

Nuclear News

August 2018

24th Annual Vendor/Contractor Profile Issue

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Topical Meeting: Nuclear Fuels and Structural Materials | 114



AT YOUR BOILING WATER REACTOR SERVICE

Westinghouse is a nuclear energy industry leader that supports both boiling water reactor (BWR) and pressurized water reactor (PWR) nuclear plants worldwide with a full array of products and services.

We offer a broad portfolio of BWR-related services, and since 1980, our expert global team has developed experience and technology to meet your BWR plant's needs, including:

- Outage Management Services
- Training
- Refueling
- Engineering
- In-vessel Ultrasonic Inspections
- In-vessel Visual Inspection
- In-vessel and Specialty Tooling
- Under-vessel Services

Westinghouse customers can count on our expertise, experience, delivery, innovative technologies and engineering. For example, Westinghouse conducts training and qualification for BWR work at our full-depth interchangeable BWR mockup in Chattanooga, Tennessee (USA). And we have personnel at locations around the world supplying technology-based and experience-proven products and services to the operating nuclear fleet.

Westinghouse — meeting the Nuclear Promise by helping utilities keep plants running safely, efficiently and effectively for the long term.

Learn more: www.westinghousenuclear.com.

WESTINGHOUSE PROVIDES SIMPLIFIED, COST-EFFECTIVE SOLUTIONS FOR BWR INTERNALS ISSUES

In line with the Nuclear Promise, the industry demands cost-effective, reliable solutions for safe, dependable operations, as well as long-term economic viability.

In line with that same promise and in support of our global customers, Westinghouse is pleased to introduce our new BWR Internals Solutions group — formed to support those same goals and counteract the historical industry experience in costly and delayed BWR internals repairs.

Capitalizing on our specialty tooling and successes in internals inspections technology and delivery, the group provides a simplified, cost-effective approach to drive component repair and replacement, and other technological solutions — including inspections and specialty tooling — to all aspects of BWR internals.

We understand the challenges our customers face as they balance the needs of an aging fleet and consider economic factors. Through our reliable solutions, Westinghouse directly

addresses those challenges with four key methods that support ongoing safe and efficient BWR plant operation. We can help to:

- Maintain the highest level of safety margins
- Make the most of Westinghouse's focused global technology leadership
- Engage a single, lean point of entry to Westinghouse's BWR

- experience and expertise
- Identify the best options for immediate, and long-term savings:
 - Safe and simplified project approach
 - Low installation cost
 - Minimal schedule impact
 - Decreased long-term maintenance and inspection costs



Westinghouse can provide your BWR plant with safe, cost-effective solutions that meet your schedule requirements, such as:

- *Jet Pump Slip Joint Extension (shown above at a test facility), which eliminates current mitigation hardware and does not just mitigate but can solve certain flow-induced vibration issues*
- *Non-cutting Sparger Repair, which can offer overall cost savings in design and installation time, and simplify the amount of equipment required for installation*

Experience Counts

For more than 40 years Westinghouse has been a leader in BWR products and services across the globe. Our BWR Internals Solutions experts are poised to deliver our tested and proven solutions to support your plant needs today and tomorrow.

Learn more: www.westinghousenuclear.com.



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Coming up . . .

September—Special Section on Nonproliferation

October—Outage Management/Plant Maintenance Special Section

December—Special Section on Fuel

Members: View Nuclear News online!

At <www.ans.org>, click on Member Center at the upper right of your screen. Log in with your email address and password (if you haven't already, you can create a password at <account.ans.org>). Click on the heading for the current issue of *Nuclear News*.

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Power 20

Dominion to Connecticut regulators regarding Millstone: "We can't wait." South Carolina Electric & Gas files lawsuit over legislated cuts in electric rates associated with Summer project. NRC considers regulatory revisions for new technologies. Focus on Finance. Arkansas Nuclear One reactors returned to standard NRC oversight. Federal appeals court backs Florida utilities on nuclear cost recovery. Report highlights threats to grid from plant closures in PJM Interconnection region.

Security 27

National Nuclear Security Administration awards Los Alamos National Laboratory M&O contract to newly formed consortium. The NNSA and Morocco sign MOU on nuclear- and radiological-related matters. Radioactive material stolen in Texas still missing a year later. NRC submits annual security inspection report to Congress.

Policy & Legislation 30

Nuclear-related legislation advances in House of Representatives. High-level nuclear advocates send letter to Energy Secretary Perry in support of nuclear power's role in national security.

International 39

China's Taishan-1 EPR is connected to grid. Canadian SMR research cluster attracts U.S. developer. International Energy Agency holds meeting to discuss future of nuclear power. Japan's cabinet approves new Strategic Energy Plan. IAEA reviews readiness of United Arab Emirates' nuclear infrastructure. Britain's Nuclear AMRC signs MOU with China General Nuclear Power Corporation. U.K. government, industry agree on nuclear sector deal.



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Waste Management

117

Demolition of K-633 Test Loop Facility at Oak Ridge Reservation completed. State of Washington approves operating permit for Analytical Laboratory at Hanford's Waste Treatment and Immobilization Plant. EDF and Veolia to cooperate on nuclear power plant decommissioning and radioactive waste management. NRC accepting comments on Exelon's post-shutdown decommissioning activities report for Oyster Creek. Vermont PUC delays decision on sale of Vermont Yankee from Entergy to NorthStar.

Fuel

120

NRC considers request to make Wyoming an agreement state. Restart strategy announced for Honeymoon uranium project in South Australia.

Isotopes & Radiation

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BWXT targets to be irradiated at Ontario Power Generation's Darlington plant to produce molybdenum-99. Canada's Bruce Power and Germany's Isotope Technologies Garching sign MOU to explore production of lutetium-177.

Research

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DOE awards another \$20 million for advanced nuclear projects.

Education, Training & Workforce

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Texas A&M University to lead NNSA-funded CENTAUR research program; University of Michigan hosts University Program Review. United States, Czech Republic host IAEA's 4th annual Intercontinental Nuclear Institute. Exelon opens new employee training center at Quad Cities.

Industry

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Rolls-Royce signs pacts with China's CTEC, Canada's Bruce Power; other business developments. Triad National Security to manage Los Alamos National Laboratory; other contracts. Conval moves into new advanced manufacturing center. AAF Flinders, Fisher Controls issue 10 CFR Part 21 reports.

Standards

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New standard published, comments requested; other actions. ANS answers multipart inquiry on standard.

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GENERAL NUMBER

708/352-6611

Fax 708/352-0499

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708/579-8245

Fax 708/579-8204

nucnews@ans.org

NUCLEAR NEWS ADVERTISING

708/579-8226

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Fax 708/352-6464

www.ans.org/advertising

advertising@ans.org

INTERNATIONAL EDITOR
(DICK KOVAN)

902/455-3575

dkovan@ans.org

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



The past, the present, and the future

The August 1995 issue of *Nuclear News* contained the very first Vendor/Contractor Profile Special Section, with the advertisements and advertorials of 35 companies. This special section—which is in its 24th edition—has been popular with advertisers over the years, and although the number of pages and companies represented has varied (following the trends in the nuclear industry), it remains a valuable venue for relaying information about the products and services provided by the companies that supply the highly specialized nuclear sector. As always, we thank our advertisers—those in this issue and all of the other issues during the year—for their support. If you are a regular advertiser, we thank you for your loyalty; if you are a new advertiser, we welcome you. The 63-page advertising special section featuring 45 companies begins on page 44.

Also in this issue are interviews conducted by Rick Michal, director of Scientific Publications and Standards and former *Nuclear News* senior editor, with the authors of two very different books published by ANS.

The first is a textbook titled *Problems in Elementary Reactor Physics, with Solutions*, in which Eleodor Nichita and his co-author, Benjamin Rouben, present a collection of problems (and their solutions) mainly intended for undergraduate students studying reactor physics, but also for others wishing to review fundamental reactor physics concepts. Among the questions Michal asks Nichita are what inspired him to write the book and how Rouben became involved in the project. Nichita notes that he sees the book as a companion to be used in addition to a textbook in the teaching of a reactor physics course. To read this interview, turn to page 25.

The second book, by Ann Winters, is a biography titled *Underway on Nuclear Power: The Man Behind the Words, Eugene P. "Dennis" Wilkinson, Vice Admiral USN*. The book—published by ANS in 2016—is based on Winters's 33-year friendship with Wilkinson (she was his assistant at the Institute of Nuclear Power Operations) and the stories he loved to tell, augmented by the recollections of more than 50 individuals who had known or worked

with him. Wilkinson's career spanned his time in the Navy, which began during World War II and encompassed his being named the first commanding officer of USS *Nautilus* (SSN-571), the first nuclear-powered submarine, and, following his retirement from the Navy, through his tenure as the first chief executive officer of INPO, which was established following the 1979 accident at Three Mile Island-2. The interview, which was timed for publication in *Nuclear News* to coincide with what would have been the 100th anniversary of Wilkinson's birth on August 10, 1918, begins on page 32.

Nearly 900 attendees at the 2018 ANS Annual Meeting, held June 17–21 in Philadelphia, Pa., heard presentations on developments in advanced reactor designs (including micro-reactors); how those involved in the industry can better communicate the importance of nuclear for, among other things, grid stability and as a clean, emission-free electricity source; the contributions of diversity and inclusion in the workforce to increasing innovation and productivity; and the benefits and challenges facing the development of small modular reactors. Held in conjunction with the Annual

Meeting was the Topical Meeting on Nuclear Fuels and Structural Materials for Next Generation Nuclear Reactors, sponsored by the ANS Materials Science and Technology Division. *Nuclear News* editors were there to cover both of these meetings, and their reports begin on pages 107 and 114, respectively.

At the Annual Meeting's opening plenary session, ANS President Bob Coward reminded the audience of his remarks at the 2017 Winter Meeting that despite the difficulties the nuclear industry continues to face, it is important to remain optimistic. He noted that although the world has changed since the first nuclear power plants were built, the future is bright, just in a different way. With the younger generation entering the industry and their enthusiasm—together with the legacy of the industry pioneers and the experience and knowledge of the current workforce—for developing the next generation of advanced reactor designs, I wholeheartedly agree.—*Betsy Tompkins, Editor and Publisher*

Based on the legacy of those who laid the foundation, the experience and knowledge of those who have been in the industry for many years, and the enthusiasm of those who are just coming up, it appears that there is good reason to be optimistic about the future of nuclear—despite the challenges it faces.



We've already met.

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August

Aug. 20–23 **2018 Long-Term Stewardship (LTS) Conference**, Grand Junction, Colo. Sponsored by the U.S. Department of Energy's Office of Legacy Management. Contact: Nicole Gordon, Navarro Research and Engineering, phone 970/248-6327; email <nicole.gordon@lm.doe.gov>; Web <www.lm.doe.gov/2018lts-conference/index.html>.

Aug. 20–23 **EPRI Nuclear Instrumentation and Control Technical Forum**, Charlotte, N.C. Sponsored by the Electric Power Research Institute. Contact: Robert Austin, EPRI, phone 704/595-2529; email <raustin@epri.com>; Web <www.epri.com>.

Aug. 21–23 **Regulatory Affairs Forum**, Bethesda, Md. Sponsored by the Nuclear Energy Institute. Contact: Denise Bell, NEI, phone 202/739-8039; email <conferences@nei.org>; Web <www.nei.org>.

Aug. 26–31 **20th Topical Meeting of the Radiation Protection and Shielding Division**, Santa Fe, N.M. Sponsored by the ANS Radiation Protection and Shielding Division and the Trinity section. Contact: Avneet Sood, Los Alamos National Laboratory, phone 505/661-8591; email <sooda@lanl.gov>; Web <http://rpsd2018.ans.org>.

Aug. 28–31 **International Conference on Technological Innovations in Nuclear Civil Engineering**, Paris, France. Sponsored by the Société Française d'Energie Nucléaire. Contact: SFEN Event Team, phone +33 1 53 58 32 12; email <tince2018@sfen.org>; Web <www.sfen-tince2018.org>.

September

Sept. 4–6 **RadWaste Summit**, Henderson, Nev. Organized by RadWaste Monitor. Contact: Kristy Keller, ExchangeMonitor Publications & Forums, phone 301/354-1779; email <kkeller@exchangemonitor.com>; Web <www.radwastesummit.com>.

Sept. 5–6 **Workshop on Non-Destructive Evaluation (NDE) for Materials Characterization**, Charlotte, N.C. Sponsored by the Electric Power Research Institute. Contact: Maria Guimaraes,

EPRI, phone 704/595-2708; email <mguimaraes@epri.com>; Web <www.epri.com>.

Sept. 5–7 **World Nuclear Association Symposium 2018**, London, England. Organized by WNA. Contact: Sharan Gallagher, WNA, phone +44 0 20 7451 1521; email <events@world-nuclear.org>; Web <www.wna-symposium.org>.

Sept. 9–14 **21st International Conference on Water Chemistry in Nuclear Reactor Systems**, San Francisco, Calif. Sponsored by the Electric Power Research Institute. Contact: Linda Nelson, EPRI, phone 828/318-8428; email <lnelson@toplanahead.com>; Web <www.epri.com>.

Sept. 9–14 **Plutonium Futures—The Science 2018**, San Diego, Calif. Sponsored by the ANS Materials Science and Technology Division. Contact: Franz Freibert, Los Alamos National Laboratory, phone 505/667-6879; email <freibert@lanl.gov>; Web <http://pu.ans.org>.

Sept. 10–13 **27th International Conference on Nuclear Energy for New Europe (NENE 2018)**, Portorož, Slovenia. Sponsored by the Nuclear Society of Slovenia and the Jožef Stefan Institute's Nuclear Training Centre. Contact: NENE 2018, phone +386 1 588 53 02; email <nene2018@ijs.si>; Web <www.nss.si/nene2018/>.

Sept. 10–13 **Nuclear Energy for the People**, Nessebar, Bulgaria. Sponsored by the Bulgarian Nuclear Society (BgNS), the European Nuclear Society, and others. Contact: Mariana Atanasova, BgNS, phone +359 878 285525; email <secretariate@bgns.bg>; Web <www.bgns.bg>.

Sept. 16–21 **18th International Conference on Electromagnetic Isotope Separators and Related Topics (EMIS 2018)**, Geneva, Switzerland. Hosted by ISOLDE, the isotope mass separator on-line facility at CERN. Contact: EMIS 2018, email <emis2018@cern.ch>; Web <https://indico.cern.ch/event/616127/>.

Sept. 16–21 **Probabilistic Safety Assessment and Management Conference (PSAM 14)**, Los Angeles, Calif. Sponsored by the B. John Garrick Institute for the Advancement of the Risk Sciences and cosponsored by ANS. Contact: David Johnson, ABS Consulting, phone 714/734-2507; email <djohnson@absconsulting.com>; Web <www.psam14.org>.

Continued

- First time listed, or significant change made.
- ANS event.
- Non-ANS event cosponsored by ANS.

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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Sept. 17–19 **4th International Conference on Physics and Technology of Reactors and Applications (PHYTRA4)**, Marrakech, Morocco. Organized by the Moroccan Association for Nuclear Engineering and Reactor Technology and others, including ANS. Contact: L. Erradi, Mohammed V. Agdal University, email <erradi@hotmail.com>; or J. Tajmouati, University Sidi Mohamed Ben Abdellah, email <jatajm@yahoo.fr>; Web <www.phytra4.gmtr.ma>. □

Sept. 17–20 **International Symposium on the Contribution of Materials Investigations and Operating Experience to Light Water NPPs' Safety, Performance, and Reliability (FONTEVRAUD 9)**, Avignon, France. Organized by the French Nuclear Energy Society (SFEN). Contact: SFEN, phone +33 1 53 58 32 12; email <fontevraud9@sfen.org>; Web <www.sfen-fontevraud9.org>.

Sept. 17–21 **62nd IAEA General Conference**, Vienna, Austria. Organized by the International Atomic Energy Agency. Contact: IAEA, phone +43 1 2600 0; fax +43 1 2600 7; email <gc-contact-point@iaea.org>; Web <www.iaea.org/about/policy/gc/gc62>.

Sept. 18–19 **IAEA Scientific Forum 2018**, Vienna, Austria. Organized by the International Atomic Energy Agency. Contact: IAEA, phone +43 1 2600 0; fax +43 1 2600 7; email <gc-contact-point@iaea.org>; Web <www.iaea.org/about/policy/gc/gc62/events/scientific-forum/programme>.

Sept. 23–27 **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>. ■

Sept. 26–28 **44th Annual Meeting of the Spanish Nuclear Society (SNE)**, Ávila, Spain. Sponsored by SNE. Contact: SNE, phone +34 91 308 63 18; fax +34 91 308 63 44; e-mail <reunionanual@sne.es>; Web <www.reunionanualsne.es/en>.

Sept. 30–Oct. 3 **6th International Conference on Nuclear and Renewable Energy Resources (NURER 2018)**, Jeju, South Korea. Sponsored by the Korean Advanced Institute of Science and Technology, Near East University, ANS, and others. Contact: NURER 2018, phone +82 42 472 7460; fax +82 42 472 7459; email <nurer2018@nurer2018.org>; Web <http://nurer2018.org>. □

Sept. 30–Oct. 3 **Applicability of Radiation-Response Models to Low Dose Protection Standards**, Pasco, Wash. Sponsored by the ANS Nuclear Installation Safety Division and the ANS Eastern Washington section. Contact: Alan Waltar, phone 509/548-5272; email <alan.waltar@gmail.com>; Web <www.anseasternwashington.org/lowdose-2018.html>. ■

Sept. 30–Oct. 5 **Pacific Basin Nuclear Conference (PBNC 2018)**, San Francisco, Calif. Sponsored by the ANS Operations and Power and Fuel Cycle and Waste Management Divisions. Contact: Don Eggett, Eggett Consulting LLC 2, phone 815/370-4846; email <don.eggett@gmail.com>; or Mimi Limbach, Potomac Communications Group, 202/466-7391; email <mlimbach@pcgpr.com>; Web <http://pbnc.ans.org>. ■

October

Oct. 1–2 **Nuclear Decommissioning and Used Fuel Strategy Summit**, Charlotte, N.C. Organized by Nuclear Energy Insider. Contact: Charlotte Howlett, Nuclear Energy Insider, phone +44 0 20

7375 7182; email <chowlett@nuclearenergyinsider.com>; Web <www.nuclearenergyinsider.com/nuclear-decommissioning-used-fuel/>.

Oct. 1–5 **International Symposium on Communicating Nuclear and Radiological Emergencies to the Public**, Vienna, Austria. Organized 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/events/cnrep2018>.

Oct. 8–11 **11th International Workshop on the Application of FPGAs in NPPs**, Dallas, Tex. Sponsored by Curtiss-Wright and RPC Radiy. Contact: Mark Burzynski, SunPort, email <m.burzynski@sunport.ch>; Web <www.sunport.ch/11thfpga>.

Oct. 8–12 **5th International Workshop on Nuclear Data Evaluation for Reactor Applications (WONDER 2018)**, Aix-en-Provence, France. Organized by the Commissariat à l'Energie Atomique et aux Energies Alternatives (CEA). Contact: CEA, phone +33 0 4 42 25 31 30; email <sprcleph@cea.fr>; Web <https://indico.cern.ch/event/701026/>. ●

Oct. 14–18 **12th International Topical Meeting on Nuclear Reactor Thermal-Hydraulics, Operation, and Safety (NUTHOS-12)**, Qingdao, China. Organized by the Chinese Nuclear Society and sponsored by the International Atomic Energy Agency, ANS, and others. Contact: NUTHOS-12, email <info@nuthos-12.org>; Web <www.nuthos-12.org>. □

Oct. 14–18 **Nuclear Materials Conference (NuMat2018)**, Seattle, Wash. Organized by Elsevier. Contact: Janet Seabrook, Elsevier, phone +44 0 1392 285868; email <jm.seabrook@elsevier.com>; Web <www.elsevier.com/events/conferences/the-nuclear-materials-conference>.

Oct. 15–18 **International Conference on Challenges Faced by Technical and Scientific Support Organizations (TSOs) in Enhancing Nuclear Safety and Security**, Brussels, Belgium. Organized 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 <https://www-pub.iaea.org/iaea-meetings/2018>.

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 <patricia.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. 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@



Plutonium Futures—The Science 2018

A Topical Conference on Plutonium and Actinides

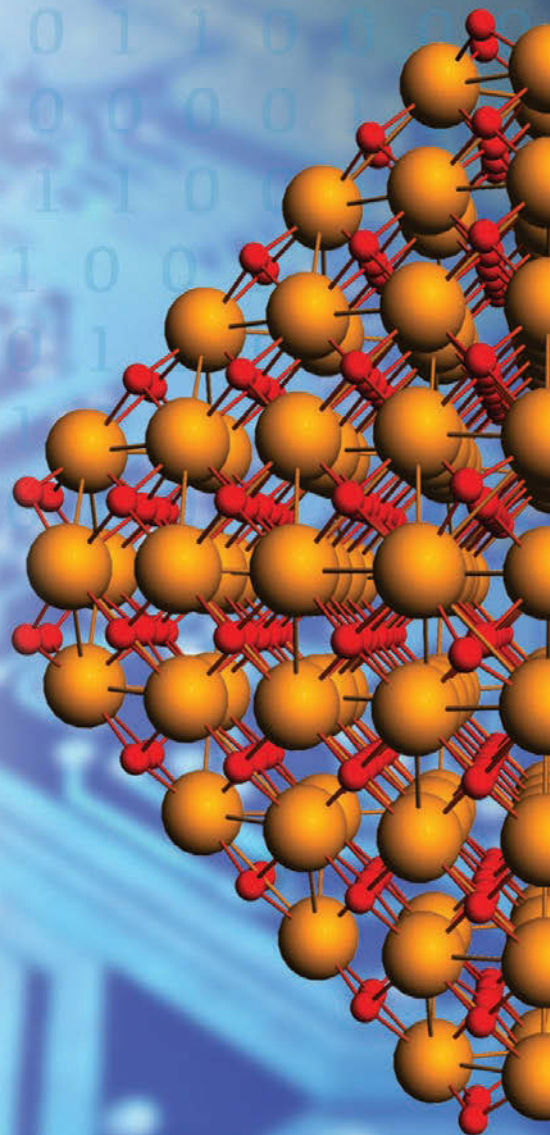
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- Plutonium and actinide chemistry
- Detection and speciation analysis
- Environmental science
- Fuel-cycle issues



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October—continued

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 Multi-purpose 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@nuclear-training.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. 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 Regulatory 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

Managing Risk in the National Critical Infrastructure

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at the Hilton Washington DC/Rockville Hotel & Executive Meeting Center

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November—continued

Lindsay, NRC, phone 301/415-0616; email <haile.lindsay@nrc.gov>; Web <www.nrc.gov/public-involve/conference-symposia/dsfm.html>.

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. 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>.

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 Education (CONTE 2019)**, St. Augustine, Fla. Sponsored by the ANS Education, Training and Workforce Development Division. Contact: Russ Godwin, Southern Company, email <frgodwin@southernco.com>; Web <http://conte.ans.org/>. ■●

Feb. 9–14 **11th 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://npic-hmit.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>. ■●

And coming up (ANS meetings) . . .

International High-Level Radioactive Waste Management 2019 (IHLRWM 2019), Apr. 14–18, 2019, Knoxville, Tenn.

2019 International Topical Meeting on Probabilistic Safety Assessment and Analysis (PSA 2019), Apr. 28–May 3, 2019, Charleston, S.C.

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

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.

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

Technology of Fusion Energy (TOFE) 2020, Apr. 19–24, 2020, Charleston, S.C.

2020 ANS Annual Meeting, June 7–11, 2020, Phoenix, Ariz.

Calls for Papers

International High-Level Radioactive Waste Management Conference (IHLRWM 2019), Apr. 14–18, 2019, Knoxville, Tenn. Sponsored by the ANS Fuel Cycle & Waste Management Division and the Oak Ridge/Knoxville local section. **Deadline for abstracts: Oct. 5.** Author notification: Oct. 22. Draft papers due: Jan. 7, 2019. Author notification: Jan. 28, 2019. Full papers due: Feb. 11, 2019. Submit abstracts per the instructions at <http://ans.org/meetings/ihlrmw>.

Conference on Nuclear Training and Education (CONTE 2019), Feb. 5–7, 2019, St. Augustine, Fla. Sponsored by the ANS Education, Training and Workforce Development Division. **Deadline for summaries: Oct. 6.** Author notification: Nov. 3. Revised summaries due: Nov. 17. PPT slides due: Dec. 1. Revised PPT slides due: Dec. 15. Submit abstracts per the instructions at <http://conte.ans.org/call-for-papers/>.

International Conference on Mathematics and Computational Methods Applied to Nuclear Science and Engineering (M&C 2019), Aug. 25–30, 2019, Portland, Ore. Organized by the ANS Mathematics & Computation Division and hosted by the Idaho local section. **Deadline for extended summaries: Oct. 15.** Author notification: Dec. 17. Full papers due: Feb. 18, 2019. Submit abstracts per the instructions at <www.mc2019.org/paper-formatting-instructions>.

18th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH-18), Aug. 18–22, 2019, Portland, Ore. Sponsored by the ANS Thermal Hydraulics Division and hosted by the Eastern Washington local section. **Deadline for abstracts: Nov. 19.** Author notification: Dec. 19. Draft papers due: Mar. 1, 2019. Full-paper review notification: May 1, 2019. Full papers due: June 3, 2019. Submit abstracts per the instructions at <http://ans.org/meetings>. **NN**



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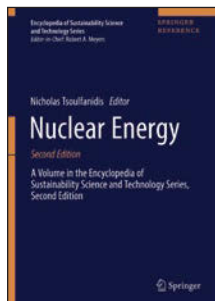
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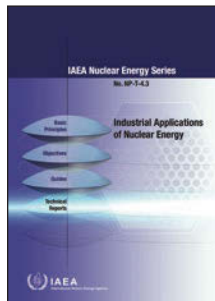
—Katie Mummah, Graduate Research Assistant, Nuclear Engineering & Engineering Physics, University of Wisconsin-Madison

Recently Published



Nuclear Energy, Second Edition, edited by Nicholas Tsoulfanidis. A volume in Springer's Encyclopedia of Sustainability Science and Technology Series, this book, edited by an ANS Fellow, is an authoritative reference on all aspects of the nuclear energy enterprise for both fission and fusion reactors. Featuring 22 peer-reviewed chapters by recognized authorities in the field, *Nuclear Energy* provides concise yet comprehensive coverage of fundamentals, current areas of research, and goals

for the future. Topics range from fundamental reactor physics calculations, reactor design, nuclear fuel resources, and the nuclear fuel cycle to radiation detection and protection and the economics of nuclear power. All chapters have been updated from the first edition, and new chapters on small modular reactors and medical applications of radioisotopes have been added. As each chapter was written by an acknowledged expert in the area, the text is accurate and up-to-date and will appeal to a broad audience of undergraduate and graduate students, researchers, and energy industry experts. (438 pp., HB, \$299, ISBN 978-1-4939-6617-2; eBook, \$299, ISBN 978-1-4939-6618-9; or HB and eBook, \$449, ISBN 978-1-4939-6619-6. Order from Springer International Publishing: phone 212/460-1500; fax 212/460-1700; email <customerservice@springernature.com>; Web <www.springer.com>.)



Industrial Applications of Nuclear Energy, IAEA Nuclear Energy Series No. NP-T-4.3. This International Atomic Energy Agency publication provides an overview of the potential use of nuclear energy for industrial systems and/or processes that require large amounts of process heat and power and of the mapping of nuclear power reactors proposed for various industrial applications. It describes the technical concepts for combined nuclear-industrial complexes that are being

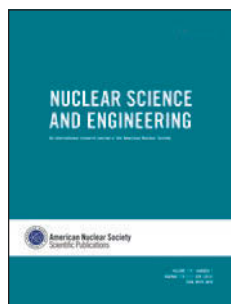
pursued in various IAEA member states and presents the concepts that were developed in the past to be applied in connection with some major industries. It also provides an analysis of the energy demand in various industries and outlines the potential that nuclear energy may have in major industrial applications, such as process steam for oil recovery and refining, hydrogen generation, and steel and aluminum production. The intended audience includes professionals in academia, industry, and government agencies. (80 pp., PB, €59 [about \$68.90], ISBN 978-92-0-101417-7, or PDF, free download. Order from the IAEA: phone +43 1 2600 22529; fax +43 1 2600 29302; email <sales.publications@iaea.org>; Web <www-pub.iaea.org/books>.)

