticipated in mid-2019. According to the company, it will be the first facility to offer commercial neutron imaging services without the use of a nuclear reactor.

Phoenix is working with Krupp General Contractors and the city of Fitchburg to build the 10,000-square-foot facility, which will provide neutron activation analysis, radiation effects testing, and neutron (n-ray) and standard X-ray imaging. The process of selecting the site was done in coordination with the local government

Isotopes & Radiation Briefs

BRUCE-8 WILL BEGIN PRODUCING HSA COBALT, Bruce Power announced on August 31. The company said that it was to begin placing medicalgrade cobalt into Unit 8 at its Bruce nuclear power plant near Kincardine, Ontario, Canada, during the reactor's planned maintenance inspection program, which began on September I. With the installation of high specific activity (HSA) cobalt rods in Bruce-8, all four Bruce Block B units will produce HSA cobalt, which is used in Gamma Knife radiosurgery to treat brain tumors. "HSA cobalt is at the forefront of innovative new medical technologies, and we're proud of the part we play in delivering this life-saving radiation therapy," said Mike Rencheck, president and chief executive officer of Bruce Power. "As a longtime supplier of Co-60, we have been helping to keep our hospitals safe for decades, and now, with the production of HSA cobalt, we will have a greater impact on human health across the globe."

AN EXEMPTION TO ALLOW NORTHWEST MEDICAL ISOTOPES to

begin construction of its molybdenum-99 production facility in Columbia, Mo., is being considered by the Nuclear Regulatory Commission, which on August 24 issued an environmental assessment and finding of no significant impact (EA/FONSI) for the proposed 10 CFR Part 70 exemption. NWMI has requested an exemption from the requirement that the Part 70 application be submitted at least nine months prior to beginning construction of the applicable portions of the facility, which will be used to recover and purify Mo-99 from low-enriched uranium targets. The NRC granted NWMI a 10 CFR Part 50 construction permit for the facility in May 2018 (*NN*, June 2018, p. 36). As part of its environmental review of the construction permit application, the NRC evaluated the environmental impacts of NWMI's Part 70 activities. According to the NRC, the exemption request concerns only the timing of the start of construction and will not affect the safety or environmental impacts of the facility. Notice of the the EA/FONSI was published in the August 29 *Federal Register*.

ALPHA TAU MEDICAL'S RADIOTHERAPY DEVICE has been approved as a sealed source and device by the Massachusetts Radiation Control Program, the Israeli medical technology company announced on August 21. Massachusetts is a Nuclear Regulatory Commission agreement state. The approval enables the initiation of clinical trials in U.S. cancer centers to investigate Alpha Tau's Alpha DaRT (Diffusing Alpha-emitters Radiation Therapy) as a treatment for various types of solid tumors. Alpha Tau, which is building a new production facility in the United States to meet the anticipated demand for the Alpha DaRT cancer treatment, announced on September 5 that it has secured \$29 million in private funding.

A FINE HAS BEEN PROPOSED ON AUTOMATED PACKAGING SYSTEMS

Inc. (APS) by the Nuclear Regulatory Commission in the amount of \$8,500 for a violation related to the loss of a fixed gauge containing a radioactive source. According to an August 13 NRC violation notice, the gauge, which contained a 150-millicurie americium-241 sealed source, was removed from service at one of APS's manufacturing plants in Keyser, W.Va., in November 2016, and at some point in 2017, was "inadvertently disposed of as scrap metal," a violation of 10 CFR 31.5. Further, APS submitted its annual registration for general-use licensed devices in May 2017 but failed to conduct the required inventory of those devices. It wasn't until March 2018 that the firm realized that the gauge was missing.

APS did not contest the violations, which were rated at Severity Level III the level at which the NRC typically considers monetary penalties.

and the Madison Region Economic Partnership. Phoenix is also planning to build a new 50,000-square-foot corporate headquarters, slated for occupancy in 2020, at the same site.

According to Phoenix, the use of its compact accelerator-based neutron generators avoids the risks, complications, and costs associated with a fission reactor and will generate high-quality 2-D and 3-D neutron images for clients in a number of industries, most prominently aerospace and defense. Neutron radiography is a nondestructive testing methodology for showing highly detailed information about the internal structure of an object. For many components, n-rays reveal defects that would be completely invisible to traditional X-rays.

Phoenix will break ground on the new facility in November and has already begun accepting customer orders. Phoenix plans to allow companies to use its neutron generator technology in the imaging services facility on a trial basis before purchasing a dedicated, on-site, custom accelerator system from the company.

Continued from page 18

coating to the fuel's existing alloy cladding offers a number of advantages, according to Framatome, including improved resistance to oxidation at high temperatures, reduced hydrogen generation in accident conditions, and increased resistance to wear and debris in normal operations.



INL workers guide a test capsule into the reactor for the first fueled experiment at the TREAT facility in over two decades. (Photo: INL)

► INL'S TREAT FACILITY HAS RESUMED OPERATIONS after over two decades on standby. Idaho National Laboratory announced that on September 18, the

Transient Reactor Test (TREAT) facility pulsed for a few seconds, subjecting a small capsule of light-water reactor fuel to radiation and heat, marking the first experiment undertaken in the test reactor since TREAT was placed on standby in 1994. Data gathered from the experiment will be compared with tests previously conducted at TREAT and other historic research facilities to verify modern experiment protocols and instrumentation performance. The experiment is part of a series that will culminate in the testing of new LWR fuels being developed by the Department of Energy's Office of Nuclear Energy through the Accident Tolerant Fuels (ATF) program. Over the coming weeks, fuel samples will be exposed to increasing energy levels, ramping up to sample melting point.

"Restoring this capability in the U.S. keeps our nation in a leading role to develop advanced nuclear fuels and reactor technologies," said INL Laboratory Director Mark Peters. Exposing fuel samples to extreme conditions in TREAT supports the development of more resilient fuels that can resist melting for longer periods under accident conditions. Many of the fuel types used in power reactors today were tested in TREAT, where operations began in 1959. Miniature fuel rods that are now being irradiated in INL's Advanced Test Reactor as part of the ATF program (*NN*, July 2018, p. 18) will be tested at the TREAT facility.

THE DEMOLITION OF THE PLUTONIUM FINISHING PLANT at the

Hanford Site near Richland, Wash., has resumed, following approval by the Department of Energy. On September 12, the DOE authorized contractor CH2M Hill Plateau Remediation Company (CHPRC) to begin low-risk work at the facility after confirming that all pre-start findings from a CHPRC management assessment had been addressed. Demolition work at the PFP was halted in December 2017 after radiological contamination spread outside the plant's demolition zone (*NN*, Feb. 2018, p. 67). According to the DOE, the resumption of work will occur in two phases. The first phase involves two lower-risk activities: processing and packaging existing debris from the demolition of the plant's Main Processing Facility (MPF), followed by the demolition of the remaining lower-risk portions of the MPF. The second phase consists of two higher-risk activities: demolishing the MPF's two former processing lines and the tunnels beneath, as well as removing the remaining rubble from the demolition of the PFP's Plutonium Reclamation Facility. Before beginning the higher-risk work, CHPRC will conduct another independent management assessment, the DOE said. DOE and regulatory agency approvals will be required before higher-risk work resumes.