Review of the Analysis of Supplemental Treatment Approaches of Low-Activity Waste at the Hanford Nuclear Reservation: Review #1, by the National Academies of Sciences, Engineering, and Medicine; Division on Earth and Life Studies; Nuclear and Radiation Studies Board; Committee on Supplemental Treatment of Low-Activity Waste at the Hanford Nuclear Reservation. The Hanford Nuclear Reservation was established in 1943 as part of the



Manhattan Project and tasked with the mission of producing plutonium for nuclear weapons. During 45 years of operations, the site produced about 67 metric tons of plutonium—approximately two-thirds of the nation's stockpile. Production processes generated radioactive and other hazardous wastes and resulted in airborne, surface, subsurface, and groundwater contamination. Currently, 177 underground tanks contain about 210 million liters (about 56 million gallons) of waste. The chemically complex and diverse waste is difficult to manage and dispose of safely. The National Defense Authorization Act for Fiscal Year 2017 called for the establishment of a federally funded research and development center (FFRDC) to conduct an analysis of approaches for treating the portion of low-activity waste at Hanford intended for supplemental treatment. This report, the first of four, reviews the analysis carried out by the FFRDC. It evaluates the technical quality and completeness of the methods used to conduct the risk, cost benefit, schedule, and regulatory compliance assessments and their implementations; waste conditioning and supplemental treatment approaches considered in the assessments; and other key information and data used in the assessments. (54 pp., eBook, \$34.99, ISBN 978-0-309-47515-0, or PDF, free download. Order from the National Academies Press: phone 800/624-6242; fax 202/334-2451; email <Customer_Service@nap.edu>; Web <www.nap.edu>.)

ANS Technical Journals



Nuclear Science and Engineering

August 2018

Discontinuous Finite Element Quasi-Diffusion Methods D. Y. Anistratov, J. S. Warsa

Discrete Eigenvalues of Case Spectrum with Anisotropic Scattering D. C. Sahni, R. G. Tureci

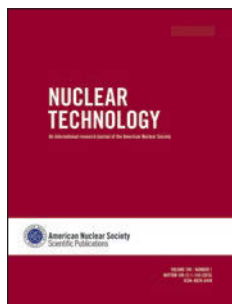
Convergence Studies on Nonlinear Coarse-Mesh Finite Difference Accelerations for Neutron Transport Analysis H. T. Kim, Y. Kim

Activation Measurements of Cross Sections for Ground and Isomeric States Production in Neutron Threshold Reactions on Y and Au P. Chudoba et al.

Studies on Reactivity Coefficients of Thorium Based Fuel (Th-²³³U) O₂ with Molten Salt (Flibe) Cooled Pebble I. Singh et al.

Concept of Stationary Wave Reactor with Rotational Fuel Shuffling K. Kuwagaki et al.

MULTI-PRED: A Software Module for Predictive Modeling of Coupled Multi-Physics Systems D. G. Cacuci et al.



Nuclear Technology

August 2018

Experimentally Known Properties of U-10Zr Alloys: A Critical Review D. E. Janney, S. L. Hayes

Safety Analysis of a 300-MW(electric) Offshore Floating Nuclear Power Plant in Marine Environment Y. Zhang *et al.*

Simulations of Pressure-Tube-Heavy-Water Reactor Cores Fueled with Thorium-Based Mixed-Oxide Fuels A. V. Colton, B. P. Bromley

Steady-State Subchannel Thermal-Hydraulic Assessment of Proposed Thorium Fuel Designs A. Nava Dominguez, Y. F. Rao

Numerical Study of Integral Inherently Safe Light Water Reactor

in Case of Inadvertent DHR Operation Based on the Multiscale Method M. Wang *et al.*

Preliminary Waste Characterization Measurements in FiR 1 TRIGA Research Reactor Decommissioning Project A. Rätty *et al.*



Fusion Science and Technology

July–August 2018

Selected papers from the Second IAEA Technical Meeting on Fusion Data Processing, Validation, and Analysis

This special issue includes 17 papers selected from the IAEA-TM2017 conference.



At the ANS Nuclear Cafe . . .

A Savannah story

Posted on July 13, 2018

By Will Davis

July 21 will bring with it another anniversary of the 1959 launching of the only U.S.-built nuclear powered commercial ship, NS *Savannah*. We've covered the ship fairly well here at ANS Nuclear Cafe over the years, so perhaps it's time for a story about the ship that's practically unknown. Did you know *Savannah* was pioneering in another way . . . with respect to uprates? That's right. The nuclear plant on *Savannah* was uprated!

The problem

When NS *Savannah* was designed and constructed, it was built to a set of predetermined requirements for performance. Most importantly, the ship was required to produce 20,000 shaft horsepower (SHP) continuously, and 22,000 SHP on overload. The normal full-power rating was achieved by the remotely operated throttle, whose controller was on the main control console; achievement of "overload" power required an operator to manually open a valve on the HP turbine throttle body itself.

What happened during the early operations was this: It was discovered that the ship's electrical and "house" steam requirements were in excess of the original planned amounts; this placed a restriction on total power that the plant could devote to propulsion, with the result being that the 22,000 SHP contractually mandated overload was not at all times



achievable without attempting to cut other loads.

The plant needed increased steam flow—and for that, it would need to have more power from the reactor. The reactor was originally rated for a maximum power of 70 MWt, with an operating limit of 69 MWt and a "normal" operating power of 64.7 MWt. If these limits were not addressed, the ship would not meet its original contractually stipulated performance.

The solution(s)

As it turns out, the reactor protection analysis (RPA) performed on the core by Babcock & Wilcox, the company responsible for it as well as the whole nuclear steam supply system and the instrumentation and control, was in some ways far overdone (as was the design of the NSSS and core). Steady-state analysis of the core design by that company's engineers had been carried out, analytically that is, up to levels of ~114 MWt. What was required, then, in way of the core itself was not really a completely new RPA, but rather a restating of the approximation at a new, higher power level to the important limits (such as PCT, or peak centerline temperature, of the fuel).

It was shown that a new core operating power limit of 80 MWt would provide the required increase in thermal energy input to the two steam generators to then get the increased steam flow that would be needed to achieve the full 22,000 SHP requirement with maximum "house loads" on the plant.

This is an excerpt from an article posted at the ANS Nuclear Cafe. Read the complete article at:
<http://ansnuclearcafe.org/2018/07/13/a-savannah-story/>

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► **THE MERGER OF DOMINION AND SCANA WAS APPROVED BY FERC** on July 12. The Federal Energy Regulatory Commission said that the merger, proposed as SCANA faces financial and legal fallout from the July 2017 cancellation of the Summer-2 and -3 AP1000 reactors, “is consistent with the public interest.” In response, Thomas Farrell, Dominion Energy’s chairman, president, and chief executive officer, said, “We are pleased with the FERC’s considered and timely action. . . . We will continue working toward achieving the other required regulatory approvals and completing our transaction by the end of this year.” The merger must still be approved by SCANA shareholders, the public service commissions of South Carolina and North Carolina, and the Nuclear Regulatory Commission. According to Farrell, the South Carolina legislature’s June 27 vote to cut SCANA subsidiary South Carolina Electric & Gas Company’s (SCE&G) electricity rates by 15 percent (see page 20) had jeopardized Dominion’s acquisition of SCANA and the \$1,000 refunds it has promised customers of SCE&G.

Meanwhile, on July 13, SCE&G released additional documents related to the Summer project that had been requested by the South Carolina Office of Regulatory Staff while withholding others and claiming that all documents should be treated as confidential. Many of the documents concern an analysis of the construction project before the reactors were canceled. On July 25, according to reports published in the *Post and Courier* and the *State*, attorneys for SCE&G argued before Judge John Hayes III, of the South Carolina Circuit Court, that all documents it shares in the course of ongoing lawsuits should be kept confidential, despite the fact that some parties in the lawsuits are agencies subject to the state’s Freedom of Information Act.

■ Santee Cooper, SCE&G’s partner in the canceled Summer project, announced on July 23 that it will maintain parts for the reactors through the end of 2018. Fluor Enterprises has been contracted to preserve and document high-value equipment at the site while Santee Cooper seeks a buyer for the parts.

THE COMMERCE DEPARTMENT IS INVESTIGATING U IMPORTS,

Commerce Secretary Wilbur Ross announced on July 18. According to the department, the investigation into whether the present quantity and circumstances of uranium ore and uranium product imports threaten national security will “canvass the entire uranium sector, from the mining industry through enrichment, defense, and industrial consumption.” On January 16, two U.S. uranium mining companies, Ur-Energy and Energy Fuels, filed a petition requesting an investigation into imports of uranium ore and products (*NN*, Feb. 2018, p. 18). The petition seeks a quota on imports of uranium, effectively reserving 25 percent of the U.S. nuclear market for U.S. producers, and proposes a requirement for federal utilities and agencies to buy U.S. uranium.

“Our production of uranium necessary for military and electric power has dropped from 49 percent of our consumption to 5 percent,” Ross said. “The Department of Commerce’s Bureau of Industry and Security will conduct a thorough, fair, and transparent review to determine whether uranium imports threaten to impair national security.” On July 18, Ross sent a letter to Secretary of Defense James Mattis informing him of the initiation of the investigation, as required by Section 232 of the Trade Expansion Act of 1962.

A LEAK AT THE COLUMBIA FUEL FABRICATION FACILITY (CFFF) in Columbia, S.C., was reported to the South Carolina Department of Health and Environmental Control on July 12. According to an event notification report posted on the Nuclear Regulatory Commission’s website on July 20, “An equipment issue was noted on July 10 during ongoing maintenance activities to repair the liner associated with Hydrofluoric Acid Spiking Station No. 2 in the conversion process area of the Columbia plant. While the polypropylene liner was removed for repair work, a crack was noticed in the epoxy coating covering the diked area at the spiking station. Upon further investigation, a hole approximately 3 inches in diameter was found penetrating the concrete floor and into the soil beneath. Measurements taken reflect the depth of the hole as approximately 6 feet into the soil.” Soil samples were obtained on July 11, and the results of the soil analysis revealed that the highest measurements of uranium and fluoride were 4,000 ppm and 24 ppm, respectively, with a pH of 2.84. The spiking station remains out of service, and a metal plate has been placed over the hole as an interim measure while the closest down-gradient well is monitored and repairs are made. Tests later revealed that no uranium contamination within the soil seeped into the shallow groundwater, according to the South Carolina Department of Health and Environmental Control.

Westinghouse Electric Company, the owner of the CFFF, is currently awaiting the NRC’s decision on its application for the renewal of its source materials license for the facility (see page 120).

HOLTEC’S APPLICATION TO BUILD A SPENT FUEL FACILITY in New Mexico has been opened to the public by the Nuclear Regulatory Commission. A notice

Late News This Month

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of opportunity to request a hearing or to petition for leave to intervene was published in the July 16 *Federal Register*, with a deadline of September 14. Holtec International submitted its license application for a consolidated interim storage facility (CISF) for commercial spent nuclear fuel in March 2017. The company intends to initially store 500 canisters holding approximately 8,680 metric tons of spent fuel, and to eventually store up to 10,000 canisters at the CISF, located about halfway between Carlsbad and Hobbs, N.M. The NRC began its environmental review of the application in March (NN, May 2018, p. 52). Further information is available on the federal rulemaking website, at <www.regulations.gov>, with a search for Docket ID NRC-2018-0055.



Yangjiang: Unit 5 began commercial operation on July 12. (Photo: CGN)

► **CHINA'S YANGJIANG-5 BEGAN COMMERCIAL OPERATION** on July 12 after completing a 168-hour trial operation at full capacity, according to China General Nuclear Power Corporation (CGN). Construction of Yangjiang-5, which is CGN's first nuclear unit built to its ACPR1000 design, commenced on September 18, 2013. The reactor attained initial criticality on May 16, 2018, and was connected to the grid on May 23. It is the first CGN nuclear unit to go on line in 2018 and is the company's 21st reactor in commercial operation.

The ACPR1000 design is a third-generation nuclear technology based on CGN's second-generation CPR1000+ design, which evolved from the Framatome technology imported to China in the 1980s for the Daya Bay nuclear station. According to CGN, the more advanced ACPR1000 provides technical improvements on 31 items based on previous designs and meets up-to-date technical safety standards.

Yangjiang-5 also features the first domestically developed nuclear-grade distributed control system (DCS), called FirmSys. Until now, China has relied on importing DCS systems, which are critical for ensuring safe reactor shutdown and accident mitigation. FirmSys is China's first nuclear safety DCS platform with independent intellectual property rights. The technology was developed by China Techenergy Company, a subsidiary of CGN, in 2010, making China the fourth country to have mastered this core technology, following France, Japan, and the United States. In addition to being installed in many new projects, including the Shidao Bay high-temperature reactor, FirmSys is expected to replace systems at plants now in service.

AN EFFORT TO REMOVE THE NNSA FROM DOE OVERSIGHT was abandoned in the wake of opposition from Trump administration officials and lawmakers from both parties. A provision in a defense bill floated by the Senate Armed Services Committee, S. 2987, would have taken direct control of the National Nuclear Security Administration away from the Department of Energy. The provision, which would thus have removed the NNSA from the authority of Energy Secretary Rick Perry, was officially dropped from the bill on July 23.

The White House had issued a statement on June 26, saying, "The administration strongly objects to elements of section 3111 [of S. 2987] because it would fundamentally alter the relationship between the DOE and the NNSA by stripping the secretary of energy of the capacity to supervise some of the most sensitive national security programs in the DOE, yet leaving the ultimate responsibility for NNSA's actions with the secretary." The NNSA also opposed the change, saying that it could lead to "unnecessary duplication of effort at NNSA for work already being carried out by DOE."

For its part, the Senate Armed Services Committee pointed to the Augustine-Mies Panel in 2014, the bipartisan Congressional Commission on the Strategic Posture of the United States in 2009, and a 2007 Government Accountability Office report to support its proposal. All three recommended divorcing the NNSA from the DOE. "The committee is frustrated that so many reports, studies, and panels have come to the same conclusions for more than 15 years, yet no structural change has been implemented," the committee stated.

THE DOE WANTS TO BEGIN STABILIZING PUREX TUNNEL 2 at the Hanford Site before Washington state has finished gathering public comments on the project. In a letter dated July 12, Doug Shoop, manager of the Department of Energy's Richland Operations Office, asked the Washington State Department of Ecology (WSDE) for temporary authorization to begin grouting Tunnel 2 of the Plutonium Uranium Extraction (PUREX) Plant at Hanford. Tunnel 2, along with PUREX Tunnel 1, contains railcars filled with contaminated pieces of plutonium processing equipment from the PUREX plant. In 2017, engineered grout was injected into Tunnel 1 to stabilize the structure following a partial collapse of the tunnel (NN, Nov. 2017, p. 37). The DOE determined that Tunnel 2 was also at high risk of collapse and that filling the tunnel with grout is the best method for stabilizing the 54-year-old structure. The DOE had previously submitted a permit change request to Washington for the grouting of Tunnel 2 and had held a public comment period on the proposal from February

Continued on page 123

GOOD NEWS FOR MILLSTONE

arrived on July 31, when Connecticut's Department of Energy and Environmental Protection (DEEP) issued its final request for proposals on zero-carbon energy contracts, stating that "at-risk" resources will be eligible to bid in June 2022—or earlier, if immediate risk can be proven—rather than having to wait until June 2023 (see page 20).

During an August 1 second-quarter earnings call for analysts, Dominion Energy Chief Executive Officer Thomas Farrell said that the company is "pleased that DEEP acknowledged that an existing resource that is determined to be at risk should have all its attributes valued now. We expect Millstone to be granted at-risk status, which means its bids will be judged on price and non-price attributes such as carbon, economic impact, and fuel security." (Also see NN, July 2018, p. 15.)

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MILLSTONE

Utility to state regulators: “We can’t wait”

Dominion urges the Connecticut Department of Energy and Environmental Protection to move up its timeline for allowing at-risk facilities to compete for zero-carbon energy contracts.

Dominion Energy issued a warning to the state of Connecticut in early July regarding the future of its Millstone nuclear plant, in response to a June draft request for proposals (RFP) from the state’s Department of Energy and Environmental Protection (DEEP) that would delay the Waterford, Conn., plant’s eligibility to bid for carbon-free energy contracts for five more years.

“Millstone is at risk now and must face critical business decisions regarding the future, irrespective of the consequences those decisions might have on Connecticut or the New England region,” said Paul Koonce, Dominion’s chief executive officer, in objections filed with DEEP. “We have deferred making these difficult decisions for three years, in good faith. . . . This is clearly not what the governor and the General Assembly envisioned after more than three years of combined legislative and executive work to chart a long-term path for Connecticut to retain the jobs [and the] economic, environmental, and energy security benefits produced around the clock by Millstone power station.”



Koonce

In October 2017, following repeated assertions by Dominion that it was considering the premature retirement of Millstone, Connecticut Gov. Dannel P. Malloy signed a bill empowering state energy officials to allow the plant to compete with other zero-carbon energy sources for fixed-price contracts with state-regulated utilities if deemed in the public interest (NN, Dec. 2017, p. 31). Earlier this year, DEEP and the state’s Public Utilities Regulatory Authority issued a report—based on the “best available public information”—stating that Millstone would likely be economically viable through 2035 under expected market conditions. The report

added, however, that Millstone should be included in Connecticut’s procurement for new and existing zero-carbon generation facilities, provided Dominion could “demonstrate through the submission of credible financial data that [the reactors] are at risk to retire.”

On May 31, Dominion turned over a number of documents—including audited financial statements, revenue and expense histories and forecasts, and tax returns from the last few years—showing, according to the utility, “proof of an unsustainable return on equity with a declining profile” (NN, July 2018, p. 15). Nonetheless, DEEP’s RFP, dated June 22, does not allow designated “at risk” resources to participate in the bidding process until June 1, 2023.

“These plants are hard to come by, and nuclear, coal, oil, and natural gas are shutting down,” said state Rep. Lonnie Reed (D., Branford), cochairwoman of the legislature’s Energy and Technology Committee, in response to the RFP. “I’m very concerned this is being pushed back to 2023. It’s short-sighted and jeopardizing a sustainable base for the near future. We wanted to get ahead and let [Millstone] play in the zero-carbon lane. New York is putting in millions to keep three nuclear plants open. We feel regulators didn’t get the point.”

Public comments on the draft RFP were to be accepted through July 20, and the final RFP was scheduled for release by July 31.

SUMMER

SCE&G files lawsuit over legislated electric rate cut

After months of delays, the South Carolina legislature on June 27 voted to cut rates for customers of South Carolina Electric & Gas and to increase consumer protections by, among other measures, creating a state consumer advocate’s office and giving the Office of Regulatory Staff subpoena power

In its final RFP, DEEP has moved the “at risk time period” in Dominion’s favor. For more details, see Late News, p. 18.



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over utilities. In response, SCE&G filed a lawsuit seeking an injunction to prevent the rate cut.

The long-anticipated legislation is intended to prevent SCE&G customers from paying more for the Summer-2 and -3 AP1000 reactor project, which was canceled by SCE&G and partner Santee Cooper in July 2017. It would temporarily reduce the portion of SCE&G's electric rates associated with the Summer project from 18 percent to about 3.2 percent, which would reduce payments to SCE&G by about \$31 million per month.

In the weeks before the vote, the Senate had passed a 13 percent rate cut, while the House favored an 18 percent cut. The agreed upon rate cut of 15 percent was to be applied retroactively to April 1, and

while it represents a compromise that is short of the 18 percent cut preferred by Gov. Henry McMaster, it was passed by a veto-proof majority.

SCE&G is owned by SCANA Corporation, which on June 27 responded to the legislation by issuing a press release stating that the two companies are evaluating their legal options and that "SCANA and SCE&G believe that the proposed legislation is unconstitutional."

Dominion Energy has offered to acquire SCANA and has promised refunds of \$1,000 to the utility's customers if the merger goes through, but it has warned repeatedly that a rate cut would threaten SCE&G's financial strength and could put an end to the merger plans and the refund offer (NN, May 2018, p. 22). Also on June

27, Dominion Energy's chairman, president, and chief executive officer, Thomas Farrell, issued a statement in response to the legislation. "The South Carolina legislature is playing a high-stakes game where they are gambling with the money of customers and taxpayers," he said. "They are jeopardizing total customer benefits of more than \$12 billion and another \$19 billion in economic activity. . . . All of this for a few headlines and a temporary rate reduction that has good odds of being overturned in court."

On June 29, SCE&G filed a lawsuit in the U.S. District Court for the District of South Carolina, Columbia Division, asking the court to declare the law unconstitutional and to issue an injunction prohibiting the state's Public Service Commission from implementing it. According to SCE&G, "The rate reduction and other aspects of the new law constitute an unlawful taking of private property, deny [SCE&G] due process of law, and constitute an unlawful bill of attainder, all in violation of various provisions of the United States Constitution."

■ On June 28, SCANA Corporation announced that its board of directors had approved a dividend for the second quarter of 2018 of 12.37 cents per share, an 80 percent reduction from the 61.25 cents per share paid in the first quarter. According to SCANA, "The board made this reduction to preserve its options as the company continues to seek a resolution to the recovery of costs for the V. C. Summer new nuclear construction project."

Power Briefs

EXELON INTENDS TO BUY FES'S RETAIL POWER BUSINESS. According to a July 9 filing with the Securities and Exchange Commission, FirstEnergy Solutions—FirstEnergy Corporation's competitive generation subsidiary—has agreed to assign all of its retail electricity and wholesale load-serving contracts, plus certain other related commodity contracts, to Exelon Generation for \$140 million in cash. The deal is expected to close in the fourth quarter of 2018, provided Exelon is the winning bidder in a court-supervised Section 363 bankruptcy auction and the purchase agreement is approved by the bankruptcy court following the auction.

FES, its subsidiaries, and the affiliated FirstEnergy Nuclear Operating Company filed for bankruptcy protection on March 31, just days after announcing that it would close or sell its three nuclear plants over the next three years (NN, Apr. 2018, p. 18).

ROBERT POWELSON WILL LEAVE FERC IN MID-AUGUST to become the president and chief executive officer of the National Association of Water Companies, a water utility trade organization. A member of the Federal Energy Regulatory Commission for only a year (he was confirmed by the Senate on August 4, 2017, and sworn in on August 10), Powelson surprised many in the energy sector on June 28 with the announcement of his impending departure. Since becoming a commissioner, Powelson has been a persistent critic of the Trump administration's efforts to support economically challenged nuclear power and coal plants. For example, in response to Energy Secretary Rick Perry's 2017 proposal to FERC on the subject (NN, Nov. 2017, p. 28), Powelson said, "I did not sign up to go blow up the markets. When that happens, we're done. I'm done." In his parting statement on the FERC website, he said, "It has been the honor of a lifetime to serve our great nation as a FERC commissioner." Until Powelson is replaced, FERC will be left with two Republicans and two Democrats, which could leave the commission split 2–2 on some issues.

THE NRC HAS TERMINATED THE COLS FOR STP-3 AND -4, per a June 22 request from Nuclear Innovation North America, the firm established by NRG Energy and Toshiba in 2008 to build two advanced boiling water reactors at the South Texas Project site. NRG bowed out of the proposed STP expansion in 2011, with Toshiba officially exiting in May of this year (NN, July 2018, p. 41). Notice of the license terminations was published in the July 13 *Federal Register*.

GEORGIA POWER CUSTOMERS RECEIVED A \$25 CREDIT last month, the second of three such credits for the Vogtle nuclear expansion project. A total of \$75 in 2018 bill credits, or \$188 million overall, was approved by the Georgia Public Service Commission as part of its order in December 2017 to continue construction of Vogtle-3 and -4 (NN, Jan. 2018, pp. 17 and 20). According to Georgia Power, the credits are "a direct result of parent guarantee payments for the Vogtle project from Toshiba, available due to the strength of the original contract for the project and protections in place for Georgia electric customers." The third and final credit is scheduled for September.

NRC

Agency mulls regulatory revisions for new tech

The Nuclear Regulatory Commission in late May received a policy issue notation vote paper from staff requesting approval of several significant revisions to the agency's regulatory framework, as well as "approaches to better enable the safe and secure use of new technology in civilian nuclear applications." Specifically, the paper makes the following recommendations to the NRC:

■ Develop an agency-wide process and organizational tools to expand the systematic use of qualitative and quantitative risk and safety insights. This will enable staff to scale the scope of review and the level of detail needed in licensing to make a finding of reasonable assurance of adequate protection of public health and safety, beginning with licensing reviews for reactors.

■ Revise 10 CFR 50.59, "Changes, Tests, and Experiments," and comparable sections, as needed, to allow licensees addi-

tional flexibility to make facility changes without prior NRC approval.

■ Develop a performance-based, technology-inclusive regulation as an alternative licensing approach for non-light-water reactors.

■ Develop a new regulation to define high-level performance-based instrumentation and controls safety design principles

and associated regulatory guidance that documents the acceptable standards for meeting these principles.

In addition, the paper identifies the need for a cultural transformation at the NRC, noting that current regulatory practices can “lead to unnecessary burden evidenced by the expenditure of undue effort on matters of low safety significance across

all technical areas.” With regard to the use of new technologies in existing facilities, the paper states, this burden “can discourage the introduction of technologies that may have safety benefits in the form of improved reliability, and reduced frequency of initiating events and mitigating system malfunctions. For future non-light-water reactors, this results in inefficient licens-



Focus on Finance

By Linda C. Byus

Recognizing nuclear's non-carbon-emitting value

In the United States, nuclear power accounts for nearly 20 percent of total electricity generation and about 60 percent of carbon-free generation. But instead of being valued as an essential component of the energy supply system, the nuclear power industry continues to shrink. The nuclear industry has failed to gain recognition as a large-scale and reliable clean energy technology.

As a result of the bankruptcy filing by FirstEnergy Solutions—the competitive generation subsidiary of FirstEnergy Corporation—and subsequent political maneuvering, the future of the company's nuclear fleet has been caught up in a high-profile financial bailout fight. Unfortunately, the value of the nuclear fleet as non-carbon-emitting generation may not be recognized.

In late March, FirstEnergy Corporation announced that as a result of “market challenges,” the company would close Beaver Valley-1 and -2, Davis-Besse, and Perry. Altogether, the four units provide 4,048 MW of generating capacity and have over 2,300 employees. The announced plan calls for the shutdown of the Davis-Besse plant by May 31, 2020. The Perry plant and one of the Beaver Valley units would be shut down by May 31, 2021, and the other Beaver Valley unit by October 31, 2021. The plants operate within the PJM Interconnection mar-

ket and are not price competitive within that market.

At the same time that the company announced its intention to shut down its nuclear plants, FirstEnergy asked the Department of Energy to issue an immediate emergency order to grid operator PJM Interconnection to provide “just and reasonable” compensation to its fleet of aging coal and nuclear power plants in order to keep them open. The concept of just and reasonable rates is based on recognizing the value of the reliability and diversity of fuel supply. Market prices in the PJM Interconnection are set by gas-fired generation, which has more price and supply volatility than either coal or nuclear.

Days later, FirstEnergy Solutions filed for chapter 11 bankruptcy protection. (Parent company FirstEnergy and other subsidiaries are not part of the bankruptcy case.) The bankruptcy is a legal/financial process, and the company will continue to operate the nuclear plants during the financial restructuring.

In mid-April, research firm The Brattle Group released a report based on a study that was conducted for the industry advocacy group Nuclear Matters. The report provides an analysis of the environmental impact of shutting down the FirstEnergy nuclear fleet and Three Mile Island-1, which is owned by Exelon Nuclear, and concludes that closing down the five nuclear units would reduce the zero-carbon capacity of the PJM grid by 21 million metric tons annually. According to the report, the plants now provide more zero-carbon energy than all of PJM's wind and solar energy sources combined. If the nuclear plants close, the increase in carbon emissions could raise societal costs by

\$921 million per year over a 10-year period, based on a federal measure of carbon pollution.

The study also suggests—depending on market price assumptions—that the ongoing operation of the nuclear plants could actually result in lower electricity costs for customers. Within PJM, the nuclear plants account for 39 terawatt-hours per year, compared to the 26 TWh of all non-hydro renewable energy provided to PJM last year. The case for zero-carbon nuclear generation is quantifiable and compelling.

The White House announced in June that President Trump had ordered Energy Secretary Rick Perry to prepare to take “immediate steps” to stop the closing of coal and nuclear plants around the country. (Trump had expressed support for the coal industry during his presidential campaign.) One proposed plan would have the Department of Energy order grid operators to buy electricity from struggling coal and nuclear plants for two years to support grid reliability and secure supply and reliability.

The presidential order for the DOE to support unprofitable coal and nuclear plants is good theater, but it may not be good economic or environmental policy. Including coal and nuclear generation in a single bailout plan effectively ignores the economic value of clean nuclear generation.