■ The DOE and Hanford Site contractor Washington River Protection Solutions (WRPS) have settled a lawsuit with the state and others over potential health risks posed by vapors vented from mixed waste stored in underground tanks at Hanford. The settlement agreement among the DOE, WRPS, and the plaintiffs—the State of Washington, Hanford Challenge, and Local 598 of the United Association of Plumbers and Steamfitters—was signed on September 19. Under the agreement, the DOE and WRPS will test and implement measures aimed at reducing worker exposure to harmful tank vapors. The DOE has also agreed to pay Washington State and the activist group Hanford Challenge \$925,000 in court costs. The plaintiffs filed their lawsuit in September 2015, claiming that the tank vapors pose a serious risk to Hanford workers. According to WRPS, the settlement agreement will become effective only if the court grants a joint motion in a separate case to extend certain tank waste retrieval milestones and grants a joint motion to stay the vapors litigation.

A SENATE HEARING ON ACCIDENT-TOLERANT FUELS, "Advanced Nuclear Technology: Safety and Associated Benefits of Licensing Accident Tolerant Fuels for Commercial Nuclear Reactors," was held by the Environment and Public Works Committee on September 13. In his opening remarks, the committee chairman, Sen. John Barrasso (R., Wyo.), said, "Following the 2011 disaster in Fukushima, Japan, Congress established a research program at the Department of Energy to encourage the development of accident-tolerant fuels. Seven years later, we are approaching the critical window for nuclear power plants to reap the safety benefits of this technology."

The hearing featured testimony from Raymond Furstenau, director of the Office of Nuclear Regulatory Research at the Nuclear Regulatory Commission; Tina Taylor, deputy chief nuclear officer and senior director of research and development at the Electric Power Research Institute; John B. Williams, director of nuclear fuel and analysis at Southern Nuclear; and Christina A. Back, vice president of nuclear technologies and materials at General Atomics.

Accident-tolerant fuels are designed to resist melting if a reactor's cooling system is compromised and to provide plant operators and equipment more time to respond. The NRC staff recently issued *Project Plan to Prepare the U.S. Nuclear Regulatory Commission for Efficient and Effective Licensing of Accident Tolerant Fuel*, which was added to the NRC's ADAMS public document library on August 24 (search for accession number ML18236A507).

20-YEAR LICENSE EXTENSIONS FOR OLKILUOTO-I AND -2 were approved by the Finnish government on September 20, allowing Teollisuuden Voima Oyj (TVO) to continue operating the units until the end of 2038. The current licenses were issued in 1998 and are valid until the end of this year. The two boiling water reactors began commercial operation in 1979 and 1982, respectively.

The government's decision was preceded by a statement from STUK, the Finnish Radiation and Nuclear Safety Authority, saying that it did not identify any safety issues that would prevent the government from granting operating licenses for the two units and that TVO's operations are safe and in conformity with the law. STUK further noted that the units were originally designed to operate for 40 years and that extending the operating licenses requires that TVO ensure appropriate aging management and safety culture.

Although the newly granted operating license extensions do not cover the operation of final disposal facilities, according to the announcement, the government attached a set of conditions to the new licenses relating to waste management and spent fuel storage. One of these allows TVO to use the site to process and store low-level and intermediate-level radioactive waste and other radioactive waste generated elsewhere. The condition was introduced to enable a safe way to process and store certain types of radioactive waste generated in Finland.

Olkiluoto-1 and -2, both with a capacity of about 880 MWe, supply about one-sixth of electricity demand in Finland. After the completion of Olkiluoto-3, which is now expected to start regular production in September 2019, the electricity generated at the site will meet about 30 percent of demand.

HOLTEC'S PROPOSED SPENT FUEL STORAGE FACILITY is being challenged by a coalition of antinuclear groups that on September 14 filed a petition to

intervene in the proceeding for Holtec International's license application to the Nuclear Regulatory Commission. Working with the Eddy-Lea Energy Alliance, Holtec is proposing to build a consolidated interim storage facility (CISF) for commercial spent nuclear fuel in southeastern New Mexico. Holtec submitted its license application for the facility in March 2017, and the NRC published notice of an opportunity to request a hearing or to petition for leave to intervene in the July 16 Federal Register (NN, Aug. 2018, p. 17). In its petition, the coalition-which includes Don't Waste Michigan, Citizens for Alternatives to Chemical Contamination, Public Citizen, San Luis Obispo Mothers for Peace, the Nuclear Energy Information Service, the Citizens' Environmental Coalition, and the Nuclear Issues Study Group-raises 13 contentions against the proposed facility and includes a reference to another 25 contentions submitted by the Sierra Club. Beyond Nuclear and Alliance for Environmental Strategies have also filed legal interventions opposing the Holtec CISF. In a September 17 press release, the coalition said that many of the groups opposing the Holtec CISF, and perhaps additional groups, are expected to file legal challenges against Waste Control Specialists' proposed CISF in nearby Andrews County, Texas (see page 73).

PRESIDENT TRUMP RELEASED A NATIONAL CYBER STRATEGY on

September 20, outlining ways to protect networks, foster innovation, deter and if necessary punish cyber criminals, and expand American influence abroad to extend the key tenets of an open, interoperable, reliable, and secure Internet. "The critical infrastructure that Americans rely on is threatened every day by nation-states, cyber criminals, and hackers seeking to wreak havoc, disrupt commerce, and even undermine our democratic institutions," said Homeland Security Secretary Kirstjen Nielsen upon the release of the new strategy. "Today's National Cyber Strategy—the first in 15 years strengthens the government's commitment to work in partnership with industry to combat those threats and secure our critical infrastructure."

The strategy specifically names Russia, China, Iran, and North Korea as countries that threaten the United States via cyberattacks, "often with a recklessness they would never consider in other domains," the report states.

National Cyber Strategy of the United States of America can be downloaded at <National-Cyber-Strategy.pdf>.



Olkiluoto: The license extensions allow Units I and 2 to operate through 2038. (Photo: TVO/Hannu Huovila)

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NEUTRON PRODUCTION

Record power level set in neutron production cycle

Oak Ridge's Spallation Neutron Source completed a neutron production cycle run at a record 1.3 MW. he Spallation Neutron Source (SNS) at Oak Ridge National Laboratory (ORNL) has reached a new milestone by operating a complete neutron production run cycle at 1.3 megawatts, the Department of Energy announced on August 9.

According to the DOE, achieving the record power level with a 94 percent accelerator beam availability establishes a new baseline of operation, as well as a path to operate reliably at higher power levels. Increased power offers researchers the ability to conduct faster scientific analyses using neutrons on more types of materials.

SNS, a DOE Office of Science User Facility, began operations in 2006 and is currently the world's most powerful pulsed



As protons (yellow) strike the target vessel and pass into the liquid mercury inside, the protons are absorbed, creating neutrons (blue) that are then sent through moderators and beam tubes to research instruments to study the fundamental properties of materials.

accelerator-based neutron scattering facility, used by scientists to reveal fundamental properties and behaviors of energy and materials at the atomic scale.

The facility accelerates protons at nearly 90 percent of the speed of light down a linear accelerator and into a ring that compresses the proton pulse by a factor of 1,000. The protons collide with a liquid mercury target, which creates a "spall" of neutrons that flow to instruments where scientists measure the neutrons' interactions with a variety of materials.

During SNS's latest 12-week production cycle, continuous and reliable operations at 1.3 MW were enabled by a more robust stainless-steel target module and a series of improvements in the accelerator systems that allowed higher proton current and energy, according to the DOE. SNS has reached power levels as high as 1.4 MW, but this is the first time the facility has sustained levels as high as 1.3 MW over a predicted time frame.

ORNL scientists and engineers have extended the lifetime of SNS targets by studying the performance of previous targets and making adjustments, such as injecting small bubbles of helium gas into the target vessel's liquid mercury flow, reducing the impact stresses caused by the proton beam.

In 2016, SNS implemented a target management plan to capture performance data and incorporate design improvements in new targets, which are currently installed approximately three times a year. Since the plan's implementation, each target has performed reliably in accordance with its intended design. During the next neutron production cycle, SNS will operate at 1.4 MW.

Section continued

FUSION

MIT researchers overcome plasma density limit

Researchers at the Massachusetts Institute of Technology's Plasma Science and Fusion Center (PSFC) have demonstrated how microwaves can be used to overcome the plasma density limit to steady-state fusion operation in a tokamak reactor, according to an August 22 press release from MIT.

In experiments performed on MIT's Alcator C-Mod tokamak before it ended operation in September 2016, research scientist Seung Gyou Baek and his colleagues studied a method of driving current to heat the plasma. Called Lower Hybrid Current Drive (LHCD), the technique generates plasma current by launching microwaves into the tokamak, pushing the electrons in one direction—a prerequisite for steadystate operation. Furthermore, the strength of the Alcator magnets has allowed researchers to investigate LHCD at a plasma density high enough to be relevant for a fusion reactor.

On Alcator C-Mod, LHCD was found to be efficient for driving currents at low density, demonstrating that plasma current could be sustained non-inductively. Researchers discovered, however, that as they raised the density in these experiments to the higher levels necessary for steady-state operation, the effectiveness of LHCD to generate plasma current disappeared. To find a way to boost effectiveness and overcome this LHCD density limit, researchers needed to examine how lower hybrid waves respond to the tokamak environment.

Lower hybrid waves drive plasma current by transferring their momentum and energy to electrons in the plasma. Temperatures in today's tokamaksincluding C-Mod-are not high enough to provide good matching conditions for the wave to transfer all of its momentum to the plasma particles on the first pass from the antenna, which launches the waves to the core plasma. Consequently, researchers noticed, the injected microwave travels through the core of the plasma and beyond, eventually interacting multiple times with the edge, where its power dissipates, particularly when the density is high.

Baek describes this edge as a boundary area outside the main core of the plasma where, in order to control the plasma, researchers can drain—or "scrape off" heat, particles, and impurities through a diverter. This edge has turbulence, which, at higher densities, interacts with the injected microwaves, scattering them and dissipating their energy.

Research Briefs

\$8 MILLION FOR PARTICLE ACCELERATOR RESEARCH has been

awarded by the Department of Energy. According to an August 27 press release, the awards will fund 12 research projects, lasting up to three years, on a range of topics in both basic and use-inspired research in the area of particle accelerator science and technology. Projects include work to develop faster methods of applying ion beams to help cure cancer, increase the power of ultrafast lasers, improve technology for industrial-scale accelerators, and research new methods of acceleration. The awards were made under the DOE Office of Science's Accelerator Stewardship program, which is closely coordinated with the Department of Homeland Security, the Department of Defense, the National Institutes of Health, and the National Science Foundation to ensure a federal government-wide investment strategy in accelerator science and technology. According to the DOE, the projects involve scientists at 12 universities, eight national laboratories, and eight companies. A list of the projects is available at <https://science.energy.gov/hep>.

TERRESTRIAL ENERGY AND SOUTHERN COMPANY HAVE partnered to investigate hydrogen production using Terrestrial Energy's Generation IV integral molten salt reactor (IMSR), Terrestrial announced on September 5. Several Department of Energy national laboratories will also be involved in the work to develop a more efficient and cleaner method of producing hydrogen using nuclear heat and power. The two-year research and development project will examine the efficiency, design, and economics of Terrestrial's IMSR to produce industrial-scale hydrogen using the hybrid sulfur process. This carbon-free method of generating hydrogen from water may be more efficient than high-temperature steam electrolysis, according to Terrestrial, whose work with Southern Company builds on two decades of research at Savannah River National Laboratory. SRNL will continue to lead the technology development along with Sandia National Laboratories and Idaho National Laboratory.

THE DOE AND THE U.K. HAVE FINALIZED AN ACTION PLAN that

seeks to facilitate cooperation between the United States and the United Kingdom in research and development for advanced civilian nuclear technologies, according to a press release from the Department of Energy's Office of Nuclear Energy (NE). The Civil Nuclear Energy Research and Development Action Plan was signed on September 13 in Washington, D.C., by the DOE and the United Kingdom's Department for Business, Energy and Industrial Strategy. "Agreement of the U.S. and U.K. action plan allows us to move forward and focus on a number of key advances in nuclear energy, including reactors and fuels," said Ed McGinnis, NE principal deputy assistant secretary, in the release. More specifically, the plan calls for working groups focused on the following areas: radioisotopes for use in space technologies, nuclear reactor technologies, advanced fuels, fuel-cycle technologies, advanced modeling and simulation, and enabling technologies.

In addition to the action plan, Oak Ridge National Laboratory and the United Kingdom's National Nuclear Laboratory have agreed, through a memorandum of understanding, to cooperate on a wide range of nuclear energy R&D efforts. The two labs plan to collaborate on projects through idea sharing, staff exchanges, and joint workshops.

According to MIT, detailed research on the edge and scrape-off layer conducted on Alcator C-Mod in the past two decades has documented that raising the total electrical current in the plasma narrows the width of the scrape-off layer and reduces the level of turbulence there, suggesting that it may reduce or eliminate its deleterious effects on the microwaves.

Motivated by this discovery, PSFC researchers devised an LHCD experiment to push the total current by nearly a factor of three, from 500,000 amps to 1,400,000 amps, enabled by C-Mod's high-field tokamak operation. They found that the effectiveness of LHCD to generate plasma current, which had been lost at high density, reappeared. Making the width of the turbulent scrape-off layer very narrow prevents it from dissipating the microwaves, allowing densities beyond the LHCD density limit to be reached. According to the researchers, the results from these experiments suggest a path to a steady-state fusion reactor.

A report on the results of the experiments, Observation of Efficient Lower Hybrid Current Drive at High Density in Diverted Plasmas on the Alcator C-Mod Tokamak, has been published in the American Physical Society's Physical Review Letters (https://journals.aps. org/prl/abstract/10.1103/PhysRevLett. 121.055001>).

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Education, Training & Workforce'

SRNL

Lab retirees to mentor, teach USC Aiken students

An MOU between Savannah River National Laboratory and the University of South Carolina at Aiken established the Collegiate Affiliate Program. Retirees from Savannah River National Laboratory (SRNL) will have an opportunity to share their expertise with students at University of South Carolina Aiken (USC Aiken) as part of an agreement reached on September 4. The Collegiate Affiliate Program was established through a memorandum of understanding signed by Vahid Majidi, director of SRNL, and Sandra J. Jordan, chancellor of USC Aiken.

The program provides two ways for retired SRNL professionals to collaborate with USC Aiken faculty, staff, students, and community. The Faculty Affiliate option allows qualified lab retirees to teach college-level courses and labs. The University Affiliate option provides a range of opportunities for retirees to mentor students, provide career counseling, connect students with internships, and serve as guest lecturers. "We have a number of lab alumni whose expertise can be a valuable resource for the university, and we look forward to seeing this turn into an opportunity that strengthens STEM [science, technology, engineering, and math] education at USC Aiken," Majidi said.

The joint effort is being launched with a \$105,000 grant from Savannah River Nuclear Solutions, which manages and operates SRNL. Part of the funding will be used to renovate space in USC Aiken's Gregg-Graniteville Library to serve as an office for the SRNL retirees. The funds will also be used to establish a training workshop and help provide salaries for Faculty Affiliate participants.