On June 26, a group of 75 industrial, political, military, and academic leaders sent a letter to Secretary Perry, encouraging him to take immediate action to prevent the premature closure of more nuclear plants (see page 30). The letter focused on the national security attributes of U.S. nuclear power plants. Major points included support of the national grid infrastructure, fuel diversity and reliability, military involvement, and international relationships. The fact that nuclear energy is the largest source of emissions-free generation was noted in the context of climate change as a national security risk.

If the United States' energy industry is serious about reducing carbon emissions, nuclear generation must be recognized and appropriately valued. The nuclear industry needs to step up its efforts to make the case for nuclear as a zero-carbon source of generation.

FoF

Linda C. Byus (<LCByus@aol.com>) is a Chartered Financial Analyst and currently runs her own business, BYI Consulting, established in 2004. As a consultant, she provides feedback to utilities' senior management regarding industry trends and investor concerns as a basis for their strategic discussions and planning.

ing processes that require applicants to obtain exemptions from rules that do not apply to the proposed technology.”

According to Amy C. Roma, an attorney practicing nuclear and radioactive materials law at Hogan Lovells, the paper “promises significant, if not fundamental, reforms to the NRC’s licensing process at this critical juncture for the ‘new nuclear’ economy.”

SECY-18-0060, “Achieving Modern Risk-Informed Regulation,” can be downloaded from the NRC’s website, at <www.nrc.gov>, through the agency’s ADAMS document retrieval system, with a search for accession number ML18110A187.

OVERSIGHT

ANO units regain high-performance status

The Arkansas Nuclear One reactors have been returned to standard Nuclear Regulatory Commission oversight, after having spent years under close agency scrutiny for safety-related issues. In a June 18 confirmatory action letter (CAL) inspection report and assessment follow-up letter, the NRC informed Entergy Operations that ANO-1 and -2, pressurized water reactors located in Russellville, Ark., were being moved from column four (Multiple/Repetitive Degraded Cornerstone) in the agency’s five-column Reactor Oversight Process action matrix, to column one (Licensee Response).

The NRC had moved the ANO units from Licensee Response to the matrix’s third column, Degraded Cornerstone, in August 2014 as a result of the facility’s fatal crane accident in March 2013 (*NN*, July 2014, p. 17), and from Degraded Cornerstone to Multiple/Repetitive Degraded Cornerstone in February 2015, after identifying significant flood-protection deficiencies at the plant (*NN*, Feb. 2015, p. 18).

According to the assessment follow-up letter, the NRC on May 31 completed a review of the remaining actions that Entergy had committed to in a June 2016 CAL, issued to address these problems. “Between August 2016 and May 2018, the NRC conducted eight CAL follow-up inspections to review Entergy’s progress in completing 161 CAL actions to address performance issues at ANO,” the letter states. “Specifically, this report closes the CAL areas for Human Performance, Equipment Reliability and Engineering Programs, Safety Culture, and Service Water System Self-Assessment. The NRC has determined that all of Entergy’s committed actions to improve the safety performance at ANO have been completed and should sustain performance improvement,” the letter concludes. ■ In a July 9 update to the matrix, the NRC

moved Duke Energy’s Catawba-2 and Tennessee Valley Authority’s Sequoyah-1 and -2 back to Licensee Response from column two, Regulatory Response. The agency upgraded the status of the Catawba unit, a PWR located near Clover, S.C., after closing a “white” finding (a finding of low-to-moderate significance) involving Duke’s failure to adequately develop preventive maintenance strategies that considered operating experience for emergency diesel generator excitation system diodes. The Sequoyah reactors, PWRs located in Soddy-Daisy, Tenn., were returned to basic oversight after the agency closed a “greater than green” security-related finding (a finding of more than very low significance).

FLORIDA

Court backs utilities on nuclear costs

A federal appeals court on July 11 affirmed a lower-court decision to dismiss a proposed class-action lawsuit brought in February 2016 against two utilities—Duke Energy Florida and Florida Power & Light Company (FPL)—to recover about \$2 billion collected from ratepayers under Florida’s Nuclear Cost Recovery System.

The NCRS, promulgated by the Florida Public Service Commission following the passage in 2006 of the state’s Renewable Energy Technologies and Energy Efficiency Act, allows utilities to preemptively charge customers through an electricity rate increase for costs incurred in the siting, design, licensing, and construction of nuclear power plants. In addition, under the NCRS, utilities retain the collected funds regardless of whether they complete the projects. In May 2016, FPL decided to “pause” for at least four years its project to expand the Turkey Point nuclear power station with two AP1000 reactors, while in August 2017, Duke Energy officially pulled the plug on its AP1000 project at a site in Levy County, Fla. (*NN*, Sept. 2017, p. 17).

In its judgment, the Atlanta-based 11th Circuit Court of Appeals rejected the plaintiffs’ arguments that the two provisions of the law authorizing the NCRS (1) violate the U.S. Constitution’s “Dormant Commerce Clause” (a legal doctrine, inferred from the Constitution’s Commerce Clause, prohibiting state legislation that discriminates against interstate or international commerce), and (2) are preempted by the Atomic Energy Act of 1954. “Plaintiffs are Florida electric utility customers,” the court stated in its dismissal of the first argument. “Utilities are Florida companies. Utilities are not ‘states’ such that their actions could give rise to [Dormant Commerce Clause] claims from an out-of-state person or entity. Plaintiffs’

interests are well beyond the zone the [clause] is meant to protect.”

With regard to the plaintiffs’ preemption claim, the court held that while the federal government has full authority over nuclear safety concerns, state initiatives based on an economic rationale, such as the NCRS, are well within a state’s authority to promote investment in new facilities.

REPORT

Study highlights grid threats from plant closures

A natural gas pipeline disruption, combined with more nuclear plant retirements or a failure to improve natural gas infrastructure, could result in prolonged electricity service disruption in regions served by grid operator PJM Interconnection, according to a report prepared by global consulting services firm ICF for the Nuclear Energy Institute. The report, released in June, examines how the loss of gas-fired generation resources could affect PJM resilience in two future nuclear capacity policy scenarios—one in which existing announced nuclear plant closures are reversed (the “Policy Case”), and one in which the current, economically challenging environment leads to additional retirements (the “Extended Case”). Both scenarios were evaluated against electricity demand patterns consistent with the winters of 2014 and 2015, which, the report states, are the two years with the highest January and February electricity demand levels in PJM in the past decade.

In the Extended Case scenario, the report concludes that a significant pipeline disruption “could result in the loss of nearly 27 gigawatts of gas-fired generation, with 18 GW serving the PJM Mid-Atlantic area, depending on the severity and location of such an event. When combined with the retirement of a similar amount of nuclear capacity, the analysis implies such an event would put as much as 22 percent of the area’s load at risk of being shed in the highest load hours. Over an assumed 60-day event, those loss-of-load impacts could take place for over 200 hours spread across as many as 34 days.”

In the Policy Case scenario, however, the report concludes that the preservation of nuclear capacity in PJM would be “able to offset the gas generation impacted by the infrastructure event, resulting in load being served in all hours over the 60-day period.”

The 53-page report, *The Impact of Fuel Supply Security on Grid Resilience in PJM*, can be downloaded from the NEI website, at <www.nei.org>, by clicking on the Resources tab and then on Reports & Briefs. ■

Nichita: On *Problems in Elementary Reactor Physics*, with Solutions

This book is a collection of problems intended primarily for undergraduate students studying reactor physics and for those interested in reviewing fundamental reactor physics concepts.

The book *Problems in Elementary Reactor Physics, with Solutions* was recently published by the American Nuclear Society. The book's authors, Eleodor Nichita, of the University of Ontario Institute of Technology, and Benjamin Rouben, retired from Atomic Energy of Canada Limited (AECL) and currently an adjunct professor at McMaster University and the University of Ontario Institute of Technology, found that students lacked enthusiasm for working on physics problems that past generations had already solved. The authors wanted to present something new.



Nichita: "This is first and foremost a collection of problems meant to be used in addition to a textbook when teaching a reactor physics course."

What the authors produced is a collection of problems intended primarily for undergraduate students studying reactor physics, with the secondary audience being graduate students and nuclear industry professionals interested in reviewing fundamental reactor physics concepts.

Nichita was born in Romania in the small city of Buzău. His interest in physics developed while he was attending the historic B.P. Hasdeu high school, founded in 1867 and counting among its graduates George E. Palade, who in 1974 was awarded the Nobel Prize in Physiology or Medicine jointly with Albert Claude and Christian de Duve.

After winning a silver medal at the 1982 International Physics Olympiad, held in Malente, Germany, Nichita went on to study at the University of Bucharest, where in

1988 he received a bachelor's degree in engineering physics with a thesis titled "Three-Dimensional Response-Matrix Code for Neutronic Modelling of Nuclear Reactors." After graduation, he worked for five years at Romania's Institute for Nuclear Research in Pitesti, and then went on to pursue a Ph.D. in nuclear engineering at the Georgia Institute of Technology.

Upon obtaining his Ph.D. in 1997, Nichita joined the Reactor Physics branch of AECL in Toronto, Ontario, as a developer of the CANDU-core neutronics simulator, RFSP. It is there that he met Benjamin Rouben, co-author of the book, who was leading

AECL's Reactor Physics branch at the time.

After a few years with AECL, Nichita joined the Faculty of Energy Systems and Nuclear Science at the newly established University of Ontario Institute of Technology, where he is currently an associate professor and director of the nuclear engineering graduate program. An ANS member since 1994, Nichita is a fellow and past president (2009–2010) of the Canadian Nuclear Society.

Rick Michal, director of ANS's Department of Scientific Publications and Standards, spoke with Nichita about his newly published book.

Problems in Elementary Reactor Physics, with Solutions is available through ANS at <ans.org/store> and at Amazon.com.

Interview: Nichita

How did you come up with the idea for a book of problems?

For the past decade or so, I have been teaching reactor physics courses to second-year undergraduate nuclear engineering students. I found that when assigning problems from established textbooks, students sometimes got a feeling of “old hat”—that they were solving problems that countless generations had solved before them and that the best they could hope for was to reproduce the “official” solution, which was very likely already available in some corner of the internet.

To counter that sense of monotony and to keep their enthusiasm alive, I often presented them with new problems, developed specially for them. These were problems that nobody had solved before and for which no “official” solution existed. The students found that much more exciting.

Such new problems also offered me additional flexibility in choosing important ideas and points that I wanted to emphasize. Since I wanted a problem to illustrate a specific point, I tried to make it such that the mathematics involved was at the lowest necessary level, so as not to obscure the main concept.

I later found such problems very useful when teaching reactor physics to graduate students with backgrounds other than physics or nuclear engineering.

How did your coauthor, Ben Rouben, get involved with the book?

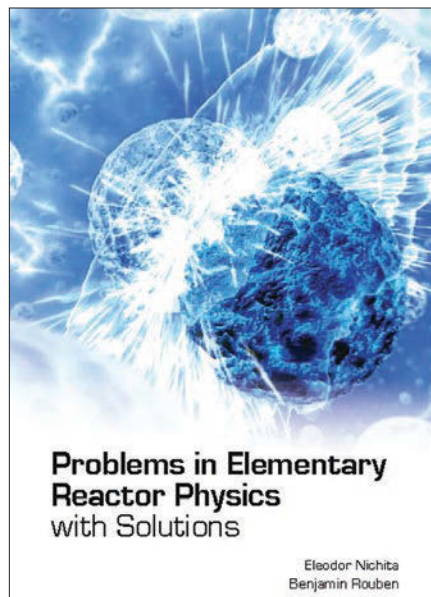
Ben Rouben is a kindred spirit with respect to the importance of problems. As head of AECL’s Reactor Physics branch, he used to periodically regale us coworkers with math or physics “puzzles” that, while requiring minimal background knowledge, made for some serious brain workouts. One evening in 2014, toward the end of the annual meeting of the Canadian Nuclear Society and after discussing our similar teaching experiences and approaches, we decided to write this book.

The book includes what you call “official” solutions. Why did you include them?

Ben and I found that today’s engineering students were very much focused on numerical results, sometimes at the expense of a full analytical solution. In our opinion, analytical solutions offer much better insight than a simple numerical value. We therefore felt that presenting full analytical solutions, and making all the important points in the process, would encourage students to take such an approach when attempting to solve problems.

We do caution readers in the preface that just because solutions are provided, they should not be treated as “official,” and so readers should also try to find alternative solutions.

A special appendix in the book shows



only the final numerical answers so that readers can do a quick check of their final results. Of course, now that the book has been published, we will have to come up with new problems for our students, and possibly cover additional concepts. Resonance absorption and heterogeneous lattices are topics that come to mind.

Who is the intended audience for the book?

The book is intended primarily for beginning undergraduate students, but we think it will be useful to graduate students as well, especially those with backgrounds other than physics or nuclear engineering.

The book is also meant for professionals who wish to brush up on reactor physics and who want to be able to perform “back-of-the-envelope” calculations to check computer-code results. It may seem counterintuitive, but computer-generated results should always be checked for plausibility using an approximate model and “hand” calculations.

When a computer-generated result is correct, it is likely correct to several decimal places, but when it is wrong, it can be wrong by an order of magnitude or more. There is no substitute for “hand” calculations.

The problems in the book are divided into three areas: Preliminary Concepts, Reactor Statics, and Reactor Dynamics. Why these three sections?

The material division follows the one used in most reactor physics textbooks. This makes it easy for students to refer to the appropriate chapter when looking for additional problems to solve.

You mention solving problems just for the numerical answer versus working through a full analytical solution. Can you expound on the difference? Related to that, you men-

tion alternative solutions. Is there more than one way to correctly solve every problem?

After figuring out the logical solution steps, one has two options: to go through each step by performing numerical calculations, starting from the given numerical data and arriving, after all the steps, at the final numerical result; or to go through each step by deriving analytical formulas and arriving at a final analytical solution, whose numerical value can subsequently be found by substituting the given numerical data in one fell swoop.

I find that the analytical approach offers better insight than the numerical one. It is also easier to verify and correct if the initial answer turns out to be incorrect.

In most cases, there is more than one way of correctly solving a problem. All correct ways of solving a problem will normally yield the same result, or demonstrably equivalent results.

Would this text make a good backbone for teaching a full course in reactor physics? Or would it perhaps make a good scaffold for writing a textbook? If so, do you foresee pursuing such developments?

This is first and foremost a collection of problems meant to be used in addition to a textbook when teaching a reactor physics course. Appendix B is meant to be a summary of the usual concepts that one would become familiar with after taking an introductory reactor physics course.

I have been thinking about writing a reactor physics textbook at a beginning undergraduate level, one that would be suitable for nonnuclear engineering students.

What is the feeling you get from your undergraduate nuclear engineering students about the state of the nuclear industry? Are they planning to find employment in the industry, and if so, in which areas (i.e., waste management, new reactor design, regulation and rulemaking)?

Twenty operating power reactors are located within a 150-mile radius of our campus, and so, not surprisingly, a majority of our students plan to work in the industry, primarily for utilities. Most of them expect to work in the area of operations, life extension, or decommissioning. Some are looking to work on special projects within utilities, such as special radionuclide production for medical and space applications.

There is also an increasing fraction of students who are looking to work for small startup companies developing Generation IV small and modular reactor concepts.

Will there be a companion volume or volumes to your book?

At this point, we are not anticipating a companion volume, but we may consider an expanded edition to include additional topics.

NN

NNSA

LANL contract awarded to newly formed consortium

Triad National Security—consisting of the University of California, Texas A&M University, and Battelle Memorial Institute—will take over Los Alamos National Laboratory's M&O contract.

The National Nuclear Security Administration has awarded a new management and operating (M&O) contract for Los Alamos National Laboratory (LANL) to Triad National Security LLC, a consortium made up of the University of California, Texas A&M University, and Battelle Memorial Institute. The five-year contract, announced in late June, is worth an estimated \$2.5 billion annually and includes five one-year options.

Fluor Federal Services, Huntington Ingalls Industries/Stoller Newport News, Longenecker & Associates, TechSource, Strategic Management Solutions, and

Merrick & Company will support Triad in the performance of the contract.

Triad will replace Los Alamos National Security LLC (LANS)—a company made up of Bechtel, BWX Technologies, the University of California, and AECOM—which has been plagued with security and environmental issues since its tenure at LANL began in 2006 (*NN*, Feb. 2016, p. 27). Perhaps the most notable was the rupture of an LANL waste drum at the Waste Isolation Pilot Plant in Carlsbad, N.M. The 2014 incident caused operations at the repository to be suspended for nearly three years.

Continued



THE NNSA AND MOROCCO HAVE SIGNED AN MOU to establish a formal pathway for cooperation on nuclear- and radiological-related matters, including security, forensics, detection, and safeguards. With support from the U.S. Embassy in Rabat and Morocco's Ministry of Foreign Affairs, the memorandum of understanding was signed in May by David Huizenga (center left), the National Nuclear Security Administration's principal assistant deputy administrator, and Khammar Mrabit (center right), director general of the Moroccan Agency for Nuclear and Radiological Safety and Security (AMSSNuR).

During the same week as the MOU signing, AMSSNuR and Global Affairs Canada cohosted a five-day workshop on developing a nuclear detection architecture in Morocco. Experts from the NNSA, the U.S. Departments of State and Homeland Security, and Canada's foreign affairs and regulatory agencies shared technical and policy expertise with workshop participants, including Moroccan customs officials, law enforcement officers, and the country's nuclear regulator.

The current M&O contract expires on September 30 but will be extended to allow for a full four-month transition period, according to an NNSA press release. NNSA spokeswoman Lindsey Geisler said that safety concerns with LANS were the primary reason the NNSA sought a new operator seven years ahead of schedule.

Thomas Mason, who currently serves as senior vice president of Battelle's global lab operations and is a former director of Oak Ridge National Laboratory, has been named president of Triad National Security.

Other bids on the new M&O contract were submitted by Bechtel, as part of a team it formed with Purdue University; by the University of Texas and Boeing; and by BWXT, Jacobs, and Southeastern Universities Research Association.

According to the NNSA's press release on the contract award, LANL's primary mission is its national security responsibilities, which include the design, qualification, certification, and assessment of nuclear weapons and the production of plutonium pits used in those weapons. The lab also conducts research in the fields of space exploration, renewable energy, medicine, nanotechnology, and supercomputing.

LANL is one of three national laboratories charged by Congress to report annually on the state and health of the nuclear stockpile to the president.

NONPROLIFERATION

Stolen radioactive material still missing a year later

Small samples of plutonium and cesium stolen from an SUV in a hotel parking lot in San Antonio, Texas, have not been recovered more than a year later, according to a recent report from the Center for Public Integrity. The investigative news organization reported that the radioactive materials were left in the rental vehicle overnight on March 21, 2017, by security experts from the Department of Energy's Idaho National Laboratory (INL) who awoke to find the back window of the vehicle smashed and the materials missing. The July report was critical of the DOE's handling of the situation and cited a lack of disclosure on the part of the DOE in dealing with similar instances of missing nuclear materials.

"More than a year later, state and federal officials don't know where the plutonium—one of the most valuable and dangerous substances on earth—is. Nor has the cesium been recovered," the report states. The security personnel were tasked with retrieving the nuclear materials from a research laboratory near the hotel and

transporting them to INL. Their radiation detectors, along with a small amount of radioactive material used to calibrate them, were left in locked cases in the backseat of the vehicle and were stolen sometime overnight.

The Center for Public Integrity learned of the theft through a brief description posted in an internal report from the DOE and obtained the police report through the Freedom of Information Act. Carlos Ortiz, a spokesman for the San Antonio Police Department, said that the materials should never have been left in an unattended vehicle. He also said that the FBI was called following the incident and recommended an extensive search for fingerprints, but none were found. No security camera footage was available, and there were no witnesses, Ortiz said.

In its description of the incident, the DOE's Office of Environment, Health, Safety & Security (EHSS) acknowledges that radiological materials should be kept secured and out of sight or within the physical control of the authorized user. EHSS management reported the incident in an effort to bring awareness to the potential for theft from vehicles in areas trafficked by high numbers of transient individuals, such as hotel parking lots, park-and-rides, and metro stations.

The security personnel dispatched to Texas were part of the Off-Site Source Recovery Program (OSRP), which is based at Los Alamos National Laboratory in New Mexico. The program has an annual budget of roughly \$17 million and is overseen by the National Nuclear Security Administration. Since 1997, OSRP has recovered

Security Briefs

THE WORLD'S MOST POWERFUL SUPERCOMPUTER WAS UNVEILED

on June 8 at Oak Ridge National Laboratory (ORNL). The scientific computer, named Summit, has a peak performance of 200,000 trillion calculations per second, or 200 petaflops, and is eight times more powerful than ORNL's previous top-ranked system, Titan. Summit is expected to produce advancements in artificial intelligence, astrophysics, cancer research, and energy and to accelerate the understanding of diseases, including Alzheimer's disease, heart disease, and opioid addiction. "The Summit supercomputer demonstrates the strength of American leadership in scientific innovation and technology development," Energy Secretary Rick Perry said in a written statement. "It's going to have a profound impact in energy research, scientific discovery, economic competitiveness, and national security." The United States has a goal of producing an exascale supercomputer system capable of at least 1 billion billion calculations per second by 2021.

Meanwhile, the Sierra supercomputer at Lawrence Livermore National Laboratory was named the third-fastest computing system in the world, according to an announcement at the International Supercomputing Conference in Frankfurt, Germany. Sierra is expected to be operational this fall and will be used by the National Nuclear Security Administration to ensure the safety, security, and effectiveness of the U.S. nuclear stockpile. Sierra produced 72 petaflops in a recent test and is expected to top out at 125 petaflops. Both Summit and Sierra were built by IBM, and together they are two of the three fastest computers in the world, the second-fastest being China's Sunway TaihuLight, a system developed by China's National Research Center of Parallel Computer Engineering and Technology.

NRC STAFF HAS SAID THAT DHS IS RESPONSIBLE for months of delays in the implementation of phase one of the Nuclear Regulatory Commission's Continuous Diagnostics and Mitigation (CDM) program, which is meant to scan federal networks for unauthorized users and threats. Enterprise Services (formerly HP Enterprise Services) holds the contract for implementing the cybersecurity program. According to the NRC, "The CDM project lacked a complete architectural vision or concept of operations from U.S. Department of Homeland Security. For that reason, the CDM project is behind the [original] schedule." As a result of the delays, the NRC is seeking an additional year and a \$389,273 contract extension for Enterprise Services to continue its work on phase one of the program.

A U.S.-JAPAN NUCLEAR PACT HAS BEEN EXTENDED despite concerns over Japan's large stockpile of plutonium. The agreement, which went into force in July 1988, allows Japan's civilian use of plutonium. Its expiration date came and went without either side calling for a reexamination, and as neither side took action, the agreement was extended. Nevertheless, Japanese officials expressed concerns over a stipulation in the agreement that allows for the termination of the pact with a six-month notice, thereby leaving Japan vulnerable to U.S. policy shifts. Meanwhile, most of Japan's nuclear power plants remain shut down following the March

more than 41,130 sources from more than 1,430 sites, resulting in more than 1.26 million curies of radioactive material being removed and secured, according to OSRP.

Sarah Neumann, a spokesperson for INL, said that the missing plutonium from the San Antonio incident was not enough to be fashioned into a nuclear bomb. DOE officials declined to provide the exact amount of the missing plutonium and cesium.

NRC

Security inspection report submitted to Congress

On July 6, the Nuclear Regulatory Commission released to Congress its 2017 annual report on the security inspection

program for commercial nuclear power plants and Category 1 fuel cycle facilities. A Category I facility is one that uses or possesses at least a “formula quantity” of strategic special nuclear material, an amount defined as “any combination in a quantity of 5,000 grams or more computed by the formula $\text{grams} = (\text{grams contained U-235}) + 2.5 (\text{grams U-233} + \text{grams plutonium})$.”

According to the report, the agency’s 13th to federal lawmakers, 230 security inspections were conducted at commercial power plants and Category I facilities in calendar year 2017, including 19 force-on-force (FOF) inspections, which simulate combat between mock adversaries and a licensee’s security force. Two exercises were conducted for each of the 19 FOF inspections unless severe weather inter-

vened or when one exercise was deemed sufficient.

All FOF inspections in 2017 were conducted at power plants. No fuel cycle facilities were included in these “combat” inspections. In all, 34 exercises were termed “effective,” three “marginal,” and one “ineffective.” In explanation of those descriptions, the report stated that “one exercise was deemed ineffective, resulting from the licensee’s inability to demonstrate an effective implementation of its protective strategy to defend designated target set components. Three exercises . . . were determined to be marginal because the licensees neutralized the adversary at a location, or in preparation to enter a location, that contained a single element target set. In all these cases, the licensees took appropriate corrective actions.”

Besides the FOF inspections, the nuclear power plants were also evaluated in the baseline areas of access control, access authorization, protective strategy evaluation, security training, equipment performance, testing, and maintenance, as well as a fitness-for-duty program, protection of safeguard information, review of power reactor target sets, material control and accounting, and information technology security. From these 215 evaluations, there were 106 total inspection findings, 103 of which were classified as either “green” or Severity Level IV violations (of very low security significance). The plant inspections also found three “greater-than-green” findings, denoting low to moderate security significance.

The NRC’s report also looked at two fuel cycle facilities: BWX Technologies Inc. in Lynchburg, Va., and Nuclear Fuel Services in Erwin, Texas. These facilities both produce fuel for government reactors and downblend high-enriched uranium into low-enriched uranium for use in commercial nuclear power plants. Both facilities have also stepped up their security efforts significantly since the events of September 11, 2001, according to the report.

A total of 15 inspections were conducted at the two fuel cycle facilities, resulting in a total of four findings. All of the findings were classified as Severity Level IV violations and thus considered of low significance. “Through its inspection program, the NRC has high assurance that CAT 1 fuel cycle facilities continue to meet the intent of the regulations,” the report states.

The unclassified version of the document, *Report to Congress on the Security Inspection Program for Commercial Power Reactors and Category I Fuel Cycle Facilities: Results and Status Update—Annual Report for Calendar Year 2017*, is available for download from the agency’s website, at www.nrc.gov, through the ADAMS document retrieval system, using accession number ML18086B249. **NU**

2011 Fukushima Daiichi accident, resulting in the accumulation of plutonium. Japan pledged to reduce its plutonium holdings in an energy plan adopted by the Japanese cabinet on July 3, and officials appear hopeful that the country’s nuclear power plants will be allowed to restart following enhanced safety inspections. These plants could use mixed-oxide fuel, which would help reduce the plutonium stockpile.

A REPORT OUTLINING CHALLENGES TO NATIONAL SECURITY

was released on July 17 by the Washington, D.C.-based Center for Strategic and International Studies. *Back from the Brink: A Threatened Nuclear Energy Industry Compromises National Security* explains why government action is critical and recommends supporting the completion of U.S. nuclear projects that are under construction and readying the next wave of American-designed and -developed advanced reactors. The authors point out that approximately 70 percent of nuclear power plants under construction worldwide are of Russian or Chinese origin, and that in comparison, in the United States, “the industry is struggling to survive.” Without a continued commitment to nuclear power, they say, the role of the United States regarding nonproliferation and operational safety will diminish, yielding leadership to China and Russia. To read the full report, authored by Michael Wallace, Amy Roma, and Sachin Desai, go to www.csis.org/analysis/back-brink-threatened-nuclear-energy-industry-compromises-national-security.

A REGIONAL WORKSHOP ON COUNTERING NUCLEAR SMUGGLING

was hosted July 10–12 by the United States and China at the China National Nuclear Security Center of Excellence outside of Beijing. The workshop brought together participants from Kazakhstan, the Kyrgyz Republic, Mongolia, Tajikistan, Turkmenistan, and Uzbekistan. This is the first time that the United States and China have cohosted a regional workshop on this topic, and both nations reaffirmed their commitment to working together against the threat of nuclear terrorism. Also attending the workshop were representatives from the International Atomic Energy Agency and INTERPOL.

BOOSTING NUCLEAR SECURITY IN SPANISH-SPEAKING NATIONS

was the motivation behind an operational plan signed last month by the International Atomic Energy Agency and the Guardia Civil, a law enforcement agency in Spain. The plan aims to “strengthen understanding, practices, and procedures related to the prevention and detection of nuclear security events, as well as ways to respond to them,” according to an IAEA press release. The plan is based on a practical arrangement between the IAEA and the Guardia Civil that was signed in September 2016. The Guardia Civil operates a chemical, biological, radiological, and nuclear explosives deactivation training center in Madrid, which will become an IAEA Collaborating Training Centre. According to the agency, the only other such center in the field of nuclear security is at the Hungarian Academy of Sciences Centre for Energy Research, which specializes in nuclear forensics. “We can now call on the Guardia Civil’s nuclear security expertise when we provide assistance, particularly to Spanish-speaking countries,” said Nigel Tottie, senior nuclear officer at the IAEA.