"This exciting partnership is another way to leverage the talents and knowledge of SRNL employees to augment and complement our work at USC Aiken," Jordan said.



hoto: USC Aiken/Phyle:

Vahid Majidi (left), director of Savannah River National Laboratory, and Sandra J. Jordan, chancellor of the University of South Carolina Aiken, sign the memorandum of understanding to establish the Collegiate Affiliate Program.

SUMMER PROGRAMS

CNL, Moscow State host students, specialists

Canadian Nuclear Laboratories concluded its 2018 Summer Co-op Program with a series of presentations showcasing students' research and engineering projects, according to a September 12 press release. CNL welcomed 80 students from academic institutions across the country to its campuses, including the Chalk River Laboratories. While most students worked in positions related to science and engineering, some in this year's program were placed in other areas, including materials science, radiobiology, regulatory affairs, applied physics, analytical chemistry, computational techniques, fuel development, nuclear safety, and environmental protection.

Mark Lesinski, CNL president and chief executive officer, said, "The program is . . . distinct because the students are given real-world responsibilities working on challenging projects, often using state-ofthe-art equipment and facilities that are typically not available to students in these types of programs. It is this meaningful work experience that makes our program so rare and successful for both CNL and our students."

■ The Faculty of Chemistry at Moscow State University and Rosatom, Russia's state atomic energy corporation, concluded their first International Summer School on Radiochemistry in Moscow on August 3. Attending the course were more than 40 specialists from Rosatom partner countries—including Belarus, Bolivia, the Czech Republic, Egypt, Hungary, Nigeria, Slovakia, South Africa, and Turkey—who learned about innovations in radiochemistry, radiation technology, and nuclear medicine.

This is the first in what is expected to be a series of educational courses that the university and Rosatom will conduct for professors at the leading technical universities in partner countries, as well as other specialists and managers.



A FELLOWSHIP PROGRAM FOR DOCTORAL STUDENTS has been launched by the National Nuclear Security Administration. The new Laboratory Residency Graduate Fellowship program places students in Department of Energy/ NNSA laboratories for long-term study in fields of science relevant to the stewardship of the nation's nuclear stockpile. The inaugural fellowship class is made up of four doctoral candidates, pictured above (along with each Ph.D. candidate's university, area of research, and lab assignment), from left: William Riedel (Stanford University, plasma physics, Lawrence Livermore National Laboratory); Travis Voorhees (Georgia Institute of Technology, materials science and engineering, Los Alamos National Laboratory); Raspberry Simpson (Massachusetts Institute of Technology, plasma physics, Lawrence Livermore National Laboratory); and Stephanie Miller (University of Michigan, plasmas and nuclear fusion, Sandia National Laboratories). The fellowships are expected to lead to employment opportunities and advancement within the labs.

Education, Training & Workforce Briefs

THE COLLEGE OF SOUTHERN MARYLAND has

received a grant from the Nuclear Regulatory Commission in the amount of \$105,804 to provide scholarships to 15 students enrolled in the college's Energy Systems Technology associate degree program. The scholarships cover tuition, books, supplies, and dedicated tutoring.

CSM, with campuses in Hughesville, LaPlata, Leonardtown, and Prince Frederick, is one of six community colleges nationwide and one of two Maryland academic institutions to receive NRC funding. This is the 10th year that CSM has partnered with Exelon Generation to offer the Energy Systems Technology program and seek NRC grants to support scholarships. Since the program's inception, 21 students have been hired by Exelon.

FENNOVOIMA OY INSTRUCTORS VISITED the Leningrad nuclear power plant near St. Petersburg, Russia, where they toured the plant's training center for operators of the new VVER-1200 reactors at the site, according to an August 6 press release from Rosatom, Russia's state atomic energy corporation. Finland's Fennovoima Oy plans to build the Hanhikivi nuclear power plant in Pyhäjoki and will also build a training simulator there. "We may employ some of these practices and staff training methods at the Hanhikivi plant, since its main power unit will be based on the same design as the new units in place at the Leningrad plant," said Vaclav Vejborny, an instructor at Fennovoima Oy.

INTERNS SHARED THEIR RESEARCH PROJECTS on nonproliferation with faculty and supporters of the James Martin Center for Nonproliferation Studies (CNS) at the Middlebury Institute of International Studies on July 27 in Monterey, Calif. The Summer Undergraduate Nonproliferation Internship Program was launched in 2015 with the help of Tom and Sarah Pattison, who are its major supporters, according to an August 2 press release from CNS. The 13 interns presented the key findings of their research projects at a luncheon attended by the Pattisons, CNS experts, institute faculty and staff, and others. Their topics included Chinese media narratives on nuclear issues, radiological weapons capabilities and intentions of the Houthi rebels and al-Qaida, and South Africa's nuclear program and former apartheid regime. The internship program helps fulfill CNS's mission to train the next generation of nonproliferation specialists.

CNNC AND TSINGHUA UNIVERSITY SIGNED an

agreement on September 3 in Beijing. The intention of the agreement, signed by Yu Jianfeng, chairman of China National Nuclear Corporation, and Qiu Yong, chancellor of Tsinghua University, is to work toward building a nuclear science research institute and technology development center. CNNC has also signed strategic cooperation agreements with Tsinghua University, Shanghai Jiaotong University, Xi'an Jiaotong University, and Harbin Engineering University, with the aim of promoting advanced nuclear energy, system integration, and capacity building in China, according to a CNNC press release.

In addition, CNNC announced in late June that it would establish a national university dedicated to nuclear research, training, and academic exchange. The China Nuclear Technology University, to be built in Tianjin, in the northeast region of China, will provide skills training and postgraduate and doctoral programs, as well as opportunities for core technology research and development. The goal is to supply personnel for the rapidly growing nuclear power industry in China.

BUSINESS DEVELOPMENTS

BWXT acquires Sotera's medical isotope business

Lynchburg, Va.-based **BWX Technol**ogies announced on August 6 that it has completed the acquisition of the medical isotope business of Nordion, a Sotera **Health** company. With the sale, BWXT takes over Nordion's radiochemical and contract manufacturing operations in Kanata, Ontario, and its isotope production facility in Vancouver, British Columbia. Nordion will retain ownership of its gamma technologies business and its stateof-the-art licensed facility in Kanata. The companies also signed a long-term lease agreement that allows BWXT to continue operating from Nordion's Kanata facility. BWXT had previously announced the launch of its molybdenum-99 product line and a number of radioisotope-based imaging and therapeutic products. Nordion's global business has included the manufacture and supply of medical isotopes and radiopharmaceuticals for research, diagnostic, and therapeutic uses. The newly acquired business unit-to be called BWXT ITG Canada Inc.-will be part of BWXT's Nuclear Power Group in Canada.

■ On August 16, **National Technical Systems** (NTS), which provides qualification testing, inspections, and certification solutions, announced the opening of its new corporate center in Anaheim, Calif., where one of NTS's 27 laboratories is located. The center will integrate corporate functions from the Calabasas, Fullerton, and Brea offices into a single location, bringing together the company's finance, accounting, marketing, procurement, human resources, contract administration, and information technology departments. NTS serves the nuclear and various other industries.

On July 26, RadioMedix and ITM Isotopen Technologien München announced that ITM subsidiary lsotope Technologies Garching GmbH (ITG) and RadioMedix signed a manufacturing and supply agreement for the production of the next generation of germanium-68/ gallium-68 generators at the new Radio-Medix Spica Center in Houston, Texas. The facility is dedicated to late-stage investigational and commercial-stage radiopharmaceuticals. RadioMedix has been the exclusive distributor of ITG products in North America since 2013, including Ge-68/Ga-68 generators, which produce the medical radionuclide Ga-68 for use in diagnosing cancers. With the new Houston facility, RadioMedix will be able to supply not only North America but the global market as well.

■ Nuclear Electric Insurance Limited (NEIL) has received a financial strength rating of "A" (excellent) and a long-term issuer credit rating of "A+" from **A.M. Best**, a rating agency of alternative risk transfer entities. According to an August 1 press release from A.M. Best, the ratings reflect NEIL's strong balance sheet, marginal operating performance, favorable business profile, appropriate enterprise risk management, and management culture. NEIL provides essentially the entire nuclear utility property insurance coverage in the United States.

ARTMS Products, of Vancouver, British Columbia, Canada, announced on August 8 that it has received CE marking approval for its QUANTM irradiation system, which produces medical isotopes, including technetium-99m and gallium-68, using medical cyclotrons. The CE marking on a product is a manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety, and environmental protection legislation. According to Kaley Wilson, ARTMS's chief executive officer, "ARTMS provides a more economical, environmentally safe, and secure supply of important radioisotopes than reactor-based sources. Now, with CE marking approval, ARTMS can be readily integrated in a standardized fashion into existing and emerging facilities."

CONTRACTS

Bechtel named Wylfa project lead; other pacts

Bechtel announced on August 22 that it has been selected by Horizon Nuclear Power, a wholly owned subsidiary of Hitachi Ltd., to be the project management contractor for a new, two-reactor nuclear plant to be built on the Isle of Anglesey in North Wales. The Wylfa Newydd power station is a part of the United Kingdom's plan to replace aging nuclear plants and fossil fuel plants with modern nuclear plants and renewable energy. Bechtel project management, procurement, and subcontract management professionals will be embedded within Horizon's organization to lead the commercial and contractual relationships with local, U.K., and global suppliers that will be required to complete the Wylfa Newydd project.

NOTE: Nuclear News publishes news about nuclear industry contracts—but only about contract awards. We generally do not publish announcements that the work is under way or announcements that the work has been completed. Send your new contract award announcements to: Industry Editor, Nuclear News, 555 N. Kensington Ave., La Grange Park, IL 60526; fax 708/579-8204; e-mail <nucnews@ans.org>.

■ Framatome has signed a contract with Talen Energy's Susquehanna Nuclear LLC to supply the Susquehanna plant, which has two General Electric 1,287-MWe boiling water reactor units, with its advanced ATRIUM 11 fuel design. The first of six fuel reloads—consisting of approximately 300 fuel assemblies—will be delivered to the site, near Berwick, Pa., in January 2021. The fuel will be manufactured at Framatome's Richland, Wash., facility. Framatome has been supplying Susquehanna Nuclear with fuel for every reload since 1983.

■ **GSE Systems Inc.** announced on August 15 that it has received separate contracts, worth a combined \$8 million, to update simulators at nuclear power plants in Slovakia and South Korea.

The first contract is from Slovenské Elektrárne, a.s. to update its Mochovce-3 and -4 simulator, which GSE initially delivered in 2013. As the VVER-440 units near commissioning, the simulator will be updated to reflect the final, as-built design. The value of the contract is estimated at \$6.5 million.

The second contract, valued at \$1.5 million, is with Greatus Company Ltd., in Seoul, South Korea, and involves upgrading Korea Hydro & Nuclear Power Company's Kori-2 simulator, originally built by GSE and Samsung Electronics in 1998 and upgraded in 2006. The project will update the plant models to GSE's latest technology and software, and will be implemented over the next 17 months.

10 CFR PART 21

Defects found in circuit boards, selector switch

On July 27, Ametek Solidstate Controls reported that during preventive maintenance in May on its AC voltage sense board (Part No. 80-210833-90), the company experienced failures of the component during the startup of a unit. Accord-

ing to the company, while the failures were experienced on commercial equipment, a version of the AC voltage sense printed circuit board is used in safety-related equipment as well. Ametek determined that the failure was caused by the opening of the 100 ohm, 2W R7 metal-oxide resistor (Part No. 03-804103-00) due to an insufficient capability to withstand peak power for the application. In all instances of failures experienced, the peak inrush power dissipation during startup caused the 2W metal-oxide resistor to open. Failure of the AC voltage sense board could cause a false low-AC voltage alarm and an inoperable high-AC voltage alarm condition, Ametek said. The potential defect and 10 CFR 21 notification applies to the company's safety-related 277-VAC version of the AC voltage sense printed circuit board (Part No. 80-9210842-90), and Ametek is recommending that any previous versions of the 277-VAC AC voltage sense boards be replaced at the earliest convenience.

On August 23, Entergy Operations reported that the company completed an evaluation of a possible defect of Westinghouse 7300 process analog control system (PAC) circuit cards at its Waterford-3 nuclear power reactor and concluded that the condition constitutes a defect pursuant to 10 CFR Part 21. According to the company, three Westinghouse 7300 PAC circuit cards were identified to have failed due to failed hex inverter chips. Some of the cards were installed in applications that support the reactor's ultimate heat sink. Entergy concluded that the condition could have prevented the heat sink from performing its safety function and therefore could have created a substantial safety hazard. The circuit card types of concern are Analog Comparator Model No. 2838A32G01, Control Board Model No. 2838A30G011, and Prom Logic Model No. 2838A33G01.

On August 28, Curtiss-Wright reported that it was notified by Exelon's Calvert Cliffs nuclear power plant that a Senasys selector switch (Part No. 910CMC-5240X), which was previously provided by Curtiss-Wright under Exelon purchase order No. 00630804, had failed a post-installation test. According to Curtiss-Wright, the suspect switch was sent to Exelon Powerlabs, where the failure was found to have been caused by an assembly screw that was 1/8-inch too long, allowing it to cut into the coil of the switch and causing an electrical short. Curtiss-Wright found that its records showed that only Calvert Cliffs received the defective switches and the plant has been notified of the issue. Curtiss Wright said that it will revise its dedication plan to include a note to ensure that no selector switches for the affected part number are manufactured with the November and December 2017 date codes. NN



Faculty Searches in Nuclear Engineering

The Nuclear Engineering Program at The Pennsylvania State University is pleased to invite applications for tenure-track positions in nuclear engineering at all ranks. All areas of nuclear engineering shall be considered. We have interests in nuclear power topics such as reactor physics and fuel management, thermal-hydraulics, nuclear materials, instrumentation and controls, nuclear safety, advanced reactors and nuclear fuel cycle analysis as well as nuclear science, nuclear security and nonproliferation.

The Nuclear Engineering program is one of the most traditional in the United States, having been founded in 1959. We offer B.S., M.S., and Ph.D. degree programs in nuclear engineering, including a very successful online graduate program. The faculty associated with the Nuclear Engineering Program conduct state-of-the-art research on nuclear power with research connections to industry and government with international partnerships, sponsored by the new Global Nuclear Power Safety Center. The Program benefits greatly from the Breazeale Nuclear Reactor and the Radiation Science and Engineering Center which is one of the premier reactor research facilities in the world for nuclear education and research. We encourage interdisciplinary collaborations across the institution. As part of the establishment of Nuclear Engineering as a separate Department at Penn State we expect it to grow significantly over the next few years.

Applicants should hold a doctorate in nuclear engineering or related field, and have demonstrated outstanding scholarly research experience and teaching interests in nuclear engineering. Successful candidates will be expected to teach courses at both the undergraduate and graduate levels, to develop an internationally recognized, externally-funded research program, and to contribute to the operation and promotion of the department, college, university, and profession through service.