CONGRESS

Nuclear legislation advances in House

According to their sponsors, H.R. 1320 will create more certainty for nuclear plant operations, while H.R. 6140 will help develop the next generation of nuclear fuels.

Two nuclear energy-related bills passed out of the House of Representatives' Energy and Commerce Committee on July 12 and have moved to the House floor for consideration. Both measures, the Nuclear Utilization of Key-note Energy (NUKE) Act (H.R. 1320) and the Advanced Nuclear Fuel Availability Act (H.R. 6140), were approved by voice vote, after also passing unanimously out of the committee's Energy Subcommittee on June 21.

H.R. 1320, introduced in March 2017 by Reps. Adam Kinzinger (R., Ill.) and Mike Doyle (D., Pa.), calls for revising the



Kinzinger



Doyle

Nuclear Regulatory Commission's fee-recovery structure and making the agency's licensing procedures more efficient, including by establishing deadlines for the completion of major licensing milestones, allowing certain hearing procedures to be conducted more informally, and revising the regulatory framework for decommissioning reactors (NN, Apr. 2017, p. 23). The fuel bill, H.R. 6140, was introduced in June of this year by Reps. Bill Flores (R., Texas) and Jerry McNerney (D., Calif.), and directs the Department of Energy to establish a program to support the availability of high-assay low-enriched uranium to help enable advanced nuclear energy technology development.

Following news of the bills' advancement, the Nuclear Energy Institute released a statement from its vice president of governmental affairs, Beverly Marshall. "The bipartisan NUKE Act sets in

motion well-justified and timely steps to reform some of the [NRC's] outdated and inefficient regulations, including the archaic funding structure developed nearly 30 years ago," she said. "Establishing a more transparent fee process and initiating common-sense reform will lift the burden of unnecessary regulations by the NRC. Furthermore, it ensures electricity customers are not bearing the back-end financial burdens of this costly overregulation."

"In addition," Marshall continued, "support of the Advanced Nuclear Fuel Availability Act signifies continued confidence in the development of the next generation of advanced nuclear reactors. By creating a program that will make high-assay low-enriched uranium . . . available for commercial use, we are making an important investment in the globally competitive race to design and deploy advanced reactor technology."

■ On July 18, the Advancing U.S. Civil Nuclear Competitiveness Act (H.R. 6351), sponsored by Rep. Bill Johnson (R., Ohio), was reported out of the House Energy and Commerce Committee by a vote of 33–16. According to the committee's description, H.R. 6351 requires the secretary of energy to assess the impact of regulatory, policy, and legal requirements on the domestic nuclear energy industry and make recommendations to improve the competitiveness of civilian nuclear commerce policies in global markets. In addition, the legislation seeks to streamline portions of the DOE's 10 CFR Part 810 export review procedures and improve the timeliness of the approval process.

ADVOCACY

Letter: Nuclear needed for national security

In a June 26 letter to Secretary of Energy Rick Perry, a broad coalition of 75

notables—mostly former industry executives, lawmakers, and military leaders—came out in strong support of saving nuclear plants from early retirement, pointing to national security as the reason.

“We write to commend you for recognizing the important role our civil nuclear energy sector plays in bolstering America’s national security,” the letter states. “We urge you to continue to take concrete steps to ensure the national security attributes of U.S. nuclear power plants are properly recognized by policymakers and are valued in U.S. electricity markets.”

According to the letter, the security benefits of a strong domestic nuclear energy sector take a variety of forms. For instance, the letter noted that the Department of Defense depends on the nation’s grid to power 99 percent of its installations, and that many of the firms serving the civil nuclear sector also supply the nu-

clear navy and major Department of Energy programs.

While acknowledging that “vital” discussions of the role nuclear energy plays in grid resiliency are under way at the Federal Energy Regulatory Commission, state public utility commissions, and regional transmission organizations, the letter asserts that those “important considerations must be integrated with the broader national security imperatives,” which can only be accomplished at the DOE.

The letter closes with an exhortation to the secretary to “ensure that no more nuclear power plants are closed prematurely due to insufficient valuation of nuclear energy’s national security, resilience, and other benefits in our nation’s electricity markets.” The plea may have been unnecessary, given Perry’s comments at a Washington press conference on June 28, when asked about the administration’s plan to keep nuclear and coal plants open

in competitive power markets (*NN*, June 2018, p. 17) and the potential cost of such a plan. “You cannot put a dollar figure on the cost to keep America free,” Perry said. “We look at the electricity grid as every bit as important to [national security] as making sure we have the right number of ships, aircraft, and personnel.”

In addition to a large number of admirals and vice admirals, signatories to the letter include former U.S. secretary of state George Shultz; former U.S. senators Byron Dorgan, Judd Gregg, Trent Lott, Jim Talent, and John Warner; former New Jersey governor and former Environmental Protection Agency administrator Christine Todd Whitman; former Areva chief executive officer Thomas Christopher; retired Westinghouse Electric Company chairman Charles Pryor; and three former chairmen of the Nuclear Regulatory Commission—Nils Diaz, Dale Klein, and Richard Meserve. **N**



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Ann Winters: On the 100th anniversary of Wilkinson's birth

The author of a recent biography of Vice Admiral Dennis Wilkinson, the first commanding officer of the first nuclear-powered submarine, shares her recollections of him over their 33-year friendship.

Dennis Wilkinson would have celebrated his 100th birthday on August 10. The life and career of the man who captained the first nuclear-powered submarine and the first nuclear-powered surface ship and was the first president and chief executive officer of the Institute of Nuclear Power Operations (INPO) have been captured in Ann Winters's book, *Underway on Nuclear Power: The Man Behind the Words*, Eugene P. "Dennis" Wilkinson, Vice Admiral USN.

Because of his inherent drive, Wilkinson was often called a cowboy, maverick, visionary, innovator, and superb leader. As the first commanding officer of USS *Nautilus*, he was a major player in revolutionizing underwater warfare. *Nautilus* and its crew were immensely popular, at home and abroad, and in the 1950s became what we now call "rock stars." *Nautilus* gave nuclear power celebrity status at a time when the United States and the world were grappling with Cold War issues.

In his post-military career, Wilkinson was chosen to lead INPO as its first CEO. INPO was established in 1979 by the U.S. nuclear power industry following the Three Mile Island accident. INPO sets industry-wide performance objectives, criteria, and guidelines for nuclear power plant operations that are intended to promote



Winters: "Dennis was a true 'people person'—interested in others, compassionate, and always willing to help."

operational excellence and improve the sharing of operational experience among nuclear power plants.

An inveterate storyteller, Wilkinson relished telling his "sea stories," which were entertaining, thought provoking, and full of life lessons. His stories were the basis for Winters's book, augmented by recollections of many people who knew him. Wilkinson, who was an American Nuclear Society member for more than 30 years, died on July 11, 2013, one month shy of his 95th birthday.

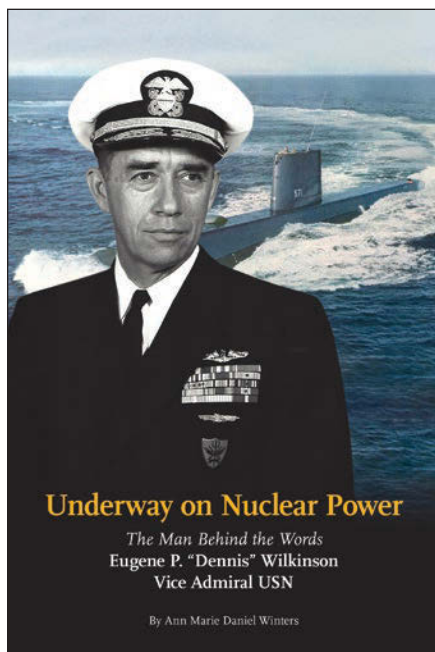
Ann Winters joined INPO in 1980 as Wilkinson's assistant, and the two maintained a friendship for 33 years. Winters was involved in INPO's early

startup activities and later managed two programs that integrated educational support into industry workforce needs. She was active in training initiatives and program development, implementation, and evaluation. An ANS member since 1994, Winters retired from INPO in 2011.

Rick Michal, director of ANS's Department of Scientific Publications and Standards, talked with Winters about her memories of Wilkinson.

Underway on Nuclear Power: The Man Behind the Words, Eugene P. "Dennis" Wilkinson, Vice Admiral USN is available through ANS and at Amazon.com.

(All photos in the main text of the interview are from the personal collection of E. P. Wilkinson)



You worked with Dennis Wilkinson at INPO from 1980 to 1984. What was he like during that time?

I'm not sure what INPO people or the commercial nuclear industry expected of Dennis Wilkinson, the retired Navy vice admiral who had done so much for nuclear in the Navy and was now the first CEO of this new organization. When he arrived at INPO in early 1980, we found him to be down to earth and friendly, and he had a great sense of humor. There was no question that he was brilliant, with a phenomenal memory and an incredible depth of technical knowledge, but he never tried to impress.

Dennis Wilkinson was the hardest working man I've ever known. His energy was phenomenal. He committed to visiting every U.S. nuclear power plant—70 to 80 sites at that time. He also attended every plant evaluation exit meeting. All that in addition to everything involved in setting up this new organization, recruiting personnel, and meeting industry needs. He was in his 60s, and even when he must have been exhausted, he still devoted immense effort to INPO. He was committed to making INPO a real asset to the industry.

Dennis was the first person I knew who truly defined "multitasking." He could take a stack of paperwork into a meeting, be completely in tune with everything going on in the meeting by appropriately interjecting questions, answers, and comments and still complete the paperwork by the end of the meeting. He never missed a point or comment while doing both.

Dennis always stressed high standards, attention to detail, and commitment to INPO and the industry. He expected the highest quality work from those around him. We used to say that INPO didn't

have the luxury of making mistakes and that we had to be right the first time. He constantly reinforced that principle. While the work was grueling, with long hours, Dennis's humor was infectious and made it fun. He was always loyal to his people. One of his favorite sayings was, "It's amazing what you can accomplish when you don't care who gets the credit." He lived those words and never neglected to praise and encourage. He truly believed in positive reinforcement before it became popular.

Dennis was a true "people person"—interested in others, compassionate, and always willing to help. I've seen people new to him spend half an hour getting acquainted and come away devoted fans. Whenever he was in the office and could make it happen, he would walk the INPO halls in the late afternoon and stop in to visit with anyone who was in their office, no matter their position or rank. He would sit down and talk, expressing sincere interest, laughing, and telling a sea story or two. That had a great impact on INPO employees.

I especially like the story about Dennis, some years before he came to INPO, talking with the son of a Navy acquaintance. The acquaintance was worried about his son going in the wrong direction. As a last resort, he asked Dennis to talk to him. As always, Dennis was pleased to do so. He met and talked with the young man. Some 30 years later, Dennis received a letter from the son, now middle aged, which said in part, "Because of you, I turned my life around. I graduated from college, have a wonderful family, and a successful career. All because of the time you spent with me and your good guidance and counsel those many years ago."



Vice Adm. Eugene P. "Dennis" Wilkinson

That story is so representative of Dennis Wilkinson.

It appears that Admiral Wilkinson had three careers in his lifetime. One of them involved his time in the Navy during World War II. Can you talk about that period and its significance?

Dennis Wilkinson's service during World War II was filled with excitement, danger, and adventure. In early December 1941, he was on his first ship—the cruiser USS *Louisville*, which was returning from escort duties in the Philippines—when a Japanese fleet came into view. The *Louisville* crew was unaware that the fleet was on its way to Pearl Harbor. *Louisville* arrived a few days after the attack, and the men saw the devastating results. That ended Dennis's expectation to serve only one year of active duty. He signed on for another four years, and that evolved into a 37-year naval career.

Later, Dennis's service on the submarine USS *Blackfish* almost ended in disaster when it was depth charged by the Germans and sustained major damage. Only by luck or the grace of God, *Blackfish* dived to the bottom below a strong current that obscured its position from further attack. Near the end of the war, Dennis was on the submarine USS *Darter*, the first to report the presence of the Japanese fleet at the Battle of Leyte Gulf, considered the largest naval battle in World War II, and maybe in history. *Darter* performed heroically but was grounded and wrecked, and the crew barely escaped capture by the Japanese. The crew was awarded the Navy Unit Commendation for heroism, and Dennis was awarded the Silver Star. His successes and expanded technical knowledge were stepping stones to his later Navy achievements.

His second career was his time with the nuclear Navy and Admiral Rickover. What can you tell us about that time?

The association with then Captain Rickover was an example of Dennis's being at the right place at the right time. He often said, "They needed an operations guy on Rickover's team, and I was it." USS *Nautilus* was the first nuclear-powered Navy submarine. Being involved in the design of the first nuclear reactor for *Nautilus* was huge. Being selected as its first commanding officer was even more momentous. That was followed by being selected as commanding officer of USS *Long Beach*, the first nuclear-powered cruiser. Both vessels were enormously newsworthy and achieved great successes. Dennis followed that with additional accomplishments after achieving the rank of admiral, including setting up standards for developing and maintaining safe and reliable nuclear operations for Navy submarines and sur-

face ships. He was instrumental in forging a mutually strong post-war relationship between the United States and Japan. He had an amazing Navy career and received four Distinguished Service Awards, among many other awards.

In the early 1990s—about 1992 or 1993, as I remember—the Navy dedicated a new 50,000-square-foot training building to Dennis. Wilkinson Hall sits on a hill inside Naval Submarine Base New London, in Groton, Conn. Dennis said he was shocked, but very pleased and humbled by the great honor. I was privileged to visit the site with him in 2005 and to see his portrait and memorabilia about his career inside the building.

Then came his time with the Institute of Nuclear Power Operations, which was his third career.

Yes, that's right. Dennis didn't expect or solicit his involvement in INPO, yet it became the capstone of his nuclear career. His career spanned the birth of nuclear propulsion through its infancy and on to its major place in the military and adaptation to worldwide commercial power, and ended with outstanding contributions to the commercial industry following its most devastating challenge up to that time, which was the Three Mile Island accident in 1979.

Over time, INPO became the service of which Dennis was most proud. He was

always proud of and grateful for his Navy career—it was the reason he was selected as INPO's first CEO. But it was his unique abilities that established a viable INPO and resulted in significant improvements for the commercial nuclear power industry. His brilliance, relationship skills, dedication, and commitment to the highest standards became his legacy in this new arena. He received a number of prestigious industry awards for his dedication and service.

What made Wilkinson able to work so well with Admiral Rickover? Why was he able to take Rickover's nuclear Navy and "make it run?"

Remembering a mentor

I had the great honor of knowing and working with Dennis Wilkinson through the early days of INPO and helping to shape it into the great organization it is today.

Although I knew of his legendary history in the U.S. Navy's nuclear power program, I had not met Dennis during my career as a naval officer in the submarine service. I completed my naval career in the aftermath of the accident at Three Mile Island and decided to reach out to Dennis as he was staffing up INPO. I called INPO and asked for Admiral Wilkinson. His assistant, Ann Winters, put me right through to him. It was soon clear that while I had not met Dennis, he knew all about me, my career, my family, and so forth. I'm sure that I got no more than 10 words in during that three-minute conversation. Dennis told me what he wanted me to do, when to do it, when I needed to be in Atlanta, etc. It was a short call but, like Dennis, was focused and direct and completely thorough. My decision to join INPO and my desire to work for Dennis were solidified through that first short interaction with him.

The early days of INPO in the 1980s were challenging as the industry tried to improve all nuclear plant operations after TMI and as INPO worked to become fully effective in its mission. All of the nuclear utilities in the United States were members of INPO, and their chief executive officers expected INPO to fix all of the industry's problems overnight. Dennis decided that he needed to visit every plant and attend each of INPO's plant evaluation exit meetings to ensure that the utility's CEO attended and fully understood the evaluation results and the significance of INPO-identified problems at the CEO's facilities. Dennis's participation in these plant visits gave him deep insights into the overall nuclear industry and established his credibility as INPO's CEO. This travel was a great personal burden on Dennis, but one that he relished. Traveling with Dennis was always exciting. He traveled with only a small briefcase but somehow got all his papers, clothes, and personal items in the small bag. Heaven forbid that Dennis would have to wait for one of the INPO team members to retrieve a checked bag!

Dennis probably shaped my life and career more than any other single person. He was a mentor to all those he touched. His thoughtful but firm management and leadership style, coupled with a wonderful sense of humor, taught me lessons about managing people and organizations that clearly helped me throughout my career in the nuclear industry.

In the mid-1980s, the industry decided to establish the Nuclear Management and Resources Council (NUMARC) as a permanent organization in Washington, D.C., to integrate the

nuclear industry's efforts in working with the Nuclear Regulatory Commission. While still at INPO, I was tasked to form NUMARC, find office space, and staff the organization. As a result, I spent many days in Washington, D.C., but I had no plans to leave INPO. It soon became all too clear that I was to be leaving INPO to head NUMARC, but it wasn't until a year later that I found out that Dennis, with some help from Adm. Lando Zech, was the force behind the decision. This unexpected and unplanned shift in my career path turned out to be the right one for me, as we ultimately evolved NUMARC into the Nuclear Energy Institute, integrating all the regulatory, communications, and political elements into a single, focused organization. I had the honor to serve as its president and CEO for nearly 20 years, and I credit Dennis's foresight and vision in seeing the future needs of the nuclear energy industry and formulating the essential ingredients for its success.

In a larger sense, Dennis brought to the commercial nuclear energy industry the understanding of the need to strive for excellence in all aspects of plant operations and the recognition that every nuclear power plant is a captive of every other nuclear plant, in that a problem at one plant is a problem at every plant. Dennis's vast experience in the development of naval nuclear power programs, from the first submarine nuclear plant to surface nuclear power, and his close personal relationship with Adm. Hyman Rickover gave him the fundamental tenets of safety and management programs necessary to ensure the success of this demanding technology. He was relentless in ensuring that those same fundamental tenets were integrated into all aspects of commercial nuclear plant operations. The results of those efforts are clearly demonstrated by the significant increases in the safety of plant operations over the last several decades.

Dennis was a leader, a visionary, and a wonderful friend and mentor. I miss him immensely.—Joe Colvin



Joe Colvin is president emeritus of the Nuclear Energy Institute, for which he served as president from March 1996 until his retirement in February 2005. While working at INPO in the 1980s, he helped found the Nuclear Management and Resources Council (NUMARC) in March 1987. He served as president and chief executive officer of NUMARC from February 1991 until March 1994, when it was merged with three other nuclear industry organizations to form NEI. Colvin also served as the 2010–2011 president of the American Nuclear Society.

The admiral always found a way

While serving as a vice president of MDM Engineering in the 1990s, I had the opportunity to work with Admiral Wilkinson, as he was chairman of the company's board of directors. This was one of the most interesting and exciting times of my career. Admiral Wilkinson was truly a humble leader in the nuclear industry, and he always introduced himself as "Dennis" to everyone he met, whether in business or at social events.

Dennis would often tell us stories from his career in World War II and his later times in the Navy with Admiral Rickover. There were also tales about USS *Nautilus* and the beginning of nuclear energy for naval and commercial purposes. And I remember that whenever we were on a business trip to visit utility and vendor customers, we always had to stop for ice cream at whatever airport we were going through, because Dennis loved his ice cream!

Dennis always took an interest in anyone working in nuclear science and technology, and he paid special attention to young people starting their careers. When he served as honorary general chair of the ANS Meeting in San Diego in the early 2000s, he was personally involved in recognizing all attendees and sponsors, including giving out awards and recognitions at the special events.

Because of his experience in starting INPO, Dennis was well connected with all levels of management at nuclear utilities. He had the ability to ask probing questions and get right to the bottom line in whatever discussion was being had. He also had an incredible talent for getting people to "do the right thing" in whatever task they were assigned.

The enduring legacy of Admiral Wilkinson has come from many examples, as brought out in the Ann Winters book. The story told is much more about true leadership and team building during his decades in the nuclear industry than it is a documentary of technical facts. Dennis always found a way, no matter how difficult the task, to work hard and enjoy it at the same time. —*Ted Quinn*



Ted Quinn has more than 40 years of experience in managing nuclear and fossil utility contracts and personnel in support of both project and supplemental assignments at various utilities in the United States. He is a past president of the American Nuclear Society (1998–1999), president of Technology Resources, and currently serves as chairman of the International Electrotechnical Commission SC45A Working Group A9 on Nuclear Instrumentation Systems.

Dennis used to say that he worked well with Admiral Rickover because Rickover wasn't the one who signed Dennis's fitness reports for the Navy. The result was that Dennis was able to "tell it like it was," with no fear of retaliation. I think it was more than that, however. I think that Admiral Rickover recognized in Dennis Wilkinson a man of comparable intellect, sound judgment, high standards, and integrity.

Rickover's focus at the time was on "selling" the nuclear Navy. His activities were mostly directed at the Atomic Energy Commission, Congress, other members of government, and the industry in order to ensure the proper support for developing nuclear. Rickover certainly understood operations and was involved in developing the nuclear Navy, but Dennis Wilkinson was an operator at heart. His focus was on making things run the way they should and being sure that high standards were met. In addition to helping design the first reactor, he learned about the entire boat, thanks to all of his submarine experiences. After reaching command rank, he spent lots of time in the engine rooms of all the ships that he commanded, including *Long Beach*, which was a large cruiser with more than a thousand personnel. When he inspected ships later on during his higher command positions, he never failed to visit the engine rooms, talk with the crew, and discuss operations, which was a forerunner to his visits to commercial nuclear power plants where he did the same thing.

When Dennis became director of the Navy's Submarine Warfare Division, he

was instrumental in setting up a comprehensive plan for the review and evaluation of operating nuclear plants on submarines and surface vessels—not only before the reactors went critical and the ships went to sea, but also periodically throughout the operating lives of the ships. Those structures are still in place today to ensure safe and reliable operations for the Navy.

While Rickover may have tested Dennis as he did everyone else, I think he appreciated a man who held his own verbally and technically and with strong integrity. With what I have learned of both men over the years, I think I can comfortably say that each was likely better because of the other.

Why was Admiral Wilkinson chosen as the first commanding officer of Nautilus? Did then Captain Rickover personally select him for this important role?

Rickover was definitely in favor of Dennis Wilkinson as the first CO of the *Nautilus*. I'm sure he wanted someone who thoroughly knew the submarine's nuclear plant. He wrote a "confidential and personal" letter to Dennis urging him to apply for the position, but Dennis chose not to. If selected, Dennis wanted it to be because he was deemed the best choice and not because he actively sought the job.

As Dennis used to tell the story, part of his selection was good luck—he was again at the right place at the right time. He was number one in his age group on the list maintained by the Submarine Detail Desk. As he said, "I was the right age,

seniority, background, command, and technical/operating experience, all at the right time." He had excellent command and operations credentials and the required nuclear knowledge. Rickover's influence was, I'm sure, another major factor in Dennis's selection, although Rickover wasn't as powerful at that time and didn't control nuclear personnel selections as he did later on. Dennis was truly grateful and recognized the assignment as a great achievement and a huge challenge.

At the time Nautilus was launched, it gave nuclear power "celebrity status." What did that mean in the 1950s?

It's hard for us today to comprehend the enormous impact of *Nautilus* in the 1950s. Dennis often told stories of media crews and large crowds that lined riverbanks and harbors whenever *Nautilus* arrived or departed a location, seeking just a glimpse of this new "nuclear" submarine. School classrooms, Boy Scout and Girl Scout troops, clubs, civic groups, and others named themselves *Nautilus*. There were *Nautilus* fan clubs throughout the United States. There were long lists of dignitaries who sought visits and short rides, including senators and congresspersons, members of the Atomic Energy Commission, the secretary of the Navy, Navy representatives, scientists, government representatives, mayors, and business leaders. Wherever *Nautilus* traveled around the world, it received warm welcomes, keys to cities, special citations—and the list went on. Members of royalty were also eager to experience this new technological marvel. Those must have been heady times. I can

only imagine the excitement of being on *Nautilus* and interacting with its crew as the men demonstrated its wonderful new capabilities.

When Admiral Wilkinson became the first commanding officer of the Navy's cruiser Long Beach, was nuclear still as newsworthy as with Nautilus?

From what Dennis told me, *Long Beach* was certainly newsworthy, although maybe not quite as well known to the public as *Nautilus*. Within the Navy, *Long Beach* was the first nuclear cruiser and was very well known. It was another huge effort for Dennis, since he took charge during the final stages of construction, with all that that entailed. Dennis was not as formal as most cruiser captains unless the situation called for the pomp and ceremony. Then he might tell his men, "Help me put on this damned uniform with all the medals." Changes of clothes could happen several times a day when VIP visitors came aboard. During routine operations, he could be found all over the ship dressed casually in khaki shirt and shorts. His men loved to see his interest in all areas of the ship. He carried forward another routine from his submarine days: He was determined to know every man on board by face and name—all 1,000-plus crewmen. So each day, he pulled out a photo of one or two men, along with some details about their lives, and memorized the information. When he made his walk-throughs, he called everyone by name and frequently recalled personal facts about the individuals. What an impact!

One of the most popular PR features of *Long Beach* was giving honors. When visiting new places or hosting important dignitaries, honors included firing two 40-millimeter guns, one round from one gun and then another round from the other. He said everyone loved it. Imagine, there was this huge cruiser of 1,000-plus personnel with the most current and up-to-date weaponry, firing those guns. How impressive that must have been! The list was long of people who wanted to visit and ride on *Long Beach*, just as it had been with *Nautilus*. When I was going through Dennis's memorabilia at his home, I found several files of thank-you letters from people who had visited *Long Beach*.

The title of your book includes the phrase "Underway on Nuclear Power." Why did you pick that for the title?

Nuclear power is almost everywhere today, so it can be hard for us to comprehend the enormity of accomplishing it for the first time in the 1950s and the importance of *Nautilus* to that time. Dennis Wilkinson and his men worked around the clock to prepare for the first underway of the submarine. It had to go right the first time. Recognizing the momentous occasion, the Navy directed its communications people to draft a suitably important message to be broadcast just as *Nautilus* got underway for the first time. Keep in mind, again going back to that time, that broadcast messages were sent from the deck via flashing lights, typically letter by letter.

Dennis often told the story of Navy PR

officers coming on board just before underway with an impressive message more than a page long to be broadcast as *Nautilus* first got underway. Gracious as always, he thanked them, but said the message had to be shorter so that it could be easily sent via flashing lights. The PR people left and returned with two paragraphs. Dennis thanked them again, but he knew that his men could not send two paragraphs by flashing lights—the message had to be succinct and easy. So he turned to his communications officer, Ned Dietrich, and told him to condense the message further. Dietrich reduced the message to several lines, but it was still too long. After additional direction from Dennis to make it short and simple, the message was finally culled down to "Underway 1100 on nuclear power." Dennis looked at the short message, said to himself that people would know the time and didn't have to be told, and he struck through the "1100." The short, succinct message, "Underway on nuclear power," was successfully, quickly flashed at 11 a.m. on January 17, 1955, and ever since it has been the byword for Navy nuclear power.

I picked *Underway on Nuclear Power* as the title of the book because it best represented Dennis Wilkinson's place in Navy history and nuclear power. He truly was the man behind those words. Without that "first" there could never have been all that has come after.

Admiral Wilkinson was the first president and CEO of INPO, serving from 1980 until his retirement in 1984. How and why was he selected for that position?

Bill Lee said it best back in 1980. Bill was chief operating officer of Duke Power. He was a leader in the industry's response to TMI and was instrumental in the establishment of INPO following TMI. Bill also was INPO's first chairman of the board and was head of the search committee to find INPO's first CEO. The selection activity was time-urgent during the fall of 1979. More than 100 qualified individuals were considered for the position, but the search committee realized that the right fit was not available from the commercial nuclear industry. Bill recognized the potential of retired Navy nuclear personnel who had depth of knowledge and experience, and he began aggressively searching those possibilities.

Bill loved to tell the story about contacting Admiral Rickover each time a retired Navy admiral was being considered as INPO's CEO. All of the early calls to Rickover ended with his shouting into the phone, "He's no damn good!" followed by his slamming down the receiver. The list was finally pared down to two highly recommended individuals—Vice Admiral Eugene Parks Wilkinson and Vice Admi-

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First transmission of the historic message "Underway on nuclear power" (January 17, 1955)

ral Dennis Wilkinson. Bill laughed about discovering that they were one and the same man! Eventually, when Bill called Admiral Rickover and asked about retired Vice Admiral Eugene P. “Dennis” Wilkinson, Rickover screamed into the phone, “He’s too damn good for you!” Slam! Bill was delighted.