Nominations and applications will be considered until the positions are filled. Screening of applicants will begin on October 1st. Applicants should submit a cover letter, a statement on teaching and research, a curriculum vitae, and the names and addresses of four professional references who are academics at the rank of Professor. Please submit these four items in one pdf file electronically to job 81826 at http://apptrkr.com/1266108. Employment with the University will require successful completion of background checks in accordance with University Policy.

Apply online at http://apptrkr.com/1266108

CAMPUS SECURITY CRIME STATISTICS: For more about safety at Penn State, and to review the Annual Security Report which contains information about crime statistics and other safety and security matters, please go to http://www.police.psu.edu/clery/, which will also provide you with detail on how to request a hard copy of the Annual Security Report.

Penn State is an equal opportunity, affirmative action employer, and is committed to providing employment opportunities to all qualified applicants without regard to race, color, religion, age, sex, sexual orientation, gender identity, national origin, disability or protected veteran status.

Standards

ACTIONS

Standards approved, comments requested

The following standards have been approved:

■ ANSI/ANS-10.7–2013 (R2018), Non-Real-Time, High-Integrity Software for the Nuclear Industry—Developer Requirements (reaffirmation of ANSI/ ANS-10.7–2013).

This standard addresses rigorous, systematic development of high-integrity, non-real-time safety analysis, design, and simulation software that includes calculations or simulations that can have critical consequences if errors are not detected, but that are so complex that typical peer reviews are not likely to identify errors. This may include nuclear design and performance codes, codes used to assign safety classification levels to systems, structures, and components at nuclear facilities, computational fluid dynamics or structural mechanics codes, complex Monte Carlo simulations, radiation dosimetry analysis codes, and nuclear medical physics analytical codes.

■ ANSI/ANS-51.10–1991 (R2018), Auxiliary Feedwater System for Pressurized Water Reactors (reaffirmation of ANSI/ ANS-51.10–1991 [R2008]).

This standard specifies updated design requirements for the auxiliary feedwater system, including system functions, performance requirements, and system description.

Comments requested

Comments are requested on the following standard by October 1, 2018:

■ ANS-41.5–2012 (R201x), Verification and Validation of Radiological Data for Use in Waste Management and Environmental Remediation (reaffirmation of ANSI/ANS-41.5–2012).

This standard establishes criteria and processes for verification and validation of radioanalytical data for waste man-

agement and environmental remediation activities. It applies to the independent review of the data generation process for field measurements and radioanalytical laboratories. This standard sets the requirements for how the data are reviewed and qualified against the data quality requirements that are established by the project to meet their intended use. While this standard does not specifically address all nondestructive assays and in situ measurements, the general principles and some of the elements of this standard may apply. This standard does not address nonradioassay measurement methods (e.g., inductively coupled plasma-mass spectroscopy, kinetic phosphorescence analysis, X-ray diffraction).

Comments are requested on the following standard by October 29, 2018:

■ ANS-8.1–2014 (R201x), Nuclear Criticality Safety in Operations with Fissionable Material Outside Reactors (reaffirmation of ANSI/ANS-8.1–2014).

This standard is applicable to operations with fissionable materials outside nuclear reactors, except for the assembly of these materials under controlled conditions, such as in critical experiments. Generalized basic criteria are presented, and limits are specified for some single fissionable units of simple shape containing U-233, U-235, or Pu-239, but not for multiunit arrays. Subcritical limits for certain multiunit arrays are contained in ANSI/ ANS-8.7–1998 (R2017). Requirements are stated for validation of any calculational method used in assessing nuclear criticality safety.

Comments are requested on the following standard by November 13, 2018:

■ ANS-16.1–201x, Measurement of the Leachability of Solidified Low-Level Radioactive Wastes by a Short-Term Test Procedure (revision of ANSI/ANS-16.1–2003 [R2017]).

This standard provides a procedure to measure and index the release rates of nonvolatile radionuclides from waste forms in demineralized water over a five-day test period. It can be applied to any material from which test specimens can be prepared by casting or cutting into a shape for which the surface area and volume can be determined. The results of this procedure do not represent waste form degradation in any specific environmental situation. The test presented in this standard is an adaptation of the provisions published in the original version of this standard in 1986.

All published and draft standards can be ordered through the online ANS Store at <www.ans.org/store> or by email to <orders@ans.org>. Comments on draft standards can be sent to ANS standards manager Patricia Schroeder at <pschroeder@ans.org>, with a copy of the comments sent to the Board of Standards Review at the American National Standards Institute.

Volunteer support needed

The following standards projects are in need of volunteer support. Interested individuals should contact <standards@ans.org> for more information.

ANS-2.32, Guidance on the Selection and Evaluation of Remediation Methods for Subsurface Contamination (development of new standard).

ANS-56.2, *Containment Isolation Provisions for Fluid Systems After a LOCA* (historical revision of ANS-56.2–1989 [W1999]).

ANS-59.51, Fuel Oil Systems for Safety-Related Emergency Diesel Generators (revision of ANSI/ANS-59.51–1997 [R2015]).

ANS-59.52, Lubricating Oil Systems for Safety-Related Emergency Diesel Generators (revision of ANSI/ANS-59.52–1998 [R2015]).

ANS-60.1, export control standard—title TBD (development of new standard).

Equipment & Services

For your convenience, the phone number of a contact and the Web address for each company are listed.

Personal dosimeter

Thermo Scientific has made available its compact EPD TruDose electronic personal dosimeter for the monitoring of gamma



and beta radiation in any environment where workers need to monitor their exposure to radiation. The unit, which incorporates pulsed detection technology, reduces the risk of radiation exposure and workplace

interruption by providing real-time, ultraprecise dosage information. It features a range of alarm capabilities, integrated electromagnetic shielding of high tolerance to electro-magnetic fields, and is configurable with Thermo Scientific EasyEPD3 software. The EPD TruDose is suitable for use at nuclear power plants, medical facilities, and other sites with radioactive materials.

Thermo Scientific • 800/274-4212 • www. thermofisherscientific.com/EPDTruDose

Isotope identifier

The SAM 950-X from Berkeley Nucleonics is a smartphone-based, hand-held radioisotope identification device (RIID)



featuring a new design that is hardened for field applications. It is installed with the latest release of the PeakAbout

app, version 2.0.3, which includes user-

friendly updates on data storage and retrieval, sleep mode options, local extensible markup language (XML) support, Wi-Fi-assist, and video annotation support. The update to version 2.0.3 also includes a larger library of radioisotopes and identification algorithm. According to the company, the SAM 950-X is the first and only RIID to integrate seamlessly with the FEMA/RadResponder network, allowing the user to log, transmit, analyze, and store data in a secure cloud environment. Applications for the SAM 950-X include homeland security, safeguards and nuclear security, and radiological area mapping. Berkelev Nucleonics · 800/234-7858 · www.berkeleynucleonics.com

Radiation portal monitor



CAENSyS has introduced the SIRIO radiation portal monitor (RPM) for the identification of radioactive and special nuclear materials in vehicles and containers. The RPM has a two-pillar structure, and all vehicles crossing the

NN

pillar gate are checked for radioactive materials. The online data analysis provides an immediate response, including the identification between gamma and neutron signals and the energy categorization of the detected gamma source. The SIRIO is suitable for use in customs inspections, site security in critical infrastructures, and the monitoring of cargo containers and vehicles. *CAENSys* • +39 0584 388 398 • www.

caensys.com

NC STATE UNIVERSITY

The Department of Nuclear Engineering at North Carolina State University invites applications for a tenure-track position in the area of advanced nuclear reactors. This involves next generation methods, design and uncertainty analysis, data analytics, and real time simulations. We are seeking highly qualified candidates committed to a career in research and teaching. Exceptional candidates will be considered at the Associate/ Full Professor level, however the focus will be at the Assistant Professor rank.

Consideration of applications will begin on December 1, 2018 and applicants are encouraged to submit materials before this date. North Carolina State University has a strong institutional commitment to diversity in all areas and encourages candidates from underrepresented groups to apply.

Application materials should include a curriculum vita, statement of research, and statement of teaching philosophy. Applications must be submitted electronically through the North Carolina State University portal:

https://jobs.ncsu.edu/postings/104070



NC STATE UNIVERSITY

The Department of Nuclear Engineering at North Carolina State University invites applications for a tenure-track position in one of our primary research areas: Nuclear Power Engineering, Radiation Science, Plasma Science, Nuclear Materials, Waste Forms and Storage, Nuclear Security and Non-Proliferation, and Nuclear Computational Science. We are seeking highly qualified candidates committed to a career in research and teaching.

Consideration of applications will begin on December 1, 2018 and applicants are encouraged to submit materials before this date. North Carolina State University has a strong institutional commitment to diversity in all areas and encourages candidates from underrepresented groups to apply.

Application materials should include a curriculum vita, statement of research, and statement of teaching philosophy. Applications must be submitted electronically through the North Carolina State University portal:

https://jobs.ncsu.edu/postings/103938



People

Gerald T. "Tim" Powell, ANS mem-



ber since 2012, has been named president and chief executive officer of STP Nuclear Operating Company, having served as interim president and CEO since January. Powell, who joined the company in April 1989, has more than

Powell

35 years of experience in the nuclear industry, including radiation protection, operations, performance improvement, and engineering. He will oversee activities at STP's two-unit station in Palacios, Texas.

Lap-Yan Cheng, ANS member since



Cheng

1983, has been elected to co-chair the Generation IV International Forum's Proliferation Resistance and Physical Protection Working Group. Cheng is a nuclear engineer in Brookhaven National Laboratory's Nu-

Cheng clear Science and Technology Department. The PR&PP

Working Group consists of 20 engineers, scientists, and state regulators from 11 countries and organizations who are working to ensure that advanced reactor systems are designed to prevent the diversion or production of nuclear material for weapons purposes and to offer enhanced safeguards against theft, terrorism, and sabotage. The first Generation IV nuclear systems are expected to be deployed starting in 2030.

Gary Ostendorf has been named general manager of National Technical Systems' testing facility in Chicago, where he will be responsible for the operational and financial performance of the facility. He most recently was director of international business development and marketing for Nammo Talley.

Marian L. Zobler has been named general counsel for the Nuclear Regulatory Com-

mission. Zobler joined the NRC in 1990 as part of the Office of the General Counsel's Honor Law Graduate Program and has served in a variety of progressively more responsible positions in the OGC, including assistant general counsel for the high-level waste repository program and assistant general counsel for new reactor programs. She most recently was deputy general counsel for rulemaking and policy support.

Timothy Howsman has been appointed chief financial officer of Williams Industrial Services Group (formerly Global Power Equipment Group), which provides a range of construction, maintenance, and plant management services to the nuclear and other industries. Howsman, who joined the company in August 2014, had served as interim CFO since May.



Navinth

Navy and nuclear power plants. Navnith had served as Fairbanks Morse's vice president of operations since 2016.

The Electric Power Research Institute has announced the appointment of three interim members to its board of directors: Sam Belcher, senior vice president and president of FirstEnergy Utilities; Jae-Hoon Chung, president and chief executive officer of Korea Hydro & Nuclear Power Company; and Mike Hummel, ANS member since 2010, general manager and chief executive officer of the Salt River Project, in Arizona. They will be eligible to serve full four-year terms at the end of their interim terms.

Consolidated Nuclear Security, which operates the Pantex Plant and the Y-12 National Security Complex for the National Nuclear Security Administration, has announced three management changes:

Doug Freund has been named vice president for operations support; Ed Rogers has been named vice president for business management and transformation; and Jason Trichel has been named manager of internal audit, ethics, and employee concerns. Freund, Rogers, and Trichel replace Darrell Graddy, Doris Heim, and Jim Nobles, who have retired.



Jon Franke has been appointed vice president of safety and health for Pacific Gas and Electric Company. Franke, who joined PG&E in January 2017, was previously vice president of the company's Power Generation Division.

(NERC), where he

will lead NERC's se-

curity programs exe-

cuted through the

Electricity Informa-

tion Sharing and

(E-ISAC). Lawrence,

who joined NERC in

July 2012, previous-

ly served as senior

director of E-ISAC,

Center

Analysis

Franke

Brian Schumel has joined Imperia Engineering Partners as its nuclear business development manager. A 35-year veteran of the commercial nuclear industry, Schumel has held executive positions at the Atlantic Group, Day & Zimmermann, Fluor, Westinghouse, and WorleyParsons, and most recently was vice president of nuclear business development at Saulsbury Industries.

Bill Lawrence has been named vice president and chief security officer of the North American Electric Reliability Corporation



Lawrence

whose mission is to identify and mitigate cyber and physical security risks to the North American grid.

David C. Lew has been named administrator of the Nuclear Regulatory Commission's Region I office, and Raymond K.





Lew

Lorson

Lorson has been named deputy administrator. Lew, who joined the NRC in 1987 as a license examiner in the Region II office, most recently served as deputy administrator in Region I. Lorson, who joined the NRC in 1991 as a reactor engineer in Region I, was previously director of the Region I Division of Reactor Projects.

Lee Eckert has joined Flowserve Corporation as senior vice president and chief financial officer. He previously served as senior vice president and CFO at CHC Group, a commercial helicopter service provider to the offshore oil and gas industry.

Charles Rice has joined Entergy Corporation's legal department after serving as president and chief executive officer of Entergy New Orleans LLC. **Rod West**, group president of utility operations for



Non-Tenure-Track Faculty Position in Nuclear Engineering Missouri University of Science and Technology Rolla, Missouri https://mne.mst.edu/

The Mining and Nuclear Engineering Department at Missouri S&T is seeking outstanding applicants for an assistant or associate professor, non-tenure-track faculty position in all areas of nuclear engineering. Preference will be given to applicants who can contribute to the department's areas of strength such as delivery of fundamental and core nuclear science and engineering classes at undergraduate and graduate levels, delivery of instruction mode that embraces innovative teaching/experiential learning, and; deployment of successful distance education/e-learning. Successful candidates will be expected to have strong commitments to (a) high-quality teaching both at the undergraduate and graduate levels, (b) service in the applicant's professional community and our institution, and (c) increasing the diversity of both the student body and faculty. Applicants must hold a Ph.D. in nuclear engineering or a closely related field. Further details on required and desired attributes, skills and characteristics of the successful candidate, and the department's vision and strategic plan, activities, and research may be found at: https://mne.mst.edu/.

Interested candidates should electronically submit their application consisting of: 1) a cover letter, 2) a current curriculum vitae, 3) a teaching statement, 4) a diversity statement, and 5) complete contact information for at least four references to Missouri S&T's Human Resources Office at: http://hr.mst.edu/careers/academic/ using Reference Number **00072965**. Acceptable electronic formats are PDF and MS Word. Applications will be reviewed as they are received and the review of applications will continue until the position is filled. For full consideration, applicants must apply by November 25, 2018. For more information prior to submitting an application, please contact the Search Committee Chair, Ayodeji Alajo, at: alajoa@mst.edu.