Bill Lee was convinced that Dennis Wilkinson was the right man for INPO, but each time he offered the job to him, he declined. After all, Dennis had retired after a long, distinguished Navy career and was comfortably settled in California. And he was soon to become CEO of the engineering company where he worked. While he was concerned about the impact of TMI on the nuclear industry and was sought out by Admiral Rickover and others for advice and counsel, he wasn’t interested in taking on another startup project that would be all-consuming.

Bill perceived that offers of money, prestige, and career building would not attract Dennis. As Bill said later, “The only way to attract Dennis Wilkinson to INPO was by appealing to his service to his country—and INPO was a major service to the country—and by his again being the first in new territory.” It still took a lot of convincing, but Dennis finally relented. And the rest, as they say, is history.

Can you talk about Wilkinson’s “Xerox box” while he was at INPO?

Dennis Wilkinson was never one to flaunt his status or fame. In fact, he did just the opposite. He once said that instead of telling people what he had accomplished, he preferred to let his actions and achievements speak for themselves. So he never demanded special treatment—although there were times he did receive it, but it was instigated by others for him, not by him.



Wilkinson and his ubiquitous Xerox box (1984). His wife, Janice, is at left.

It wasn’t long after he started work at INPO that we began seeing him carry a Xerox box into the office each morning and carry it out each evening. We soon learned that he loaded the box with paperwork before leaving the office, took it home and completed it that night, then brought the completed work back the next morning. While the box itself generated

smiles, knowing what it meant and the volume of work he completed caused head shaking and marveling at his abilities.

After a number of months of the Xerox box, several of us tried to convince Dennis that he needed a briefcase, but he always answered “No, the box is fine.” When a box became ragged or torn, he went to the copy room and found a replacement. An

A proud INPO legacy

The Institute of Nuclear Power Operations owes its creation, methods, and long-term success in influencing nuclear industry performance to Admiral Dennis Wilkinson’s vision and leadership. The genesis of INPO was not easy, and it required profound leaders and leadership to convince the commercial nuclear power industry of its need to embrace INPO and its message. Admiral Wilkinson’s ability to influence industry leaders, set and enforce the highest standards of nuclear safety and reliability, and guide INPO’s evaluators to uphold those standards in both their work and their own personal conduct enabled INPO’s success.

At the end of each year, INPO presents awards to INPO members and teams whose work has defined excellence. The highest single honor for an INPO employee is to receive the Wilkinson Award, which is reserved for an individual whose contributions to the nuclear power industry are befitting of Admiral Wilkinson’s legacy.

I think that Admiral Wilkinson would be proud to see his

legacy hard at work, influencing nuclear industry performance. He would certainly recognize the high standards that are being upheld every day, and he would be impressed by the dedication of INPO employees to their mission. But mostly, Dennis Wilkinson would be awed by the nuclear industry that INPO has helped to shape. He would be amazed at its professionalism, mutual support, and incredible safety and reliability.—Bob Willard



Robert F. Willard has been president and chief executive officer of INPO since May 2012. He retired with the rank of admiral in March 2012 after 39 years of service in the U.S. Navy. During his naval career, he served in many capacities, including as commander of the U.S. 7th Fleet in Yokosuka, Japan; vice chief of naval operations; commander, U.S. Pacific Fleet; and his final assignment as commander, U.S. Pacific Command, Camp H. M. Smith, Hawaii.

Interview: Winters

important industry meeting was coming up in Washington, D.C., and we feared he would take a Xerox box or something similar along for his papers. Finally, after a lot of pleading, he let us buy him a small leather attaché case that held just a few papers. As soon as he returned to the office, he was back to the Xerox box.

I think he liked the Xerox box because it was efficient—he could carry a large amount of papers easily—and it demonstrated that he was a professional who worked just as hard as everyone else in the company. He never asked people to do more than he himself was willing to do. When people saw him with his box, they knew he was taking home lots of paperwork that would be completed that evening and that he was working as hard as or harder than they were. I don't think he was trying to impress but rather to set an example of dedication and commitment.

What do you think would have been Admiral Wilkinson's reaction to his biography?

Over the years, I had often urged Dennis to write his autobiography—his life was filled with exciting adventures and accomplishments that should be recorded. He was adamant that he would never do that. He wasn't shy about his achievements, but I think he viewed an autobiography as self-promotion, which he would never do.

Finally recognizing that Dennis would never write his memoir, I began asking him about a biography. He still refused. After several years, I finally said to him,



Vice Adm. Eugene P. "Dennis" Wilkinson, USN (retired), next to his portrait during the dedication of Wilkinson Hall (July 9, 1993)

"Dennis, you need a biography—the world needs your biography. I'll write it." He still said no. After more time passed, I said, "Dennis, I'm going to write your biogra-

phy. Other people are enthusiastic and will help. Don't you want to be involved to be sure the right people are involved and we get it right?" He reluctantly agreed. Several months later he gave me a long, well-organized list of people who had known or worked with him during the different phases of his life: youth, college, Navy, each vessel, government, INPO, commercial industry, and so on. By this time, he was okay with the effort and I think even eager to see what developed.

I was able to contact more than 50 individuals from the list. Their memories added so much.

The interviews and research took a long time—much longer than anticipated—followed by the actual writing and publishing, which also took a long time. I sent several versions of early chapters to Dennis that he reviewed and on which he made corrections. I soon recognized that I had little leeway to add or improvise—he wanted the facts to be correct. The book was published by ANS in 2016. I was extremely saddened and disappointed that my effort was not completed before Dennis passed away in 2013.

Based on feedback from people who knew him, the book does a good job of presenting Dennis Wilkinson. His family was especially pleased to have his history captured in print. I like to think that Dennis would have been pleased, too. **NW**



William S. Lee presenting the Henry DeWolf Smyth Nuclear Statesman Award to Wilkinson (November 1994)

CHINA

Taishan-1 connected to grid

The world's first operating EPR has been undergoing a period of power-raising and associated testing, which will lead to steady-state operation at full power.

Unit 1 of China's Taishan nuclear power plant, now the lead EPR project in the world, was connected to the grid on June 29 at 5:59 local time. Construction of the reactor began in 2009, with that of its sister plant, Taishan-2, starting in 2010. These two units were, respectively, the third and fourth EPR reactors to start construction (Olkiluoto-3 in Finland and Flamanville-3 in France were the first two, with construction beginning in 2005 and 2007, respectively).

On April 10, following the completion of preparatory work and testing, China's Ministry of Ecology and Environment gave permission to load fuel in Unit 1, which commenced that same day, and first criticality was achieved on June 6. Following grid connection, the reactor started a period of power-raising and associated testing, which will culminate in steady-state operation at full power.

The plant's owner-operator is Taishan Nuclear Power Joint Venture Company Limited (TNPJVC), which is made up of China General Nuclear Power Group (CGN), with a 51 percent stake; EDF, with a 30 percent stake; and the provincial electricity company Yuedian, with a 19 percent stake.

EDF's nuclear activities in China date back to CGN's Daya Bay project, which was initiated in the 1980s. The longstanding strategic partnership of the two companies led to the establishment of TNPJVC to handle the construction and operation of two nuclear reactors based on France's EPR Generation III technology in Taishan, Guangdong Province. The EPR was jointly developed by EDF and Framatome.

During a January 9 visit to Beijing, French President Emmanuel Macron, along with Chinese President Xi Jinping, unveiled a plaque to celebrate the completion of Taishan-1. It reads: "The First EPR Reactor in the World."

Besides EDF and CGN's long-time partnership, other factors that contributed to Taishan-1 becoming the world's first EPR to go on line, according to the press announcement, were the experience of both partners in the construction and operation of many nuclear power plants and the strong support of leaders in both countries. During the initial stage of the project, Taishan also benefited from experience gained from work on the two European EPR projects at Flamanville-3 and Olkiluoto-3.



Photo: CGN

Taishan: Unit 1 is the world's first EPR to be connected to the grid.

CANADA

SMR research cluster attracts U.S. developer

Advanced Reactor Concepts (ARC), an American company based in Maryland,



U.S. company Advanced Reactor Concepts (ARC) will participate in the SMR research cluster being created in the Canadian province of New Brunswick. From left: Rick Doucet, New Brunswick's minister for Energy and Resource Development; Gaëtan Thomas, president and CEO of NB Power; Heather Chalmers, president of GE Canada; and Don Wolf, CEO and chairman of ARC.

will participate in a new nuclear research cluster focused on small modular reactor (SMR) technology being created in the province of New Brunswick. According to a July 9 press announcement, the cluster offers significant infrastructure and expertise that already exists at New Brunswick Power's Point Lepreau nuclear plant, a CANDU 6 pressurized heavy-water plant located on the Bay of Fundy. On June 26, the province said that it was investing Can\$10 million (\$7.6 million) to help establish the research cluster.

"We are pleased to announce the participation of ARC, a company with significant experience and ability to make advancements in this burgeoning sector," said David Campbell, chair of the New Brunswick Energy Solutions Corporation, a joint venture of the provincial government and NB Power that is setting up the cluster. ARC will commit Can\$5 million (\$3.8 million) to operations and research and will establish a local office in Saint John.

ARC is developing a metallic-fueled, sodium-cooled fast reactor, and aims to license, construct, and commission its first operational, grid-connected reactor in Canada. The company is currently working toward the development of a 100-MW SMR using proprietary PRISM technology from GE Hitachi Nuclear Energy, and is working with support from GE Hitachi's engineering and design teams. The two companies have a development agreement.

"ARC Nuclear is an excellent fit for us here in New Brunswick," said Gaëtan Thomas, president and chief executive

officer of NB Power. "The company is a world leader in its field and will be a great asset here in the province, along with our other partners [that] we will announce soon as we broaden our opportunities in the energy sector."

"We are well-positioned to seize an opportunity in this sector thanks to the know-how of our people and the tremendous asset we have in Point Lepreau," said New Brunswick's Energy and Resource Development Minister Rick Doucet. "We are pleased to see that we have partners coming to the table who have the ability to make advancements in this sector as we seek to transition to a lower-carbon economy."

INTERNATIONAL ENERGY AGENCY

Meeting held to discuss future of nuclear power

With growing concerns about the diminishing role of nuclear energy in providing energy security and zero-emissions generation, the International Energy Agency (IEA) held a high-level meeting to identify and explore key issues challenging nuclear's future, including increased competition with renewables and natural gas and, in some cases, public opposition. The meeting, "Nuclear Energy: Today and Tomorrow," was held in Paris on June 28.

According to the IEA's new Tracking Clean Energy Progress website, which tracks trends in the development of nu-

clear and other sources, nuclear capacity additions declined significantly in 2017, falling to just 3.6 GW, down from 10 GW in 2016, with construction starts also remaining low. Over the past five years, 33 GW of capacity was connected to the grid, with China accounting for two-thirds of that total. Meanwhile, 18 GW has been shut down permanently, including 7.3 GW in Japan and 4.9 GW in the United States.

"Declining investment, announced phaseout policies, and planned retirements, combined with only 56 GW of nuclear capacity under construction in 2017, suggest that meeting the goal of 185 GW of net increase needed by 2030 will be very challenging," the IEA said, adding that pending construction decisions by China, India, and Russia in 2018–2020 will play a major role in whether nuclear power will meet the IEA's Sustainability Development Scenario targets in 2030 and beyond.

IEA Executive Director Fatih Birol, in his opening remarks at the meeting, said, "With current policies, there is little prospect for significant growth for nuclear power in developed economies on the horizon—although there are new efforts to spur innovations that could change this picture."

In his keynote address, Dan Brouillette, the U.S. deputy secretary of energy, highlighted the importance of innovation in nuclear energy. "In the United States, we are committed to reviving, revitalizing, and ultimately expanding the use of nuclear energy because we know its benefits," he said. "We are just starting to see the potential of nuclear power in meeting our energy security needs and our clean energy goals. The advanced reactors, the advanced fuels, and the advanced materials being developed in the U.S., France, and around the world all offer the promise of lessened emissions and increased reliability."

The meeting participants—among them ministers and senior government officials from IEA member countries and chief executive officers of energy companies, including Ontario Power Generation and EDF—examined the role of nuclear energy in mature power markets and the challenges it faces to remain a significant source for meeting the goals set for energy security and the environment.

The meeting focused on three areas: the challenges of meeting nuclear-specific policy targets while balancing overall economic, environmental, and energy security goals; the position of nuclear power in mature power markets; and the potential of nuclear technologies to address future power flexibility challenges and emissions reduction targets.

The meeting sessions highlighted how—under current policy frameworks and

with limited investment in new plants—the contribution of nuclear to the power mix in mature markets is set to decline significantly. Most new construction is in Asia, with China and India accounting for over half of the new reactors under construction. In the IEA's World Energy Outlook New Policies Scenario, nuclear power production grows, with two countries, China and India, responsible for over 90 percent of net growth to 2040. By contrast, outside of Japan, nuclear power generation in developed economies is set to decline 20 percent by 2040.

On a positive note, the meeting attendees also heard about new initiatives to advance innovative nuclear power technologies, including those that can better address the need for greater power systems flexibility, spurred by the rise of generation from variable renewables.

JAPAN

Cabinet approves new Strategic Energy Plan

Japan's government approved the latest revision of its Strategic Energy Plan, which calls for nuclear power to provide 20 to 22 percent of the country's total electricity, in line with the previous 2030 target for nuclear power's share. The target for renewable energy is slightly higher, at 22 to 24 percent, and for fossil fuels is at 56 percent.

The Strategic Policy Committee, which was charged with drafting the new plan, began its deliberations in August 2017. The Strategic Energy Plan is revised every three to four years, with the last one done in 2014. The committee, which comes under the powerful Advisory Committee for Natural Resources and Energy, finalized its draft in May. According to the Japan Atomic Industrial Forum (JAIF), the draft also included the development of a 2050 scenario, taking into account the targets set out under the 2016 Paris Agreement on Climate Change.

The new plan, JAIF said, adheres firmly to the conventional priorities of energy security, economy, environmental protection, and safety. It calls for energy conservation, as well as the implementation of measures tailored to each energy source to meet their targets. For 2050, the plan embraces a more ambitious goal of reducing greenhouse gas emissions by 80 percent.

JAIF also noted that for 2030, nuclear power will remain an important baseload power source, but for the long term, it is positioned less clearly as only one option for realizing a low-carbon future.

Following the government's decision, Satoru Katsuno, chairman of the Federation of Electric Power Companies (FEPC), released a statement that says, in part: "We

consider the declaration of this policy to be highly meaningful, and hope that the government will steadily promote this plan as a key policy. [The FEPC intends] to contribute to the government's energy policy in achieving the 2030 energy mix put forth in this plan by accelerating [its] efforts in various areas, including restarting nuclear power plants and expanding the use of renewable energy."

UNITED ARAB EMIRATES

IAEA reviews readiness of nuclear infrastructure

On July 1, an International Atomic Energy Agency team of experts concluded an eight-day Integrated Nuclear Infrastructure Review (INIR) mission to the United Arab Emirates to review the development of the infrastructure needed to implement the country's nuclear power program. This mission was the first the IAEA has conducted for a country during the third and final phase of infrastructure development as preparations are being completed to start the operation of its first unit. The UAE is the first country to reach this landmark as defined by the IAEA's Milestones Approach, which provides detailed guidance for developing nuclear infrastructure. The INIR mission was hosted by the UAE's Federal Authority for Nuclear Regulation (FANR).

The UAE's nuclear program is led by the Emirates Nuclear Energy Corporation (ENEC), which is partnering with Korea Electric Power Corporation to construct and commission the country's first nuclear power station—consisting of four 1,400-MWe Korean-designed APR-1400 units—at Barakah, in Abu Dhabi. The INIR mission was conducted as FANR is considering the application for Unit 1's operating license, which will allow fuel loading to begin and, ultimately, the start of the unit's operation.

The IAEA Milestones Approach sets out three phases of infrastructure development with three associated milestones, at which point the progress of the development effort can be evaluated. It also identifies 19 specific infrastructure issues that developers need to consider.

For this INIR Phase 3 mission, the team used an IAEA document titled *Evaluation of the Status of National Nuclear Infrastructure Development at Milestone 3*. The nine-member team reviewed the UAE's development since the INIR Phase 2 mission was conducted in 2011. The team focused on the conditions required to achieve Milestone 3, based on the 19 infrastructure issues, including, for example, human resource development, regulatory and legal frameworks, funding and

financing, procurement practices, and a range of safety and environmental topics.

"This INIR Phase 3 mission is the first of its kind, marking an important milestone for both the UAE and the IAEA," said team leader Milko Kovachev, head of the IAEA's Nuclear Infrastructure Development Section. "We met with highly motivated and competent professionals from the UAE and the mission was conducted in a cooperative and open atmosphere."

In preparing its report, the INIR team met with FANR; ENEC; Nawah Energy Company, ENEC's subsidiary that will operate the plant; and other key organizations. The missions are expected to help them develop an action plan to fill any gaps in their infrastructure development. INIR missions also enable project specialists to have in-depth discussions with team experts about the experiences of and best practices used in different countries.

The UAE has made steady progress since the 2011 INIR mission, Kovachev said, noting that the IAEA team identified several good practices that would benefit other countries developing new nuclear programs. These included FANR's request that Nawah develop an operational readiness report and carry out an extensive self-assessment. The IAEA also praised the development of a strong engineering team within Nawah that will later become the design authority for the plant. The IAEA team also highlighted the UAE's research and development programs that will ensure the project's long-term sustainability and identified good practices in the areas of management and human resource development, nuclear safety, safeguards, and safety-security interface.

The team's report has several recommendations for further actions, including the finalization of all necessary arrangements for attaining operational readiness before fuel loading, and the implementation of all appropriate arrangements for radioactive waste management.

Ambassador Hamad Alkaabi, UAE's permanent representative at the IAEA and deputy chairman of the FANR board of management, said: "The successful conclusion of the Phase 3 INIR mission is a testament to the UAE's commitment to upholding the highest international standards of safety, security, and transparency as we approach the commissioning of the nation's first nuclear energy plant. The extraordinary progress of the UAE's peaceful nuclear energy program is a result of our continuous collaboration with an extensive network of international organizations whose members include some of the world's most renowned professionals in nuclear energy. [This] has allowed us to rise to the forefront of the peaceful nuclear energy industry."

Section continued

Nuclear AMRC signs MOU with China's CGN

The Nuclear Advanced Manufacturing Research Centre (Nuclear AMRC) and China General Nuclear Power Corporation (CGN) have signed a memorandum of understanding to help strengthen links between CGN and Britain's nuclear supply chain. According to a June 29 announcement, the areas covered by the MOU include the supply chain model to be used by CGN for the Bradwell B nuclear project and how U.K. businesses can prepare themselves to participate in the project; how British companies and universities

can add value to CGN nuclear operations in China and elsewhere; and how links can be built between Chinese companies and academic institutions and their counterparts in Britain.

CGN plans to deploy its HPR1000 reactor technology, which is currently undergoing the generic design assessment process for deployment in the United Kingdom, at the Bradwell site in Essex, England. "This significant agreement with the Nuclear AMRC paves the way for our two organizations to develop the U.K. supply chain," said Zheng Dongshan, chief executive officer of General Nuclear International, the U.K. business unit of CGN. "It also will help to ensure that British companies are given the best possible opportunity to benefit from our

planned investments in the U.K. nuclear fleet.

"The MOU also covers knowledge-sharing between the nuclear industry and academic institutions in the U.K. and in China," Zheng said. "Deeper relationships in these areas will enable us to learn from the best practice on both sides. . . . We have made clear that we intend to become a major and credible industrial player in the U.K., and this agreement is a big step forward towards that goal."

Andrew Storer, CEO of Nuclear AMRC, said that the agreement would bene-



Storer

fit U.K. manufacturers of all sizes. "By working with CGN to understand their requirements in terms of quality and cost," he said, "we will be able to help U.K. manufacturers qualify, identify suitable opportunities, and win

work at Bradwell." He also said that he expects this collaboration to help U.K. organizations access opportunities in CGN's operations in China and worldwide, supporting exports and sharing best practices internationally. "It's a great example of U.K. industry and academia working with the global top tier for the benefit of all, in line with the aims of the new nuclear sector deal," he said.

U.K. government, industry agree on sector deal

On June 28, Business and Energy Secretary Greg Clark announced an ambitious agreement between the British government and the country's nuclear sector to ensure that through major innovation, cutting-edge technology, and a diverse and highly skilled workforce, nuclear energy will continue to power the United Kingdom for years to come. This follows both the government's publication last November of the national Industrial Strategy, which aims to create significant opportunities in the various industrial sectors and generally transform the economy, and its announcement in June that it has entered into negotiations with Hitachi for the Wylfa Newydd project (NN, July 2018, p. 43).

According to the announcement, the deal, worth over £200 million (about \$264 million), will lead the way for Britain to move toward cleaner economic growth. It will also promote new opportunities in the nuclear sector focused on innovation to develop the technology and skills that will allow Britain to continue to be one of the world's leading nuclear countries.

International Briefs

NUCLEAR SITE CHARACTERIZATION STUDIES IN SAUDI ARABIA

will be conducted by French engineering company Assystem to help identify the most suitable locations to build the kingdom's first nuclear power plants. According to a July 3 announcement from Assystem, a contract for the work was awarded by the King Abdullah City for Atomic and Renewable Energy (K.A. CARE), the Saudi agency in charge of developing renewable energy and nuclear power. Besides site characterization studies, which will include geological and seismic analyses, Assystem will also undertake studies covering such things as environmental and demographic effects and the impact on electricity grids. These studies will also provide important technical details for designing the plants.

In July 2017, the Saudi government announced its decision to add nuclear power to its energy mix as it seeks to diversify its power production capacity away from fossil fuels. The Saudi National Atomic Energy Project agreed on by the cabinet also includes the construction of small modular reactors to provide heat for applications such as desalination, petrochemical processing, and, possibly, nuclear fuel cycle activities.

In its announcement, Assystem pointed to synergies it can leverage between its long-standing expertise in the nuclear sector, its specific skills in site characterization provided for Turkey's Akkuyu nuclear project by its Turkey-based subsidiary, Assystem Envy, and its local knowledge obtained through its Saudi-based subsidiary, Assystem Radicon. Assystem is also involved in the United Arab Emirates' nuclear program working for Emirates Nuclear Energy Corporation, the company that is developing the Barakah nuclear project.

UAE NUCLEAR DEVELOPER ENEC SHARED BEST PRACTICES

with partners and stakeholders at a Knowledge Sharing Forum on July 4 in Abu Dhabi City. The forum is an integral component of ongoing efforts of the Emirates Nuclear Energy Corporation (ENEC) to support the transition of the United Arab Emirates to a knowledge-based economy by engaging with local stakeholders, driving growth, and setting new standards of excellence.

The nuclear industry has some of the most stringent quality, technical, and risk management standards in the world, and, according to ENEC Chief Executive Officer Mohamed Al Hammadi, "Adherence to these high standards is what enables us to achieve our strategic goals and objectives." Since its inception, ENEC has committed to sharing its experience in implementing and maintaining these standards with national stakeholders to learn how ENEC developed, managed, and implemented the UAE's civil nuclear program, and how this experience can be applied to other sectors. "[The nuclear program's] development is already supporting many strategic sectors through the enhancement of local businesses, the development of new industries, and the creation of high-value jobs," Al Hammadi said.

More than 300 attendees representing UAE governmental and semi-governmental bodies and organizations from outside the UAE discussed strategy, performance management, innovation, business continuity, risk management, and stakeholder management during the forum.

Another aspect of the deal is that it includes a strong commitment to increasing the diversity of the workforce so that more women can take advantage of new dedicated nuclear colleges and national programs. The announcement notes that currently only 22 percent of the British nuclear workforce is female, and only 15 percent of those are nuclear engineers. This deal aims to deliver up to 100,000 jobs overall in nuclear by 2021, as well as significantly more diversity, with a goal for women to make up 40 percent of the nuclear sector workforce by 2030.

"With this investment in innovation and our commitment to increasing diversity in an already highly skilled workforce, I want to ensure we remain the world leader," Clark said. "Nuclear energy not only fuels our power supply, it fuels local jobs, wages, economic prosperity, and drives U.K. innovation. This sector deal marks an important moment for the government and industry to work collectively to deliver the modern Industrial Strategy, drive clean growth, and ensure civil nuclear remains an important part of the U.K.'s energy future."

Some specific goals of this deal include driving down the costs of nuclear energy and stimulating a new advanced manufacturing program to develop potential world-leading nuclear technologies, such as advanced modular reactors, which will complement the industry's existing plans for larger-scale new nuclear power stations.

As a result, according to the announcement, "The nuclear industry will cut costs of new nuclear power stations by 30 percent by 2030, while cutting the cost of decommissioning old nuclear sites by up to a fifth—all essential to future-proofing this crucial part of the energy sector."

The deal makes available up to £44 million (about \$58 million) to support the development of advanced modular reactors. This will include direct support to reactor vendors to develop their designs and to carry out detailed technical and commercial feasibility studies. Additional funding will be available for regulators to build the capability and capacity needed to assess and license small and novel reactor designs.

Among other priorities, the sector deal will also provide for the following:

- Growth opportunities in the nuclear supply chain through joint government and industry support for smaller companies, allowing them to access higher value contracts and new markets.

- The creation of a national fusion technology platform at the U.K. Atomic Energy Authority's Science Centre in Culham.

- The development of a thermal hydraulics facility in North Wales to support the design and development of advanced nuclear technologies. **EN**

Nuclear News



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24th Annual Vendor/Contractor Profile Special Section

Pages 46–106 contain advertisements and “advertorial” information about products and services provided by the companies in the nuclear industry listed below:

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Framatome completes major refurbishment of 31 reactor coolant pump motors



Framatome recently completed the refurbishment of 31 reactor coolant pump motors for three southeastern nuclear energy facilities. From 2002 to May 2018, the company modified and upgraded these components, which resulted in a 100 percent reliability and zero-failure performance record since being re-installed.

The motors in reactor coolant pumps help move coolant around the primary circuit of a nuclear reactor core. This keeps the reactor from overheating while ensuring the safe heat transfer from a reactor core to steam generators.

“The success of this refurbishment campaign is a tribute to Framatome’s dedicated and experienced employees,” said Craig Ranson, senior vice president of the Installed Base Business Unit at Framatome in North America. “Their unmatched expertise, bolstered by access to world-class facilities, allows us to provide our customers with solutions that, in many cases, are more innovative and cost effective than their plant’s original equipment manufacturer.”

Members of Framatome’s Installed Base services team worked with the plants’ personnel to remove each motor.

They then brought the motors to the company’s 70,000 square-foot Pump and Motor Service Center in Lynchburg, Virginia. While at the center, experts inspected the components, completed necessary repairs and replacements, and tested each motor. Such refurbishments allow these components, and thus their nuclear facilities, to operate safely and reliably for longer durations.

Following successful testing, pump and motor specialists re-installed the motors and assessed their performance on-site.



www.framatome.com/us



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AZZ Nuclear

Headquartered in Fort Worth, Texas, with major facilities in Fort Worth and in Suwanee, Georgia, AZZ Nuclear combines the capabilities of Engineered Solutions, Specialty Welding, and other AZZ business units that supply equipment to the nuclear industry. With the primary goal of keeping nuclear plants operating safely, AZZ Nuclear supplies critical equipment and performs highly technical services aimed at extending the life of plant systems.

AZZ Nuclear Engineered Solutions (formerly NLI) supports the global nuclear industry with equipment solutions for obsolescence, equipment maintenance and qualification services. Engineering, design, manufacturing, testing and qualification are all performed in a 200,000-square-foot state-of-the-art manufacturing and testing facility located in Fort Worth, Texas. In addition to third-party supply, AZZ Nuclear is an OEM for certain equipment types, a manufacturer of other equipment, and routinely dedicates commercially available products. AZZ Nuclear's mission is to provide the worldwide nuclear industry with critical and safety related equipment, equipment maintenance, equipment qualification and engineering services, in a manner that causes the least impact to nuclear plant resources, at the lowest long-term cost, and deliver expeditiously to meet demanding schedules.

AZZ Specialty Welding (formerly WSI) is a leading global provider of technologically advanced maintenance, repair and overhaul services. With a long track record of enhancing safety, reducing risk and improving plant productivity and performance, AZZ Specialty Welding has delivered planned and emergency response solutions to a wide range of nuclear facilities around the world. With repairs successfully performed in more than 130 nuclear power plants around the world, whatever the location, material and size of the asset, AZZ Specialty Welding can offer a field upgrade to your component at the time that repairs are required, ensuring nuclear plants are working at their best. Reducing outages and increasing uptime for nuclear and industrial applications globally.

Nuclear Equipment Services

With best-in-class testing to ensure operation under worst-case scenarios, AZZ Nuclear's Qualification and Dedication programs include thermal aging, radiation testing, EMI/RFI testing, LOCA testing, seismic testing, and software V&V.

Nuclear Equipment Supply

Encompassing thousands of products ranging from Electrical, Mechanical, Instrumentation and Control, HVAC and even specialty one-of-a-kind items, AZZ Nuclear supplies the nuclear industry with everything but fuel.

Stress Corrosion Mitigation

Stress corrosion cracking affects nearly every plant and mitigation strategies are an essential component of plant life extensions. AZZ Nuclear employs several strategies, such as weld overlays and waterjet peening to mitigate the effects of stress corrosion cracking.

Quality Assurance

The AZZ Nuclear quality assurance program has become an industry standard, ensuring our products and services meet the most demanding expectations.



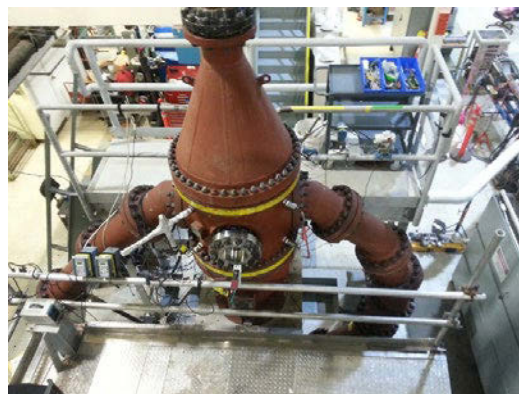
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AN UPDATE FROM CANADIAN NUCLEAR LABORATORIES: SUPPORT FOR REACTOR COMPETITIVENESS, SUSTAINABILITY, AND MODERNIZATION

Canadian Nuclear Laboratories (CNL) is dedicated to enhancing the competitiveness, sustainability, and modernization of both heavy and light water reactors. Through strategic investment in our capabilities and workforce, and through engagement with our customers, CNL is working harder than ever to bring our world-class services to utilities around the globe. We would like to take this opportunity to highlight a few of our recent projects.

CNL Research Contributes to Steam Generator Performance and Longevity

Steam generator (SG) performance and longevity are essential to sustainable reactor operations. In order to better understand what factors contribute to the degradation of SG tubing, the US Electric Power Research Institute (EPRI) looked to CNL for help. Using our unique facilities and expertise in vibration and thermalhydraulics, CNL designed and completed the first phase of an experiment to determine which conditions produce damaging levels of SG vibration. The results will enable the industry to establish clearer safety margins for both new and existing SG units.

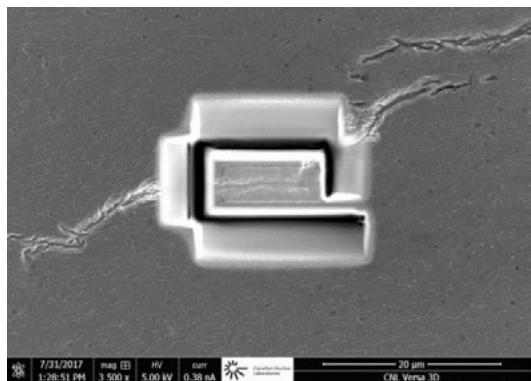


The multi-span U-bend test rig at CNL

Predicting the remaining service life of ex-service cables

CNL completed a study of low voltage cables removed from a reactor that had been operating for over thirty years in order to validate assumptions made as part of their initial Environmental Qualification (EQ) process and to predict their remaining service life. CNL researchers carefully selected cables based on environment, then assessed them through a series of mechanical and electrical integrity tests, supported by existing reference data. CNL researchers confirmed the validity of EQ service life estimates for the majority of cables, and also identified environments that had a significant impact on cable longevity. This study revealed a need to test additional cables from the same reactor, and a broader need to test cables at other reactors.

CNL continues to build its irradiated material analysis capabilities



A 10 micron sample milled along a crack by the FIB

Studying the microstructure of highly irradiated materials is valuable for identifying radiation damage and its impact on the material's mechanical properties and performance. To enhance our capabilities in this area, CNL commissioned a Thermo Scientific Versa 3D dual beam focused ion beam (FIB), and a JEOL F-200 Transmission Electron Microscope (TEM). In combination, these facilities allow CNL researchers to extract micro-specimens from materials of interest, transport them easily between laboratories, and perform high resolution analysis of their microstructure. We are excited to leverage this equipment to expand our

capabilities and bring added value to our customers and partners.

This is just a small sample of CNL's recent work. For more information on all of the exciting projects taking place at CNL, please email commercial@cnl.ca for a copy of our annual report!



Canadian Nuclear
Laboratories

Laboratoires Nucléaires
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NUCLEAR SOLUTIONS From Burns & McDonnell

Burns & McDonnell is focused on providing services to the nation's operating fleet of nuclear utilities. More than 80 percent of our engineers have spent much of their careers working full-time in the nuclear fleet and have lived the nuclear culture.

"When it comes to understanding the safety and operational culture of our nuclear fleet, we understand, we've lived it," says Glenn Neises, Chief Nuclear Officer for Burns & McDonnell. "There is no substitute for direct experience."

Burns & McDonnell has experienced engineers and project managers deployed in offices throughout the U.S. "We are

local and committed to the success of our clients wherever they are because we are familiar with their needs," Neises says.

As a 100 percent employee-owned firm, Burns & McDonnell is committed to the success of each and every project because "you are our client, both personally and professionally," Neises adds. "Ownership means we care about making sure every project is executed to perfection. Our clients notice this attention to detail.

"Burns & McDonnell has more than 6,000 employee-owners working in engineering and construction services across 11 divisions. We bring a broad experience base to the nuclear industry, which results

in innovative solutions for the most complex problems."

Burns & McDonnell has revenue of more than \$2 billion annually, half of which comes from construction projects. "We can do any size project from the smallest study to the largest design-build project," Neises says.

For more information, visit:



www.burnsmcd.com/nuclear



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We are also ISO 9001-2008 certified.



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RSCC maintains the largest inventory of both low voltage and medium voltage single and multi-conductor products. Our entire inventory is fully documented and ready for immediate shipment.

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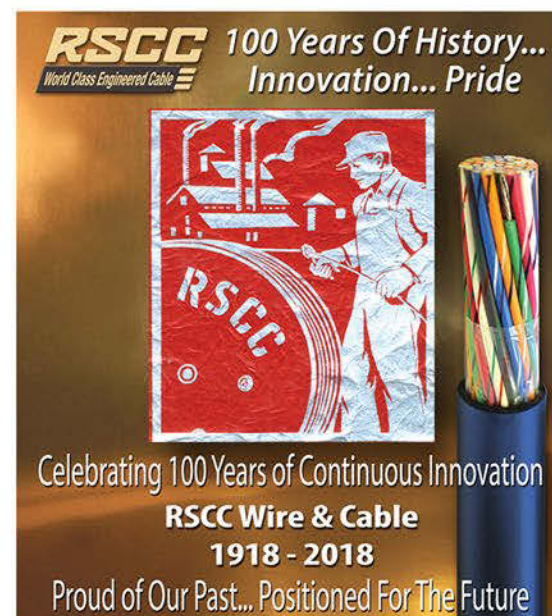
Innovation

Our in-house R&D lab is continually examining and evaluating new materials to identify new opportunities for products. Our broad line of insulating and jacketing materials and engineering expertise allow us to provide virtually unlimited product options.



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deployed worldwide in the most hazardous of environments. Furthermore, you may also be aware that there have been no injuries incurred by operators using BROKK equipment deployed on some of the most challenging projects at nuclear sites worldwide.

We can all appreciate the significant negative impact to a project if there is an injury, a near miss, exposure to radiation or exposure to hazardous materials for any individuals engaged on the project. This negative impact may go beyond the project, to the overall site, even to the industry itself. The use of BROKK remotely operated

equipment keeps the operators at a safe distance from the hazardous workforce avoiding the possibility of injury or exposure.

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Innovative BROKK features such as our "NQH" auto-tool change interface avoids any operator radiation exposure on projects requiring multiple tools and a variety of functions to be performed by a single machine. Vision systems, additional radiation hardening and auto recovery systems are also available as integrated machine options where required.

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BROKK has a dedicated internal Special Engineering Group to assist our customers in defining the best overall solution to meet the project goals. We continue to provide ongoing technical support for all of our customers after equipment delivery, through the duration of the project. We stock a full range of spare parts which are typically shipped out the same day as they are requested. We also provide on-site technical support and certified operator training at the customer's site(s) as needed.

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The BROKK Special Engineering Group can also develop custom designed machines and custom designed attachments where needed for special projects. We have a proven track record of successfully working with our customers to develop and deploy application specific solutions.

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Brokk also offers hundreds of standard and custom designed tools and attachments for our machines. With our standard quick change attachment interface or our optional fully remote tool change interface, a single Brokk machine can perform multiple tasks in hazardous environments with the operator always working in complete safety.

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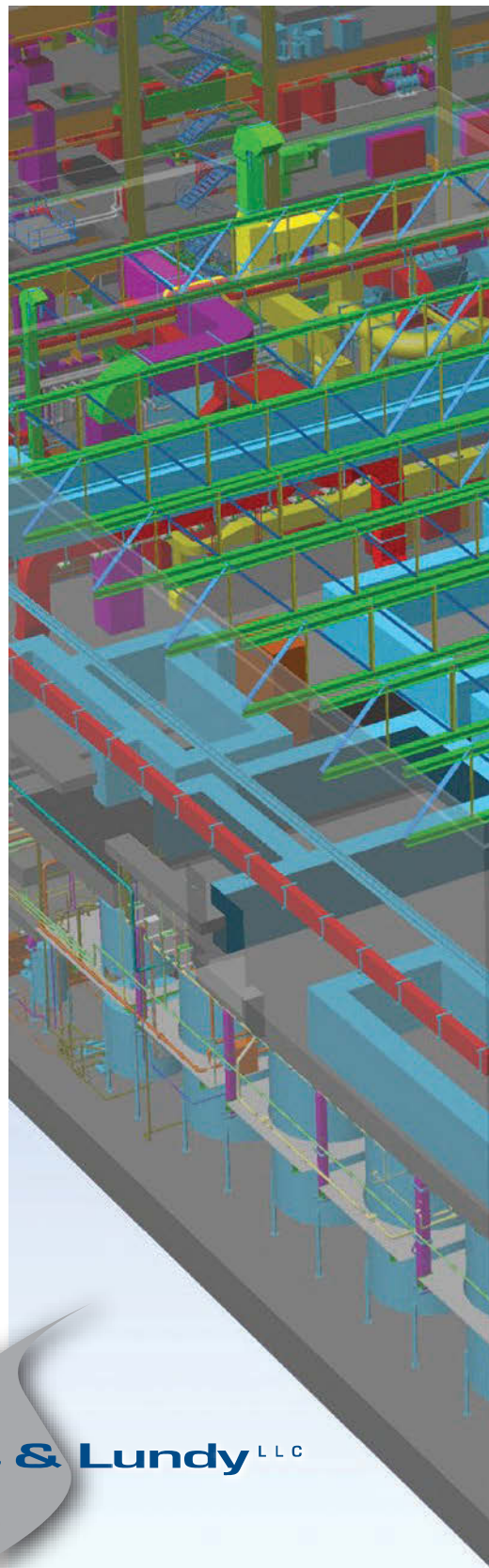
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DP Engineering Ltd. Co. (DPE) is a leading provider of engineering and consulting services to the power industry in the United States. DPE was established to provide value-added engineering services and continues to grow rapidly by contributing to the continued success of our clients. Our primary goal is to establish long term relationships with our clients while ensuring their short and long term goals are met in a safe, timely, and cost-effective manner. Our core engineering competencies include project studies, design modifications (including implementation support), technical reports, engineering analysis as well as development of specifications and calculations.

DPE provides engineering services in support of design engineering. We also provide services to Programs and Systems Engineering and other departments where



engineering support may be required, such as Procurement, Maintenance Engineering, Project Management, and Special Projects.

DPE maintains a 10CFR50 Appendix B Quality Assurance Program. Our QA Program has been approved for use by multiple nuclear utilities, and is available for review at the NUPIC website. DPE provides continuing training as well as just-in-time training specific to the project and/or task. Many of our on-site staff maintain qualifications specific to the client within the clients' accredited training program. DPE also maintains an internal qualification program for its technical staff.

In addition to the main office in Fort Worth, Texas, DPE maintains personnel in other areas. To effectively support the Waterford 3, River Bend, and Grand Gulf stations, DPE has an office in Baton Rouge, Louisiana. For our clients in the gulf coast region, the Baton Rouge office has been a huge success in supporting their needs. To support the ongoing success of the Arkansas Nuclear One units, DPE maintains a staff of approximately 20

professionals on-site working both on managed tasks (modifications, engineering studies, calculations) and in staff augmentation positions in support of ongoing engineering efforts.

There are approximately 120 employees currently working for DPE in our Fort Worth, Baton Rouge, and Arkansas locations. Temporary staff and associate consultants are also available on an "as needed" basis. This approach allows DPE to maintain a staff size and discipline mix that is responsive to our clients' needs while maintaining flexibility and a range of technical experience to address specific project or consulting requirements.

For more information, please contact:

David McKibbin,
Business Development Manager
davemckibbin@
dpengineering.com
Direct Dial: 817-710-8407
Cell: 817-917-5547

Website:
www.dpeengineering.com

Address:
6100 Western Pl. Ste. 500
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The vision to define. The experience to make it happen.

With expert evaluation, planning, and execution, **MPR** solves complex technical and business challenges, mitigates risks, and implements successful plans and strategies. **MPR** is one of the world's leading specialty engineering organizations. Our goal is to enhance equipment reliability, improve plant performance, and reduce operational risk.

With more than five decades of proven engineering experience in nuclear power, let us help you take the next step in your nuclear project.

INDEPENDENT ENGINEERING SERVICES

PROJECT LIFECYCLE

Problem Definition & Acceptance Criteria
Alternatives Analysis
Conceptual Design
Detailed Design
Test Planning
Implementation

ENGINEERING

Analysis
Design Reviews
Industry Experience
Operational Reviews
Major Equipment Inspections
Commercial Grade Dedication & Equipment Qualification
Equipment Obsolescence
Technical Issue Ownership & Resolution
Regulatory Initiatives

PROJECT SERVICES

Project Controls
• Budget
• Schedule
• Resource Integration
Risk Management
Construction Planning
Quality Reviews
Configuration Management
EPC Technical Specification

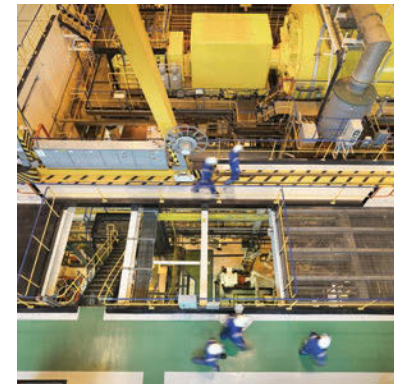
SUPPLIER OVERSIGHT AND INTEGRATION

Engineering Governance
Issue Resolution
Supplier Performance/Incentive Management
Conformance Reviews



ENGINEERING EXCELLENCE

to understand technical needs and deliver results



IMPACTFUL SOLUTIONS

that are innovative, reliable, safe, and cost effective



CUSTOM STRATEGIES

that focus on your company's particular needs, challenges, and opportunities



INDUSTRY LEADERS

whose trusted voices continue to influence the energy landscape



LEADERS IN THE FIELD *every step of the way.*



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An industry leader with an unrivaled record of excellence, MPR is uniquely qualified to address your needs – offering practical advice, unbiased insight and technical solutions that make a positive impact.

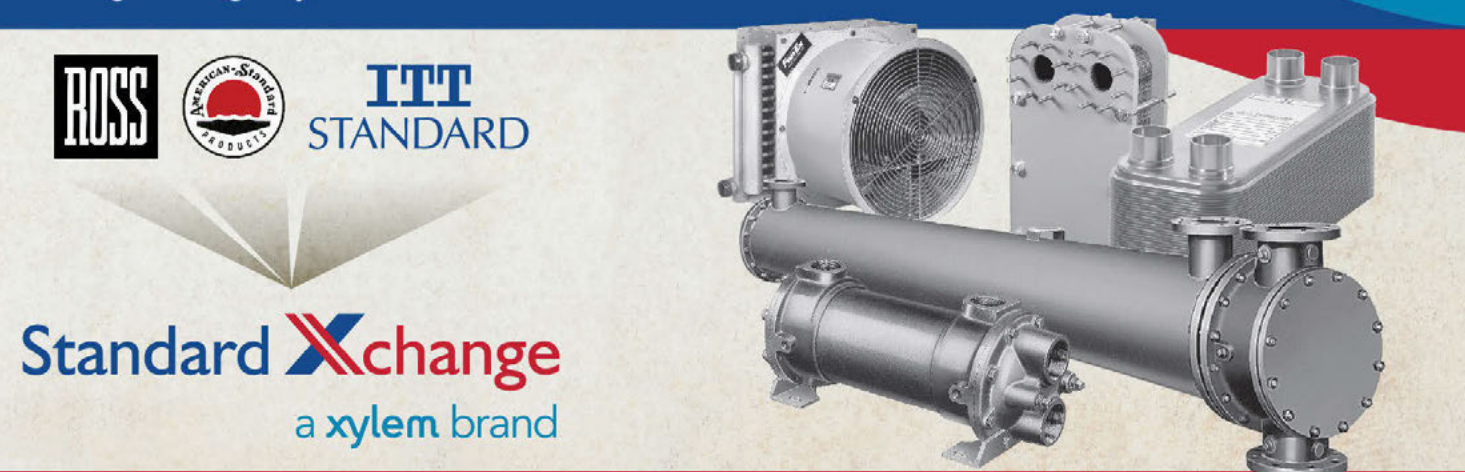
MPR: A trusted partner for the life of your plant.



A century later, we're still the same company with the same unmatched expertise in heat transfer solutions.

Our name has changed a few times over the past 100 years. But one thing that hasn't changed is the fact that our heat exchangers deliver dependable, efficient, performance for a wide range of industrial applications - no matter whether their medallions say Standard Xchange, Ross, American Standard or ITT Standard. We offer a wealth of experience, service and insight that will help you reduce operational costs while maintaining efficiency.

Continuing a Legacy of Heat Transfer Solutions



Today, Standard Xchange hardware is delivered to the nuclear industry through NuSource, LLC and meets the stringent requirements of Section III and Section VIII of the ASME Boiler and Pressure Vessel Code.



**Exclusive Partner for
Standard Xchange Commercial Nuclear Plant Applications**

**NuSource LLC | 320 King Street, Alexandria, VA 22314 | Phone: (571) 482-7404
www.nusourcellc.com**

NuSource is an MPR | Gavial Company



Nusource Designs Replacement Heat Exchanger Tube Bundles for Emergency Diesel Generators with Improved Materials

Earlier this year, NuSource LLC was awarded a significant project to deliver custom hardware for a nuclear power plant located in the southeastern United States. The project included the design and manufacturing of safety related, ASME Code Section III replacement heat exchanger tube bundles to be installed on the Emergency Diesel Generators at the site.

Emergency Diesel Generators (EDG's) are one of the most critical pieces of equipment at nuclear power plants, acting as the redundant electrical power source for emergency cooling and shut-down equipment. Given their importance to plant safety and increased regulatory scrutiny post-Fukushima, EDG

maintenance reliability is a top priority at all plants.

The scope of the job demonstrates NuSource's capability to deliver specialty replacement hardware with an improved design which will solve an ongoing material degradation problem that has challenged the plant over the past several years.

With the improved design, NuSource will utilize alternate materials that will be more corrosion resistant, will provide a longer life of the equipment, and will exhibit improved thermal performance of the units.

The NuSource Quality Assurance Program meets the highest standards of the nuclear industry, including 10 CFR 50 Appendix B and the ASME Boiler and Pressure Vessel Code "N"

Stamp. For more information, visit www.nusourcellc.com

Typical Applications

EDG

- Lube Oil Coolers
- Jacket Water Coolers
- Intercooler Heat Exchanger

Balance of Plant

- Steam Turbine Oil Cooler
- Gland Seal Condenser
- CCW / TBCCW

Skid Mounted Pump Coolers

- Charging Pump Oil Coolers
- Safety Injection Pump Oil Cooler
- Aux Feed Pump Oil Cooler

Typical Services

Engineering

- Certified Design Specifications
- ASME Code Design Reports
- Safety Related Thermal Performance Calculations
- Safety Related Tube Plugging Margin Calculations

Installation

- On Site Engineering Support during installation





NAC celebrates 50 years of providing solutions to the nuclear industry

In August 2018, NAC completes a half-century of designing, licensing, and deploying technologies and providing expert consulting and information services for the nuclear industry. Our proven process for

obtaining regulatory approvals covers methods and equipment for storing, transporting, packaging, and/or managing spent nuclear fuel, high level, GTCC, other solids, and liquid wastes.

Custom-tailored solutions

When your project requires storage and/or transportation of challenging nuclear materials, NAC offers proven systems and trained personnel to lower risk and ensure success.

Innovation to meet challenges

Throughout our history, NAC has created new designs and adapted older ones to meet industry needs:

- Two out of every three casks loaded with spent fuel at shutdown U.S. NPPs is an NAC design.
- The CoC for our workhorse NAC-LWT transport cask has been amended 68 times for specific contents, for over 400 shipments.
- Our newest cask, OPTIMUS™, is a versatile Type B package for 55 to 110-gal. drums with fissile material contents, and can be configured to transport HLW, transuranic, and other wastes.
- To meet NPP spent fuel storage and transport needs, NAC developed MAGNASTOR®, the first licensed and first loaded ultra-high capacity multi-purpose spent fuel dry storage technology. 124 MAGNASTOR systems have been loaded to date, at both operating and decommissioning NPPs.

Building on our legacy

NAC's 50-year history of facilitating management, transport, storage, and tracking of nuclear materials has been performed worldwide. With the vital role that nuclear power plays in meeting increasing global clean energy needs, safe management of nuclear materials is more vital than ever. NAC will continue to develop and license technologies, partnering with our clients to support a sustainable nuclear energy future.

For more information:

Doug Jacobs, Vice President
djacobs@nacintl.com, 678-328-1257



**Ideal cask solutions
for your most
challenging storage &
transportation needs**



www.nacintl.com

THE NUCLEAR INDUSTRY'S RIGGING AND TRANSPORTATION EXPERTS

The unique nature of the nuclear power industry demands vendors with the skills and experience that can consistently perform at extremely high levels. Barnhart's Nuclear Services Group has proven its rigging and transportation expertise in nineteen years of working with the nation's leading nuclear energy producers, contractors, and engineers.

LIFE EXTENSIONS, UPGRADES, AND MAJOR MAINTENANCE REQUIRE THE HANDLING OF CRITICAL COMPONENTS WITHIN OPERATING PLANTS. To perform this work during planned outages, a thorough knowledge of major construction techniques, advanced structural engineering, and ALARA is required. It is also crucial that the company has practical working knowledge of the demanding requirements of nuclear protocol, such as NuReg 0612. Barnhart exceeds that criteria and has developed unique tools and methods to perform the movement of major equipment such as:

- RPV Closure Heads
- Moisture Separator Reheaters
- Pressurizers
- Feedwater Heaters
- Condensers
- Transformers
- Steam Dryers
- ISFSI Installations

RIGGING SUPERVISION, LIFT PLANNING, HEAVY RIGGING, AND CRANE SERVICES are provided through their team of professional supervisors, engineers, and project managers. Barnhart ensures the safety, quality, and timely completion of plant outages. Often they are called upon to participate in the "Readiness Planning" of various operating plants. These plans serve to limit downtime during emergency outages by coordinating the engineering, rigging plans, and transportation schedules. In some cases, heavy rigging in nuclear power facilities presents the challenge and opportunity for development of custom designed rigging tools. Barnhart's ISO9001 certified engineering and fabrication capabilities provide solutions, from concept through completion, to handle major components safely and on schedule.

EXPERIENCED AND CERTIFIED FOR HAZMAT SERVICE, Barnhart also brings a working knowledge to the transportation of contaminated components to burial or processing. Barnhart's Heavy Lift Terminal in Memphis serves as a transfer point and waste processing facility of Energy Solutions. Barnhart provides transportation of such components by barge, rail, or road. Barnhart rounds out their experience by providing warehousing services to support the Pooled Inventory Management (PIM) program administered by Southern Company. The PIM program is a mechanism for nuclear plant owners to jointly procure and store critical plant spare equipment. Permanent PIM management resides at the Barnhart facility coordinating the maintenance and handling of the inventory by Barnhart personnel. To learn more about Barnhart's work experience in the nuclear industry, visit www.barnhartcrane.com.

BARNHART NUCLEAR SERVICES

2163 Airways Blvd., Memphis, TN 38114
800.587.3249 • nuclear@barnhartcrane.com

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YOUR PLANT'S PERFORMANCE AND BOTTOM LINE.

video.barnhartcrane.com/NN

BARNHART

Minds Over Matter





***Service... Innovation...
Value... Integrity.***

Founded in 1979, WMG Inc. is headquartered in Peekskill, New York. WMG provides the nuclear industry with professional nuclear engineering and waste management services. Beginning with our industry-standard RADMAN™ software program for radioactive shipments, WMG has continued to provide innovative solutions to the industry's most complex challenges. WMG is recognized throughout the nuclear industry as a leader in software, engineering, project and waste management innovations and accomplishments. WMG's proven expertise has been demonstrated in such areas as Major Component disposition, D&D Project Management and support services, Irradiated Hardware and Spent Fuel Pool Services, as well as spent filter storage systems and Torus desludging services.

WMG continues its legacy of developing innovative solutions, including two new software programs; FME Guardian™ and FuelCAL™. FME Guardian™ allows our customers to electronically log and track items entering and exiting FME Level 1 zones as well as manage FME workers and zones. Our newest software application; FuelCAL™, provides for efficient fuel selection for dry cask storage loading campaigns. The software has the ability to import fuel assembly parameters, non-fuel hardware and spent fuel pool location information. The graphic interface will allow the user to interactively obtain fuel assembly information and manage transfers for fuel assembly and/or non-fuel hardware.

WMG has performed projects at every nuclear power facility in the United States as well as in Canada and Europe. To date, WMG has successfully completed over 2,500 projects related to the management and control of radioactive materials.

Whatever your challenge, WMG is ready to help you find a sound and cost effective solution.

When you don't know who to call...



16 Bank Street
Peekskill, New York 10566
www.wmginc.com

Phone: (914) 736-7100
Fax: (914) 736-7170
Email: wmg@wmginc.com

40 Years of Radwaste Management Innovation Built on a Foundation of Trust

Since 1979, WMG Inc., a small, family owned business, has led the nuclear industry in innovative waste management solutions. From developing the only NRC approved waste characterization/classification software program, to working with the DOT on the first ever Special Permit to transport Large Components, WMG has found new and innovative ways to solve the industry's most challenging waste management issues.



Today, that tradition continues with new products and services aimed at helping our customers reduce costs, manage their radwaste in a safe and ALARA manner, and receive the highest return on their investment. Our success is based on 5 tenets: **Service, Innovation, Value, Integrity, but most of all Trust.**

So call us today to discuss your waste management challenges and we'll work with you to find the right solution.

- Waste Characterization
- Decommissioning Services
- Engineering Services
- Filter Management
- Specialty Packaging
- Custom Steel Liners
- Torus Desludging
- Training Services
- Fuel Pool Cleanup Services
- Software Solutions

Service...Innovation...Value...Integrity...but most of all TRUST

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Delivering Powerful Solutions for the Next Generation

Bechtel's commercial nuclear power business is a global leader in the licensing, design, procurement, and construction of nuclear power plants. From a new build to plant completion and recovery, or existing facilities modifications to advance reactor technology development, Bechtel has the breadth of knowledge to lead a wide range of nuclear projects. Bechtel has been an integral partner to the nuclear power industry since its

inception, and remains at the forefront by providing a range of services and technical expertise that no other contractor can match.

With more than 60 years in the nuclear power industry performing nuclear security, production, laboratory, cleanup, and naval nuclear propulsion work, Bechtel is an industry-leading organization with capabilities across the lifecycle of facilities and sites for commercial

and government customers. We provide customers the expertise and capabilities of over 5,100 professionals, including 150 internationally recognized technical specialists, 100 nuclear specialists, 11 Bechtel Distinguished Engineers and Scientists, and 9 Bechtel Fellows who are nationally or internationally known in their respective fields of seismology, civil/ structural design, water use, meteorology, hydrology, soil structure interaction, metallurgy, and hydraulics. With this much know-how, Bechtel has the ability to deliver first-of-a-kind solutions for any nuclear technology.