Missouri S&T is an AA/EEO employer and does not discriminate on the basis of race color, religion, national origin, sex, sexual orientation, gender identity, gender expression, age, disability or status as a protected veleran. Females, minorities, and persons with disabilities are encouraged to apply. Missouri S&T seeks to meet the needs of dual-career couples. The university participates in E-Verify. For more information on E-Verify, please contact DHS at: 1-888-464-4218. Entergy Corporation, will serve as interim president and CEO of Entergy New Orleans until Rice's successor is named.

Brig. Gen. Ron Allen of the U.S. Air



Force has joined the National Nuclear Security Administration as principal assistant deputy administrator for military application in the Office of Defense Programs. The twoyear assignment involves overseeing stockpile manage-

ment activities, major modernization programs, and the transport of special nuclear materials.

Obituaries

Allen

Walter V. Mosgovoy, 88, ANS member since 1999; born in Belgrade, Yugoslavia; lived in Germany during World War II and emigrated to the United States in 1949; was a second lieutenant in the U.S. Air Force and served as a nuclear research officer; graduated from the University of Colorado at Boulder with a bachelor's degree in engineering physics in 1959; worked at General Electric's Vallecitos Atomic Laboratory in Livermore, Calif., and at Gulf General Atomic in San Diego, Calif.; died July 6.

Theodore Petry, 94; was recruited out of Chicago's Tilden Technical High School



Petry

at age 17 to work as a lab assistant at the University of Chicago; worked with Nobel Prize-winning scientists Arthur Compton and Enrico Fermi to build the graphitemoderated reactor known as Chicago Pile-1; was one of 49

people to witness the world's first selfsustaining nuclear reaction on December 2, 1942; was part of the university contingent that was invited to Washington, D.C., to meet President John F. Kennedy in the Rose Garden, where his former colleagues referred to him as "the baby of CP-1"; later joined the Merchant Marine, made engines for the war effort at the Dodge Chrysler plant, worked as a tool-and-die maker at the Pullman plant, and taught shop classes in the Chicago Public Schools; in December 2017, was recognized as the last surviving witness to the landmark nuclear experiment by the Chicago Tribune and the Washington Post; died July 28. N

PURDUE

FACULTY POSITION SCHOOL OF NUCLEAR ENGINEERING

The School of Nuclear Engineering at Purdue University invites applications for a tenured/tenure-track faculty position at all ranks. Purdue University seeks to attract exceptional candidates with interests and expertise in nuclear power, advanced reactor technology, nuclear materials, fuel cycle and non-proliferation; however, other areas are also considered. Successful candidates must hold a Ph.D. degree in Nuclear Engineering or a related discipline and demonstrate excellent potential to build an independent research program at the forefront of their field, as well as potential to educate and mentor students. The successful candidates will conduct original research, will advise graduate students, will teach undergraduate and graduate level courses, and will perform service both at the School and University levels. Candidates with experience working with diverse groups of students, faculty, and staff and the ability to contribute to an inclusive climate are particularly encouraged to apply.

The School of Nuclear Engineering at Purdue University has experienced significant growth in the past decade and has a strong faculty core engaged in all areas of nuclear engineering as well as significant interdisciplinary efforts across campus, with other academic institutions, and industrial partners. The College of Engineering at Purdue is currently undergoing extensive growth, with an expanding number of faculty that are opening new and exciting research directions. For information on School of Nuclear Engineering, please see at https://engineering.purdue.edu/NE.

Purdue University's School of Nuclear Engineering is committed to advancing diversity in all areas of faculty effort, including scholarship, instruction, and engagement. Candidates should address in their cover letter, their past experiences, current interests or activities, and/or future goals to promote a climate that values diversity and inclusion.

Submit applications online at https://engineering.purdue.edu/Engr/AboutUS/Employment/Applications. Applications must include a cover letter, curriculum vitae, teaching and research plans, and names of at least three references. For information/questions regarding applications contact the Office of Academic Affairs, College of Engineering, at <u>coeacademicaffairs@purdue.edu</u>. Review of applications will begin on October 8, 2018 and will continue until position is filled. A background check will be required for employment in this position.

Purdue's main campus is located in West Lafayette, Indiana, a welcoming and diverse community with a wide variety of cultural activities, events, and industries. Purdue and the College of Engineering have a Concierge Program (<u>https://engineering.purdue.edu/Engr/Concierge</u>) to assist new faculty and facilitate their relocation.

Purdue University is an EOE/AA employer.

All individuals, including minorities, women, individuals with disabilities, and veterans are encouraged to apply.

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A. PRIORI Water, water pretty much everywhere

Science journalists, and science professionals, may believe that they don't get enough attention. It seems as though every news item about a discovery that isn't on this here planet has to be pitched on what it says about the possibility of life somewhere beyond Earth.

This is an angle taken every time a new planet has been found orbiting a distant star. The discovery itself isn't enough there has to be the "is-there-life" discussion. People who make decisions on what is news (who, I imagine, tend not to have science backgrounds) may believe that hints of aliens are sure to get the attention of readers and viewers, either raising hopes that We Are Not Alone or scaring the audience's pants off.

This tendency came up again in the reports this summer of an inferred liquid water lake under the south polar cap of Mars. Yes, liquid water is widely conceded to be a necessary condition for Life as We Know It. (OK, I'll try to dial back the capitalized stuff; as far as I know, *Nuclear News* is not yet able to supply finger-quote emojis.) There's also a pretty good chance that water is the most common chemical compound (made up of more than one element) in the universe. It's very stable and, under terrestrial conditions, has an extremely wide temperature range in which it is liquid.

It should therefore be no surprise to find water in a lot of places where there is solid matter generally (given water's ability to be bound up in hydrates). Also, it should not be concluded that the presence of water guarantees the presence of life.

There was a debate several years ago over whether a different chemical compound methane—occurs on Earth only as a result of the processes of living things (meaning that it is biogenic; you may insert your cattle flatulence joke here if you wish). Over time, enough data were gathered and analyzed to produce a consensus that some methane exists as a result of processes not connected with living things, making it abiogenic. Here again, we're talking about an extremely abundant compound of more than one element. Anything with hydrogen, far and away the most abundant element in the universe, is likely to be abundant, and a simple compound also figures to exist fairly often: two hydrogens and one oxygen for water, four hydrogens and one carbon for methane.

The cases cited above on water and methane are indeed about two different things. In the case of methane, the question was whether it is produced only by life; in the case of water, it is whether it is supporting life any time it is found. In the lake under the Martian surface, it is inferred that the water would be salty (and thus would perhaps contain other ingredients for living things, such as nitrogen, sulfur, and phosphorus). This is something of a "well, duh," because the water is apparently confined in place and in contact with the minerals that surround it. On Earth, pretty much every body of water that doesn't have an outflow becomes, like the open sea, salty. This is true of bodies of water large (the Caspian Sea) and small (the Dead Sea, which is *really* salty). Lake Winnipeg appears to be an exception, because of glacial connections.

There have also been reports this year of more subsurface water on the moon than had been presumed earlier. To me, that's interesting in its own right. Water for a lunar colony? Great. This doesn't have to be related to anything living, because it almost certainly isn't.

I'm reminded of the trend in space exploration about a decade ago to send spacecraft smashing into things, like comets. One was sent to smash into the south pole of the moon to see if there was water ice there. For me, there would have been three potential outcomes: (1) Yes, there is water on the moon (which turned out to be true); (2) No, there is no water on the moon; or (3) Well, there was water on the moon, until some clown crashed a satellite into it and blasted all of the water out into space.—A. Priori

A. Priori is a biogenic by-product of former NN staffer E. Michael Blake; Life as He Knows It is pretty much the same as always, only slower.



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