To date, Bechtel has been a major architect/engineer participant on more than 150 nuclear power plants worldwide and has provided the following services around the world:

- construction of 42 plants
- architect/engineer services for 71 plants
- 34 steam generator replacements
- 11 reactor head replacements
- 7 extended power uprates
- first major underground pipe replacement in the nuclear industry

Bechtel is leading the way in constructing tomorrow's nuclear power solutions. Currently, Bechtel is supporting a number of new generation activities, such as front-end engineering and design (FEED) development for Horizon Wylfa Newydd; construction completion for Vogtle 3&4; licensing services for the Clinch River SMR; and project management and consulting services at Olkiluoto 3, Hinkley Point C, Shin Kori 3&4, Shin Hanul 1&2, and Barakah 1-4. Additionally, we have been selected to perform innovation research for small modular nuclear plant projects by the U.S. Department of Energy.

With Bechtel's vast experience in delivering nuclear solutions, we play a critical role in helping customers deliver current and future nuclear projects, and will continue to lead future generations on the journey to providing clean, reliable energy.





INFRASTRUCTURE

MINING & METALS

NUCLEAR, SECURITY & ENVIRONMENTAL

OIL, GAS & CHEMICALS

Delivering Powerful Solutions

75,000 + MW

of completed nuclear design and construction projects

40+ years

operating plant and specialty engineering

9 COL

combined operating license (COL) applications for 5 advanced reactor technologies

6 new builds

currently engaged on 6 nuclear new builds

4 advanced technologies

design certification support and first-of-a-kind engineering for 4 advanced reactor technologies

bechtel.com

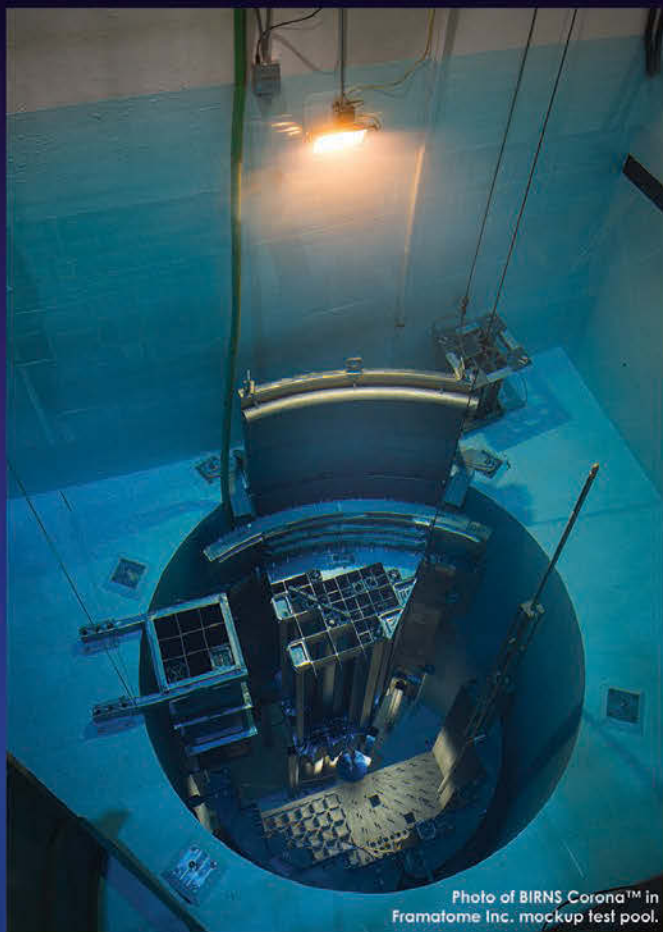


Photo of BIRNS Corona™ in Framatome Inc. mockup test pool.



Nuclear Lighting That Stands the Test of Time

BIRNS, Inc. has proudly been serving the nuclear power industry with high performance lighting solutions since 1977. Since then, the company has contributed to the advancement of industry technology for fuel and reactor pool lights, drop lights, seismically qualified emergency lights and high bay lights.

Our Quality Management System is ISO 9001:2015 certified, and complies with the requirements of NRC 10CFR50 App. B. Our products are custom engineered, precision manufactured in the U.S.A. and are stringently tested to exceed the requirements of our nuclear customers worldwide.

We're proud that our lights have been trusted to provide long term use and brilliant output for the past four decades, and we look forward to an equally bright future.



BIRNS' Quality Management System is
ISO 9001:2015 Certified;
NRC 10CFR50, App. B Compliant



www.birns.com





The Best Imager for Many Applications..... The Only Imager for Some!

Thermo Scientific – CIDTEC is a supplier of radiation hardened, machine vision, and scientific cameras based on the proprietary Charge Injection Device (CID) technology for use in the most demanding imaging applications.



The **MegaRAD** series of cameras are capable of operating in high dose radiation environments such as nuclear reactors, fuel inspection, hot cell monitoring, remediation, surveillance, and

X-ray imaging applications. Most importantly, this capability can now be provided in either Monochrome or Color version cameras, with remote head cable lengths up to 150-meters.

The **SpectraCAM** scientific camera series offers unparalleled dynamic range, exceeding 26-bits in some applications and is available in purged as well as hermetically sealed systems. These cameras exhibit low noise, excellent UV sensitivity, non-destructive readout, and user programmable windowing capabilities. CIDTEC's RACID Exposure software makes the SpectraCAM easy to use and provides the user with the required data in a wide variety of formats at the touch of a button.

CIDTEC's intensified cameras are available in RS-170, Progressive Scan, and CCIR formats for extremely low light level imaging, UV sensitivity, or for gating high-speed events.

All of the CID based cameras offer the unmatched anti-blooming, wide dynamic range, and UV sensitivity performance that has become synonymous with CID technology.

Charge Injection Device

The Charge Injection Device (CID) is a solid state imaging sensor with capabilities well beyond the limitations of today's consumer Charge Coupled Devices (CCDs). Like a CCD, the CID uses pixels to capture images, converting light into an electronic charge which is directly displayed on a monitor or captured digitally on computer. The superior resistance to radiation is a significant advantage for radiation tolerant imaging within facets of the nuclear power industry, medical, dental, and space based applications, and the inherent anti-blooming performance of the CID ensures accurate image detail even under extreme lighting conditions. The CID is uniquely positioned to serve the growing imaging market and the challenges for higher levels of accuracy in the radiation tolerant inspection market, as well as machine vision, scientific imaging. Thermo Scientific - CIDTEC is the leading manufacturer of CMOS imagers using the CID pixel architecture, and supply imaging solutions to OEM's as well as end-users throughout the world.

Applications

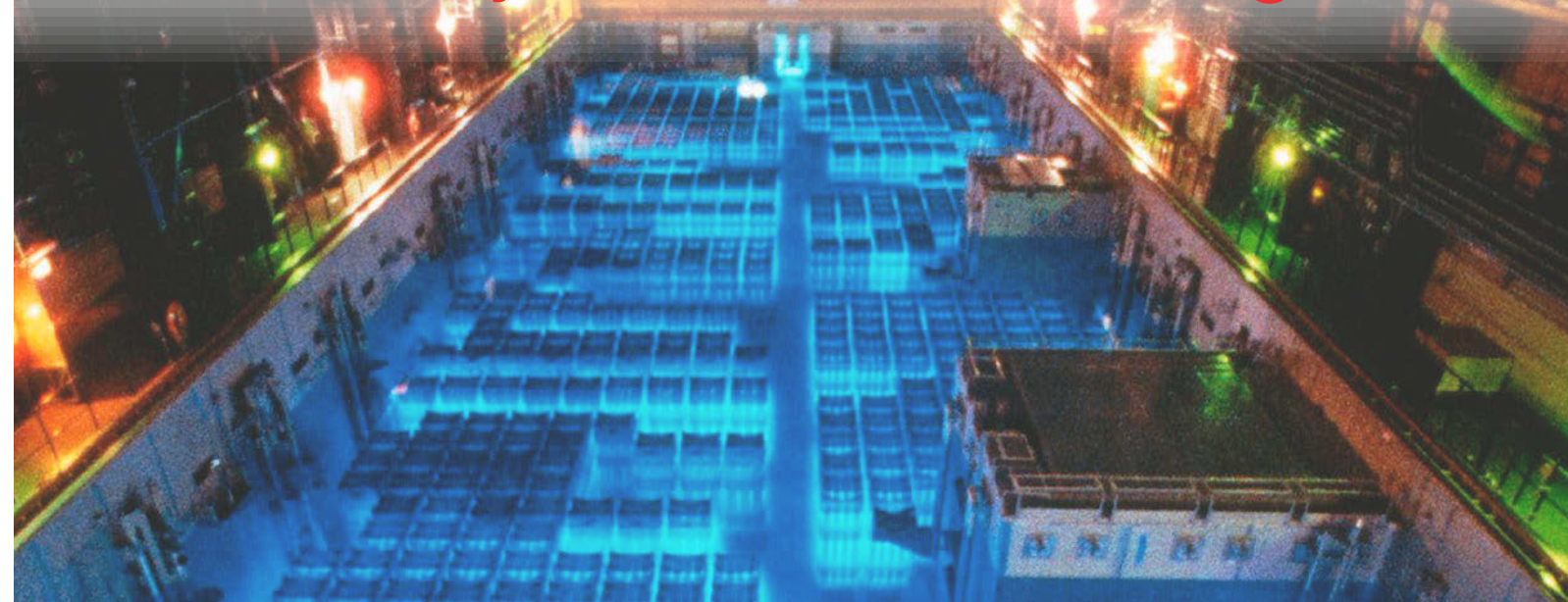
Thermo Scientific CID based video cameras and sensors provide solutions for the most demanding applications including:

- Radiation Hardened
- Spectroscopy
- UV Imaging
- Measurement
- Laser Profiling
- Medical Diagnostics
- Interferometry
- Aerospace
- Semiconductor Inspection
- Synchrotron Beam Profiling



thermo scientific

Got radiation? See what you've been missing



Imaging in radiation environments just got easier

With superior capabilities for operating in radiation environments, the MegaRAD cameras provide excellent image quality well beyond dose limitations of conventional cameras, and are well suited for radiation hardened imaging applications



MegaRAD3 produce color or monochrome video up to 3 x 10⁶ rads total dose



MegaRAD1 produce monochrome video up to 1 x 10⁶ rads total dose



KiloRAD PTZ radiation resistant camera with Pan/Tilt/Zoom

In the United States:

For customer service, call 1-800-888-8761
To fax an order, use 1-315-451-9421
Email: sales.cidtec@thermofisher.com

International:

For customer service, call [01] 315-451-9410
To fax an order, use [01] 315-451-9410
Email: sales.cidtec@thermofisher.com

Find out more at thermofisher.com/cidtec

ThermoFisher
SCIENTIFIC

Veolia Nuclear Solutions, a world-class player in nuclear facility clean-up and treatment of radioactive waste

Veolia Nuclear Solutions includes the most comprehensive range of technologies and services for facility restoration, decommissioning of plants, and the treatment of radioactive waste, all nurtured by our nuclear experts and backed by thousands of Veolia staff worldwide. Nuclear Solutions is present on the most complex sites of the nuclear industry, all over the world.

Responding to the crisis at Fukushima Daiichi, Japan

We were among the first responders to assist TEPCO in the Fukushima tsunami recovery. We have deployed a mobile technology platform to remove radioisotopes from water streams held in hundreds of storage tanks on the site. At the reactors themselves, our Remote Access technologies

are used to inspect and repair reactor containment systems.

Veolia Nuclear Solutions' remote access activity is the undisputed leader of advanced engineering, Remote/Robotic technologies and Decommissioning/Remediation solutions for a variety of high-hazard end markets where quality and timely delivery are paramount.

Dexter®, our remote manipulator system

Dexter® is a touch-sensitive remote manipulator system specifically designed to replicate human arms. The human operator performs tasks with the master manipulator, which the slave replicates exactly, in real time, in the remote location. The slave can be positioned up to 8km from the master because there's

no mechanical connection between the two – just cables for power and data. Our remote access solutions have been used on some of the most publicized, mission-critical projects worldwide.

Whiteshell, a challenging case

Our experts will provide Canadian Nuclear Laboratories an integrated solution under the agreement, designing, fabricating and commissioning a system to remediate a range of intermediate, and low-level waste from in-ground concrete standpipes and bunkers at the Whiteshell site. The system deployed at Whiteshell will be using proven technologies to retrieve and sort the waste.

In addition to our remote access solutions, we also deploy or vitrification capabilities on many sites.



Veolia's Nuclear Solutions is a leading world-class player in nuclear facility clean-up and treatment of radioactive waste.

It provides the most comprehensive range of technologies, expertises and services to develop the activity of facility restoration, decommissioning and treatment of low- and intermediate-level radioactive waste.

We propose a complete value chain for the nuclear sector and other related industries, including:

- Investigation and Characterization.
- Remote Access Solutions (Robotics).
- Separation of Radioisotopes from Waste Streams.
- Radioactive Waste Treatment.
- Stabilization of Radioactive Waste.
- Nuclear Facility Operation and Management.

www.nuclearsolutions.veolia.com

NUCLEAR SOLUTIONS

Geomelt®, our vitrification technologies to stabilize waste

GeoMelt® technologies are a group of vitrification processes that are configured to meet a wide range of radioactive and hazardous waste treatment and remediation needs. GeoMelt® vitrification destroys organic wastes and immobilizes radionuclides and heavy metals in an ultra-stable glass. Our GeoMelt® technologies are among the most advanced and we work with the biggest names in the industry.

Recently, EDF and VEOLIA concluded a partnership agreement on nuclear plant decommissioning and radioactive waste processing

EDF and Veolia entered a partnership agreement to co-develop remote control solutions for dismantling gas-cooled reactors and for vitrifying radioactive waste, in France and worldwide. Veolia will thus provide EDF with its experience in remote handling technologies with a view to designing and delivering innovative solutions to access the cores of gas-cooled reactors and to cut up and extract components under optimum safety and security conditions. In parallel, EDF and Veolia will work to develop an industrial solution for the vitrification of low- and intermediate-level waste using VEOLIA's GeoMelt® technology.

Contact: Veolia Nuclear Solutions, Technology Business Lines, David Kelly, Business Development Manager : david.kelly@veolia.com / +1 (720) 699-2446

COMMERCIAL GRADE DEDICATION

In-House and In Control.

Quality is key in the nuclear industry, and quality starts before any fabrication ever does. It begins during the procurement of materials. Commercial Grade Dedication (CGD) is a method used in accordance with NQA-1 standards to accept materials that are determined to be safety related.

When safety related materials are required, there are two options available: 1) materials can be procured in accordance with NQA-1 requirements, or 2) materials can be accepted through CGD. While both options are viable, utilizing a vendor capable of performing CGD offers a variety of benefits: cost, time, and quality.

Cost. Performing CGD in-house offers some cost savings to the buyer. The vendor is capable of procuring commercial materials and then dedicating them in-house, offering a less expensive option than having to initially procure dedicated materials.

Time. Dedicating materials can be time consuming, especially if procured from a third party vendor. Long lead items often cause the most delays in a project schedule. Using a vendor that has the capability of performing CGD in-house can alleviate scheduling concerns as commercial materials can be procured sooner, and then dedicated in-house.

Quality. It begins and ends with quality, especially so when it comes to safety related items. Which is why the ability to perform CGD in-house is likely the greatest benefit to a potential customer. NQA-1 requires complete traceability of materials, from procurement to delivery. Performing CGD in-house allows greater quality and traceability control, which provides a greater level of confidence to the buyer.

To see how quality and CGD can benefit your next nuclear project, contact Premier Technology, Inc.

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commercialnuclear@ptius.net

Because your only
outage should be
planned.

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Nuclear Fabrication

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- Vertically Integrated Manufacturing
- Sample Projects
 - Lifting and Handling Equipment
 - Spent Nuclear Fuel Canisters
 - Shielded Containers
 - Skids and Construction Modules
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NUPIC Audited | NQA-1 Certified | 10CFR50 Appendix B | 10CFR21
 ASME Certificates NA, NPT, NS, U, and S

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Over 40 Continuous Years as a Nuclear Safety Related Fabricator & Installer

SSM Industries, Inc. (formerly Schneider Sheet Metal) is the largest Safety Related HVAC designer / fabricator / supplier / installer in the United States. SSM entered the nuclear industry over forty (40) years ago as the metal fabrication division of Schneider Power.

Based in Pittsburgh, the Power Division of SSM Industries Inc. provides design, qualification, fabrication, and installation support to utilities in today's nuclear market for both safety related and non-safety related HVAC ductwork, dampers (tornado, bubbletight, balancing, manual, fire/smoke), fans, VFD's, louvers, skid units, etc. We have supplied equipment to virtually every Commercial Nuclear plant in the United States, as well as Nuclear Plants worldwide.

Starting in the 1970's, SSM has performed complete HVAC duct fabrication and installation at 7 nuclear new builds, and this continues at Vogtle 3 & 4. SSM is performing the complete HVAC fabrication and installation of duct, dampers, and standalone fans.

Together with Westinghouse we designed the AP1000 Containment Building HVAC Duct and Supports system and VCS containment fans.

The industries we serve include Commercial Nuclear Power Plants, DOE EM Facilities, and critical mission research facilities and laboratories.

We can supply new equipment, replacement parts, spare parts – if it's related to HVAC and air movement we can support your needs.

SSM maintains a complete 10CFR50/NQA-1 (including all Supplements) Quality Assurance Program. SSM is listed in the NUPIC data base as a pre-qualified vendor to supply Safety Related HVAC equipment and services, including the commercial dedication of components fabricated by others, to all commercial nuclear plants.

Give us the opportunity to be a part of your next project and we'll help you stay on budget and on time.

SSM INDUSTRIES, INC.
3401 Grand Avenue
Pittsburgh, PA 15255
Phone: (412)-777-5101
www.ssmi.biz

Over 40 Years of Nuclear HVAC Experience

SSM Industries has over 40 years experience designing, qualifying, fabricating and installing complete HVAC ductwork systems and equipment in DOE facilities and Nuclear Power Plants around the world.

Let us work with you on all of your HVAC needs. From custom retrofits to new plant build, we are the HVAC solution that you have been looking for.



HVAC SYSTEM COMPONENTS

Access Doors
Actuators: Electric & Pneumatic
Air Handling Units
Charcoal Adsorber Units
Dampers:
Backdraft
Balancing
Bubble-Tight
Control: Manual, Electric & Pneumatic
Diverter
Fire & Smoke
Guillotine
HELB
Isolation

HVAC SYSTEM COMPONENTS

Tornado
Variable Frequency Drives
Ductwork & Supports
Fans: Axial & Centrifugal
Filters & Filtration Units (incl. HEPA)
Flexible Connections
Grilles, Registers & Diffusers
Housings
Heat Exchangers
Cooling Coils
Louvers
Plenums
Sleeves

SPECIALTY FABRICATIONS

Angle Rings
Cable Trays & Covers
Control Cabinets
Doors: Access, Heavy-Duty & Blast
Equipment Bases
Filter Boxes
Fire Barriers
U. L.-Rated, 3 Hour
Glove Boxes
Sealed Enclosures
Seismic Supports
Cooling Coils
Heating Coils
Heat Exchangers
Tanks

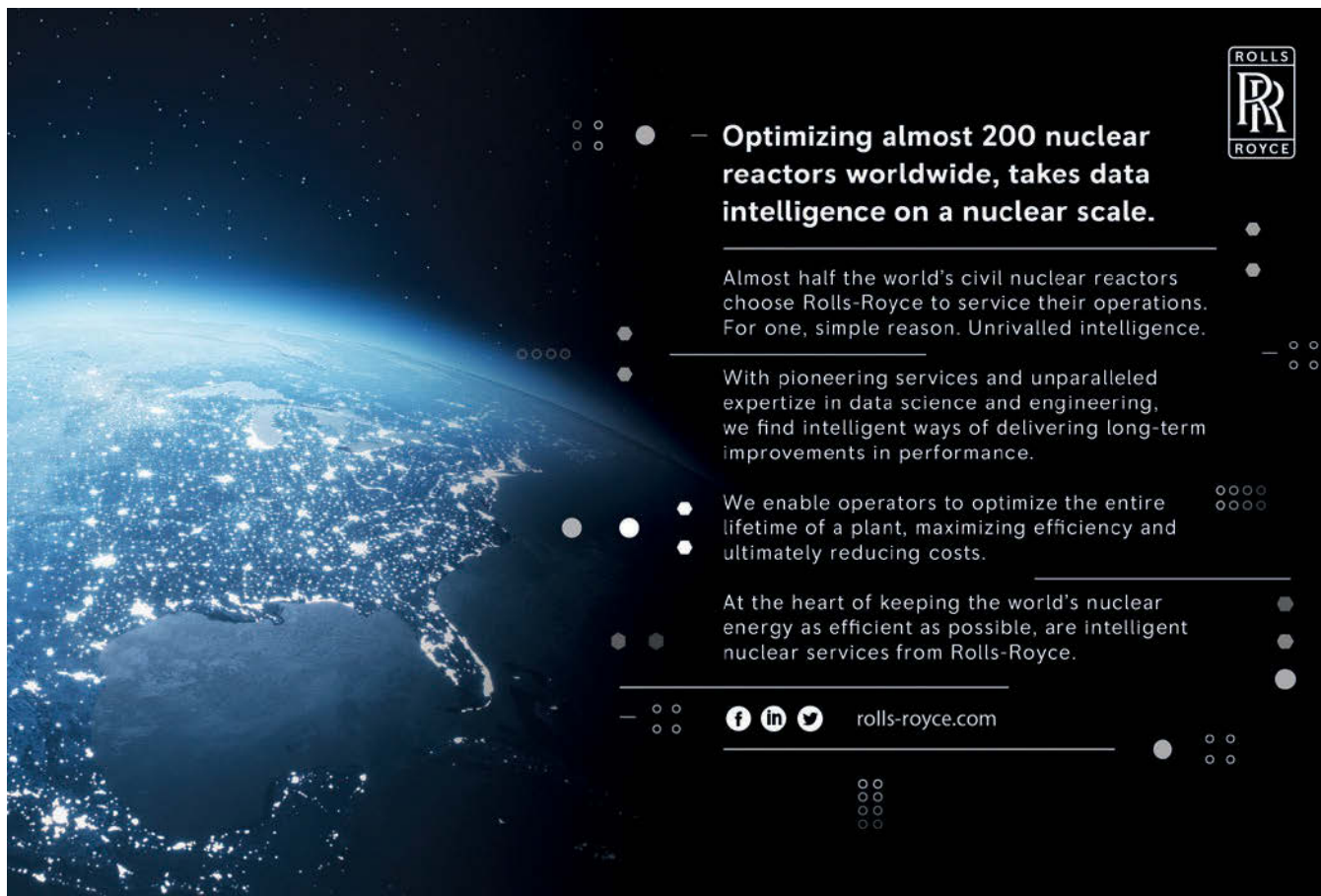
QUALITY CERTIFICATIONS


NQA-1
ASME AG-1
10CFR50
Appendix B
ASME
AWS



For more information contact the SSM Power Division at (412) 777-5101 or visit us at www.ssmi.biz to learn how our experience can benefit your next project.

(412) 777-5101 • ssmi.biz








Optimizing almost 200 nuclear reactors worldwide, takes data intelligence on a nuclear scale.

Almost half the world's civil nuclear reactors choose Rolls-Royce to service their operations. For one, simple reason. Unrivalled intelligence.

With pioneering services and unparalleled expertise in data science and engineering, we find intelligent ways of delivering long-term improvements in performance.

We enable operators to optimize the entire lifetime of a plant, maximizing efficiency and ultimately reducing costs.

At the heart of keeping the world's nuclear energy as efficient as possible, are intelligent nuclear services from Rolls-Royce.

   rolls-royce.com

HELPING CUSTOMERS GENERATE MORE POWER FOR LONGER

We help our customers find new ways to generate more power for longer, creating a lasting competitive edge with which they can face the world's low carbon electricity demands of the future.

Our intelligent approach is to invite them to collaborate with us to develop long-term relationships so we can use their data to create intelligence that can generate lifetime savings, making the operation of their nuclear power stations more efficient, simpler and easier.

Our expertise spans data analytics and world-leading instrumentation and control systems, to engineering design and site support services like robotic inspections. This equips power station operators with the essential tools they need to face the current cost and reliability challenges, as well as positioning them as strongly as possible for the future.

Turning data analysis into operational intelligence creates value

We break through barriers to greater operational reliability and efficiency by collaborating with customers to analyze, diagnose and optimize their operations, using cutting edge predictive data techniques.

By combining our unique data resources with our world-class engineering design and services, the insights we create bring lifetime savings and bring existing nuclear power stations into a new, intelligent age.

Predicting maintenance, managing obsolescence

From maintenance optimization to obsolescence management, our tried and tested technology brings new clarity and insights to how operational availability and efficiency can be improved; new ways to optimize asset management; and innovation to manage the complex and dispersed supply chain to secure best value for our customers.

And this is just the start. Our vision for bringing our intelligent approach to our customers will transform how clearly they see new savings and efficiencies in their operations.

Almost half the world's reactors rely on our systems

Rolls-Royce has a 50-year heritage in supplying critical safety control and instrumentation systems, back up power generation, and more recently heat exchangers and waste treatment

systems. We're also one of the only end-to-end in-house suppliers in the world for back-up diesel generators, using the full scope of the Rolls-Royce Group to design systems, manufacture and supply equipment with full I&C integration. Among the many systems projects we're currently supplying OEM long-term I&C support solutions to all 58 EDF reactors in France; performing Safety I&C modernization for 20 French 1300MW reactors; delivering rod control, neutron instrumentation and pressure transmitters to all CPR1000 reactors in China; as well as heat exchangers to Hinkley Point C in the UK.

Value from integrated services for a lifetime partnership

Focusing on efficiency and cost reduction across the lifetime of nuclear power stations, we provide integrated through-life engineering design and site support services that span the latest capabilities in physical, systems and cyber security strategy, to plant process computer systems; remote inspections and non-destructive testing; component design, small component manufacture; supply chain integration and commercial grade dedication.

rolls-royce.com



MIRION
TECHNOLOGIES

Mirion Technologies provides products and services for a wide range of radiation safety, measurement and scientific purposes.

Mirion solutions are employed in advanced space, technology and research applications as well as to secure critical facilities, protect people from radiation exposure and limit the spread of contamination.

Our organization is comprised of over 1700 talented professionals, passionate about delivering world class products, services, and solutions to our customers.

From our operating facilities across North America, Europe, and Asia, Mirion Technologies offers products and services in **6 key areas**:

- Health Physics
- Radiation Monitoring Systems
- Spectroscopy
- Characterization
- Dosimetry Services
- Sensing Systems


Sensing Systems Division

The Sensing Systems Division, maker of IST and IST-Conax range of products, offers a range of operational safety and non-safety radiation monitoring equipment, including in-core and out-of-core detectors and electrical penetrations. This equipment is used by power generation establishments to ensure the safe and efficient operation of their facilities. In addition, Mirion manufactures the associated electronics, temperature sensors, thermocouples, special purpose valves, connectors, cable/ connector assemblies and electrical conductor seal assemblies.

The entire Mirion team is dedicated to providing a new standard of solutions for our customers in nuclear facilities, military and civil defense agencies, hospitals, universities, commercial, state

and national laboratories, and other specialized industries.




For more information about our wide range of products and services visit: www.mirion.com.



MIRION
TECHNOLOGIES SENSING SYSTEMS DIVISION

Operational Safety & Non-Safety Radiation Monitoring Equipment


Out-of-Core Detectors, In-Core Detectors & Electrical Penetrations

*Proven quality **SOLUTIONS** to meet your requirements*

Sensing Systems Division
315 Daniel Zenker Drive
300 IST Center
Horseheads, NY 14845 USA

Phone: 607-562-4530
FAX: 607-562-4482
Email: ist@mirion.com



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Radiation Safety. **Amplified.** www.mirion.com

A NEW DAY OF ENERGY | IS ON THE HORIZON

It began with a simple idea: *If more people, across the globe, had access to power, we could make the world better.* But first, we realized we need to make the power better. Now, we are changing the power that changes the world.

NuScale Power is creating a new kind of nuclear power plant, one that is smarter, cleaner, and safer to improve the quality of life for all humankind.

Our innovative concept features a small modular reactor (SMR) that is a scalable version of a pressurized light water reactor. It's called the NuScale Power Module™ (NPM) and is capable of generating 60 MW of electricity. Each NPM operates independently within a multi-module configuration. Up to 12 modules are monitored and operated from a single control room within a plant.

Our NPM is premised on well-established nuclear technology principles with a focus on integration of components, simplification or elimination of systems, and use of passive safety features.

Its flexible design can support desalination, integrate with renewables resources, provide highly reliable power to mission critical facilities, or serve as clean baseload power.

The scalable nature of our reactor allows it to fit different energy needs. And its different sizing options allows the reactor to be assembled in a wide range of locations, from the most populated urban areas to remote destinations.

We have centered our reactor's design and business model around four key elements, which have led us to producing superior energy. First, we looked to make our energy smarter. Every aspect of our design was carefully analyzed; all redundancies removed to focus on creating more reliable, efficient energy. Next, we concentrated on generating cleaner energy. To change

the world, we have to preserve it. We have reduced our carbon footprint to zero, helping to secure a future for all humankind. After that, we put all our efforts into safety—an element we hold to the highest standards. And finally, we did all that we could to ensure that more people had access to our power by making it cost competitive.

SMARTER

Smarter energy means focusing on simplicity. With this in mind, the NuScale Power Module™ (NPM) is comprised of the reactor vessel and containment vessel in a single cylindrical module. The NPM has no reactor coolant pumps, no external steam generator vessels, and no large-bore reactor coolant piping. NuScale Power is building SMR technology with unique safety characteristics, a small footprint, and flexible, scalable installation. This isn't just a small version of a big reactor.

CLEANER

The need for carbon-free power has never been greater. Changing regulator requirements, challenging economic environment, and uncertain long-term fossil fuel pricing means a diverse energy mix is essential to meeting that need. The NPM's innovative, efficient design has produced a power source that is 100% carbon-free clean energy. It's as clean as wind or solar, cleaner than any fossil fuel.

SAFER

Safety comes first, second to none. NuScale's Triple Crown for Nuclear Plant Safety™ has achieved a paradigm shift in the level of safety of a nuclear power plant. As we set new standards for rigorously proven safety, we ensure our protocols will help reduce the need

for future maintenance, lowering repair costs. Should it become necessary, the NuScale Power Module shuts itself down and self-cools for an indefinite period of time, with no operator action required, no additional water and no AC or DC power. This is a world-first in nuclear design. NuScale is the only developer to achieve this groundbreaking capability.

COST COMPETITIVE

The economics of this advanced nuclear technology offer long-term financial certainty over the plant's life. The NPM is far less complex than other designs. Off-site fabrication and assembly reduce cost. Components are delivered to the site in a ready-to-install form. All of this results in construction occurring in a shorter, more predictable period of time.

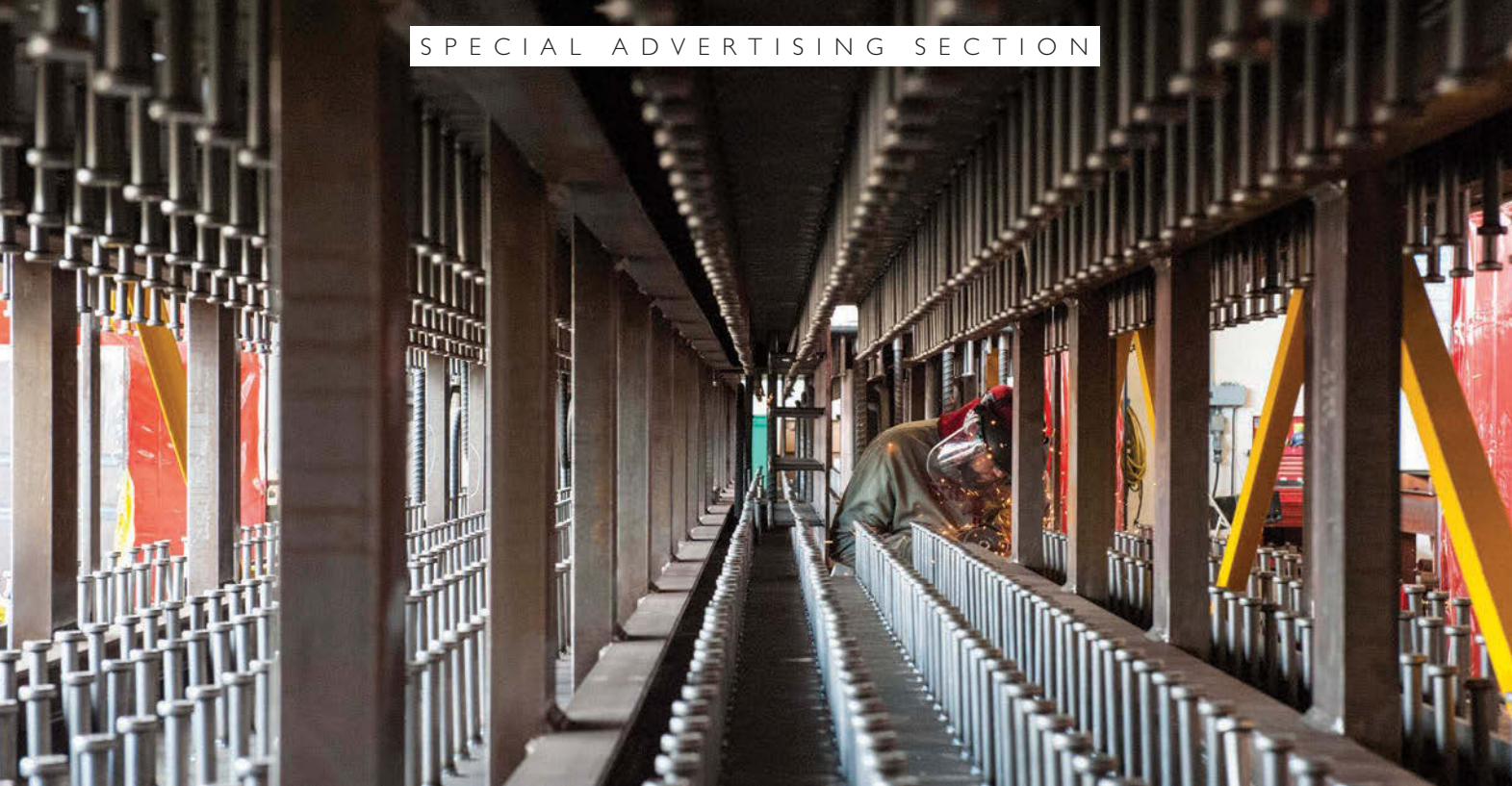
NuScale's SMR technology is a revolutionary solution to one of the biggest technical challenges for the current fleet of nuclear energy facilities. Its innovative and comprehensive safety features provide a stable, long-term solution to our energy needs. It can make smarter, cleaner, safer and cost competitive energy accessible for people everywhere.

NuScale is truly the answer to changing the power that changes the world.

A NEW DAY OF ENERGY | IS ON THE HORIZON

NuScale is a pioneering force, advancing the energy industry. We're challenging what's possible in the field by developing a new nuclear power technology. Through innovative design and best practices, we're producing smarter, cleaner and safer energy to power all humankind. Together, we can usher in a new era of energy. nuscalepower.com

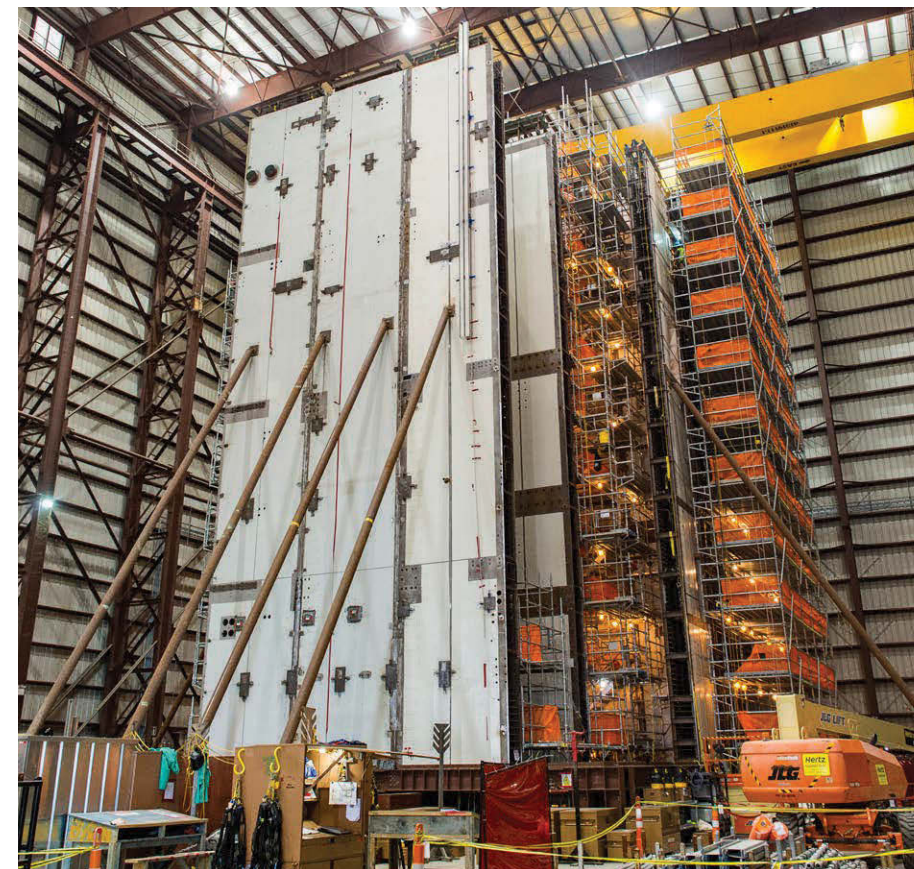




UNSURPASSED COMPLEX FABRICATION

Located in Oregon, Vigor offers customers across America innovation in complex fabrication and systems integration. Technology combined with a highly skilled workforce and expert project managers have enabled Vigor teams to fabricate a diverse project portfolio. For more than two decades, we have been the primary integrated fabrication supplier for the nation's Ground Based Mid-Course Defense (GMD) program. We build bridges, critical components for the aerospace industry, sophisticated gates for hydroelectric power, pressure vessels, shield doors, gloveboxes, reactor modules and more.

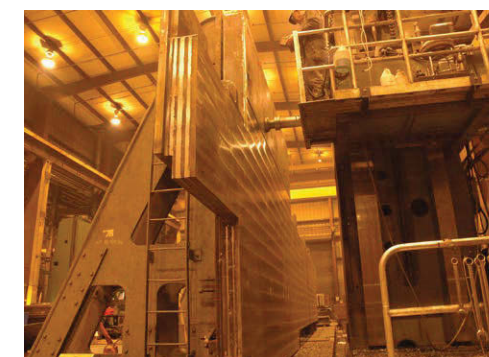
Vigor manufactures to the highest quality standards in all industries we serve. Trust us for reliable performance and exceptional quality on your next project.



INNOVATION, FABRICATION, SYSTEMS INTEGRATION

Vigor Works (formerly Oregon Iron Works) provides expert metals fabrication and systems integration for the nuclear supply chain. With more than 3 million manhours of production logged under nuclear quality programs, we consistently deliver the oversight and detailed documentation the world's most critical customers demand.

- 320,000 SF Fabrication, Machining & Integration
- 150 Certified ASME Welders, 10 ga. To 12 inch
- Stainless, Inconel, Carbon, Nickel, Titanium, Hastelloy
- 160 Ton Shop Lift Capacity
- CNC Machining, 10 lbs to 100+ tons
- Mechanical Assembly, Integration, Controls
- EPRI Compliant Commercial Grade Dedication



NUCLEAR STAFFING AND SERVICES EXPERTISE

System One delivers workforce solutions and integrated services for nuclear power utilities, the Departments of Defense and Energy, OEMs, EPCs and other energy utility providers. For more than 35 years, System One has achieved consistent year over year growth and market share increase in our energy and engineering businesses. We continue to expand our presence within the commercial nuclear power sector delivering custom workforce programs, including emerging NDE technologies.



System One Delivers for its Nuclear Power Partners

Workforce Solutions

From traditional staffing to managed staffing programs (MSP), recruitment process outsourcing (RPO) and vendor management system (VMS) staffing, we are experts in delivering top energy and engineering talent within the electric power industry. System One's dedicated and highly tenured "nuke squad" delivers specialized resources and programs to address the unique workforce challenges in the nuclear industry, specifically:

- **Contract and direct hire staffing** across all nuclear plant specialty areas.
- **Customized workforce solutions** leveraging our MSP and RPO solutions.
- **VMS staffing** using our proprietary technology platform to deliver talent.

Our customized workforce programs are ideal for plant design, construction, decommissioning, outage support and other major programs to ensure you have the talent needed for success.

Integrated Services

In addition to our workforce solutions, System One has expertise in supporting the entire nuclear plant lifecycle with the following integrated services:

- **Advanced NDE and Testing** delivered through a full set of QC and NDE services supporting the commercial nuclear fleet. Extensive history of providing phased array UT and computer aided RT, MT, PT and VT services in support of client nuclear inspection programs. We have an exclusive partnership with Evisive, LLC. to employ EvisiveScan's™ volumetric microwave inspection technology

for dielectric materials such as REJs, HDPE and fiberglass, saving critical outage time, improving maintenance programs and reducing costs from unnecessary equipment replacement.

- **Technical Training** to provide NDE and pipeline inspection instruction to thoroughly prepare individuals for working in energy, power, industrial and technical facilities.
- **Transmission & Distribution Services** providing management resources for construction and capital projects including: smart meter installation, smart grid integration services, project scheduling and project controls.

Let System One take the guesswork out of your project resource needs. Visit our website, **systemone.com** to learn more.

Valcor: Designer and Manufacturer of High Quality Flow Control Devices

Valcor Engineering Corporation designs and manufactures valves for nuclear, aircraft, space, industrial, and scientific applications. Since 1951, Valcor's involvement with supplying components for difficult applications with high-pressure, flow, temperature, and vibration under extreme environmental/seismic conditions has been continually expanding. Today, Valcor manufactures over 100,000 solenoid valves and other fluid system components per year!

Valcor Engineering originally started out in the aircraft and space industries. Applications include both commercial aircraft and space components to major programs. We have also supplied hydraulic, fuel and pneumatic solenoid valves, APU shut-off valves, pressure and flow regulators, and pressure vessels for military programs including naval nuclear, fixed wing, rotary and unmanned aircraft.

In 1970, Valcor expanded and began designing and manufacturing high quality flow control components to the nuclear industry, with most activity centering on solenoid operated valves and regulators. Within Valcor, the Nuclear Group is structured as one of three integral corporate business units, which allows us to focus very clearly to develop, design and produce products for the nuclear industry worldwide, and be extremely responsive to individual customer needs. Our business is split approximately 50/50 between the domestic and international markets.

Most of our products are either ASME "N" stamped process valves for various fluids (including hydraulic fluid applications), or Class 1E air pilot valves for pneumatic actuators. There are also many special designs within our installed base of well over 15,000 "N" stamped units. Our products range in application from reactor coolant pressure boundary isolation to cryogenic, liquid sodium and marine (nuclear navy) services. These products generally are less than 4" NPS, and are used extensively in both domestic and international nuclear programs.

We have also signed license agreements and other supply arrangements with well-known former suppliers to the nuclear marketplace to manufacture and supply their unique nuclear product lines:

- a. Hoke Inc. (Cresskill, NJ) for the supply of instrument isolation valves and manifolds
- b. Circle Seal Controls (Corona, CA) for the supply of inline check valves and solenoid valves.

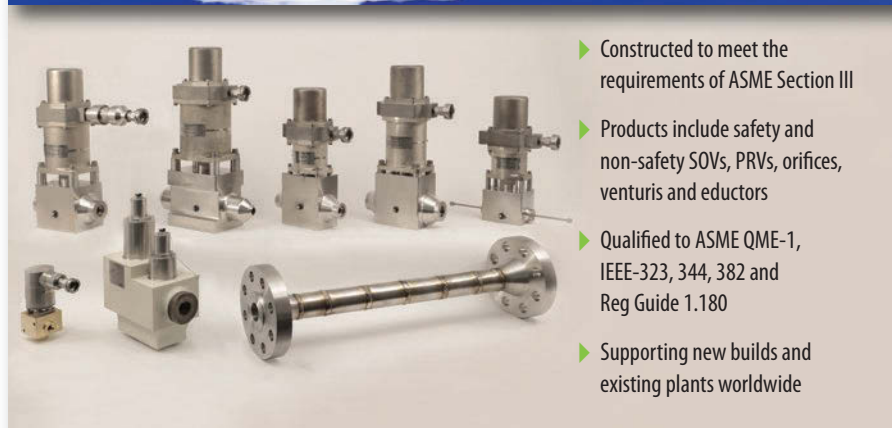
- c. Fox Valve (E. Hanover, NJ) for the supply of cavitating venturis and eductors
- d. CU Services (Elk Grove Village, IL) for the supply of plug resistant orifices and let down orifices

These relationships have greatly expanded our supply capability beyond our traditional ASME Section solenoid valves.

In 2017, Valcor underwent a highly successful ASME re-certification audit for our "N", "NPT" and

"NS" certification/stamps. We are excited that this renewal now extends to welded piping systems, subassemblies, and component supports, and pressure vessels. This, in turn, opens significant new markets to us for the supply of complete systems, such as skid-mounted process packages requiring an extensive degree of installed instrumentation components.

For more information on our products and services, please visit www.valcor.com, call us at (973) 467-8400 or email us at nuclear@valcor.com.



- ▶ Constructed to meet the requirements of ASME Section III
- ▶ Products include safety and non-safety SOVs, PRVs, orifices, venturis and eductors
- ▶ Qualified to ASME QME-1, IEEE-323, 344, 382 and Reg Guide 1.180
- ▶ Supporting new builds and existing plants worldwide



Valcor Engineering Corporation

Contact us to learn how Valcor can help meet your specific flow control needs
www.valcor.com | (973)-467-8400 | nuclear@valcor.com



1527 N 2000 W, Ogden, UT 84404 • (801) 732-2000 – Phone • (801) 732-2098 – Fax • www.peterseninc.com

Petersen Inc. has been the industry leader in custom steel manufacturing for the nuclear industry for decades. How? By creating solutions to difficult problems and helping our customers meet their high demand project timelines and producing high quality products efficiently and in-budget.

HISTORY

Petersen Inc. of Ogden, Utah opened its doors in 1961 and has been manufacturing products for a variety of industries worldwide since that time. For over 50 years Petersen Inc. has been the company to go to when custom fabrication, design, engineering, and field installation are required for difficult projects. We have become the industry leader in the field of fabrication and precision machined components.

Petersen Inc. has been chosen as a partner in high-profile projects such as the Department of Energy's Hanford Waste Treatment Plant, Savannah River MOX facility, WIPP, Zion, West Valley, Kewaunee, APS, ORNL, LANL, LLNL, INL, and others.

The Petersen Inc. fabricated Melters will be the heart of the Hanford Waste Treatment Plant which will be the world's largest chemical radioactive waste treatment plant.



Up to 53-million gallons of radioactive waste is anticipated to be processed through the melters.

Petersen Inc.'s participation in the Department of Energy's MOX Services project at the Savannah River Site is constructing storage components, gloveboxes, and other associated equipment for the facility which converts weapon grade plutonium into fuel for electricity generating power plants.

The Petersen Inc. involvement with Energy Solutions, NAC International, West Valley, Kewaunee, GEH and APS is in providing dry fuel storage casks and

transportation equipment, as well as custom equipment to support the dry fuel storage requirements.

Petersen Inc. is a major supplier of containers for many industries including Nuclear, Oil & Gas, Aerospace and is proud to be a part of the clean-up of waste generator sites around the country, helping to make it a cleaner and safer environment for future generations. Petersen Inc. fabricates RLC's, SWB's, and TDOP's for Nuclear Waste Partnership LLC, (NWP) at the Department of Energy's WIPP site which allows us to provide storage containers of various sizes and specifications to anyone who purchases them through NWP.

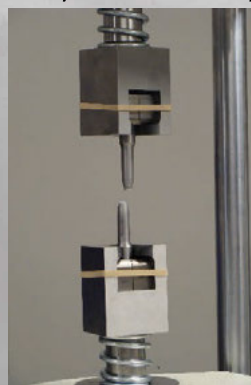


CERTIFICATIONS

- ASME NQA-1
- ISO9001:2008
- NRC Subpart H of 10CFR71
- ASME {U} {U2} {S} {R}
- AS9100:2009 Rev C
- AISC

CGD In-house Test Lab

- Commercial grade dedication of material for nuclear applications
- Spectrographic chemical analysis of low alloy steels, stainless steels, nickel base alloys (includes nitrogen and oxygen determination)
- Rockwell hardness
- Certified penetrant, magnetic particle and visual examination
- Weld procedure testing
- Weld wire certification including welding of test coupons in accordance with filler material specifications



Dry Fuel Storage Cask • IP Containers • Standard Waste Box • Standard Large Box • Glovebox
Process Equipment • Melters • Material Handling Equipment

WE DON'T SWEAT

75 TONS
OF STEEL.

WE DO SWEAT

THE LAST
THOUSANDTH
OF AN INCH.

Whether you're looking for gloveboxes, melters or other nuclear processing equipment, we have the experience, people and know-how to get it done right — down to the very last detail. It's why companies like Bechtel, Energy Solutions, NAC International, Nuclear Waste Partnership and more have relied on us for decades for their nuclear manufacturing needs.



800.410.6789 | peterseninc.com

Sandvik's in-house capabilities make it a leader in quality advanced materials for nuclear applications

For more than 50 years, Sandvik has delivered products to nuclear plants worldwide. In doing so, the developer and manufacturer of advanced stainless steels and special alloys has built extensive experience in the materials field for nuclear power applications. The company can today classify itself as a major player in the nuclear steam generator market having delivered more than 300,000 tubes, exceeding 60 million meters in combined length, to more than 100 reactor units worldwide.

Sandvik offers a wide and expanding portfolio of products including seamless steam generator tubing and nuclear fuel tubes for both pressurized and boiling water reactors. Its services must satisfy ever growing needs for life extension programs, success building and new product and relationship development. Sandvik understands that meeting these customer requirements will prove vital in consolidating nuclear as a growing source of global energy.

Due to its trusted reputation as a fully integrated supplier of tube, strip and wire in advanced stainless steels and special alloys, Sandvik is increasingly approached by end users directly rather than through distributors. The company's guarantee of quality assurance is therefore key and certified to a number of quality management system standards such as ASME NCA 3800, ISO 9001, RCCM and ISO/TS 16949.

Simon Sun, Sales Director Nuclear, China, Sandvik Materials Technology, explains: "When we talk about quality assurance, everything is based on the normal standard ISO 9001 system and different international standards depending on where the products are going, the market and the design. Sandvik also has its own quality program called the Nuclear Driver's License, completely our own add-on system where we audit and certify different mills to produce and handle nuclear products.

"For example, we have set up a dedicated state-of-the-art mill for the manufacture of nickel alloy steam generator tubes in Sandviken, Sweden. This was opened in 2012, right in the middle of Fukushima which was not exactly the best timing, but it doesn't matter because we now have a new and fully efficient mill that is world class with improved capabilities. We will remain one of the top suppliers, the capabilities and performance that we have in this mill will ensure that."

Streamlined in-house capabilities

In 2014, Sandvik streamlined its organisation by forming a dedicated Business Unit that is devoted to its offerings for the nuclear industry. The company's in-house capabilities are crucial to the Business Unit's operations.

Mikael Blazquez, Director of Business Unit Nuclear, Sandvik Materials Technology, said, "Normally, you have to go outside of your own company to find alliances, or you have to buy external resources to complete the package. With the broad Sandvik portfolio, more products can be provided to the customer within the Business Unit Nuclear umbrella. We can have more valuable discussions with the customer about their needs, desired products and service packages.



"Sandvik's services also meet increasing technical requirements and this is where we invest our 50-plus years of nuclear experience. Being a fully integrated company that meets all customer demands in-house, Sandvik has gained the trust of both fabricators and suppliers. They regard us as being a supplier of the utmost quality products which meet the highest safety standards."

Sandvik maintains strict control over the entire manufacturing process, from steel melt and heat treatment to the finished product. Customers can therefore feel confident in being able to achieve trouble free operations with high quality products, and fully-manage the entire purchase process through a single supplier whether for steam generator tubing, zirconium fuel tubes, heat exchangers and more – supplied either as straight or u-bent.

Nuclear fuel tubes

Sandvik's program of zirconium alloy nuclear fuel cladding tubes covers all fuel designs and most technical specifications.

The integrated manufacturing of these starts with alloying and melting zirconium sponge and concludes with the finished tubes. Sandvik controls and optimizes a range of critical process parameters to safeguard the high quality and material property demands.

For customers, the result is safe and trouble free performance during reactor peak activity levels. It is possible to achieve longer life times for the nuclear fuel elements of which the cladding tubes are the most critical component. Sandvik manufactures nuclear fuel tubes to the pressurized water reactor (PWR)/VVER, BWR, CANDU (HWR), AGR and LMFB nuclear fuel types.

Steam generator tubes

Nuclear steam generator tubes by Sandvik meet the most stringent Eddy Current multifrequency inspection demands and a signal-to-noise ratio of 15:1 or better. The tubes are manufactured in a mill specially dedicated for the production of long U-bent steam generator tubes, with state-of-the-art non destructive examination (NDE) equipment.

The Sandvik program includes steam generator tubes in two alloys, Sanicro 30™ and Sanicro 69™, in size range OD 10-25.4 mm (0.394-1 in.). Sanicro 30 is a low-carbon version of Alloy 800 austenitic nickel-iron-chromium alloy. It is used for steam generator tubing and other heat exchangers at temperatures of up to about 550 °C (1020 °F), where good resistance to stress corrosion cracking (SCC) and intergranular corrosion are required.

Sanicro 69 is an austenitic nickel-chromium-iron alloy used primarily in the 'thermally treated' condition for steam generators. The grade has good structure stability and good weldability with extremely high resistance against SCC in primary side PWR water conditions, and improved pitting corrosion resistance in chloride containing solutions compared with Alloy 600.

For more information:
materials.sandvik

Sanicro 69 and Sanicro 30 are trademarks owned by Sandvik AB through Sandvik Intellectual Property AB.

YOUR NUCLEAR PARTNER LET'S POWER THE FUTURE TOGETHER

Advanced specifications. New SMR designs. Nickel release. Meeting the most demanding nuclear specifications can be challenging. This is where Sandvik can help. Since 1964 we have supplied over 65 million meters of zirconium nuclear fuel cladding tubes and more than 400 tube bundles for steam generators in over 20 countries. We partner with all major EPCs to meet advanced tube and pipe requirements for all reactor designs. Take advantage of our extensive nuclear portfolio, materials R&D expertise and experience in guiding your team through complex specifications.



MATERIALS.SANDVIK

LANXESS Lewatit® IX Resins for the Power Industry

The Liquid Purification Technologies business unit of LANXESS has a wealth of experience in the nuclear power plant sector in Europe, Asia and North America. Nuclear power plants throughout Western and Eastern Europe, China and North America have chosen Lewatit® ion exchange resins to meet their demanding specifications and water purification challenges. Ion exchange resins help at numerous points to ensure the efficient, safe and reliable operation of these power plants over many years. These include applications in primary and secondary cooling, blowdown, fuel pool, stator cooling, and condensate polishing. Lewatit® resins are also used in the rad waste servicing industry.

LANXESS' most recent brochure, "Ion Exchange Resins for the Power Industry," highlights the Emsland nuclear power plant in Germany, a

1400 Mw PWR plant. LANXESS supplied Lewatit® MonoPlus S 200 KR and Lewatit® MonoPlus M 800 KR, both processed to nuclear specifications and used in mixed bed applications within the plant. Lewatit® resins have shown extended run lengths, greater physical stability, and higher operational efficiencies in these applications.

Nuclear Plants Using Lewatit®

Below are nuclear power suppliers and plants that have used Lewatit® resins:

- Électricité de France S.A (EDF)
- China
- Germany
- Korea Hydro Nuclear (KHNP)
- Mexico
- Russia
- Slovakia
- Spain
- United States ☐



"Ion Exchange Resins for the Power Industry"

Visit our web site to learn more and download the brochure "Ion Exchange Resins for the Power Industry" at <http://lpt.lanxess.com/en/products-lpt/product-groups/ion-exchange-resins/>

QUALITY PURIFIES.

LANXESS understands the ion exchange resin and reverse osmosis (RO) needs of nuclear power stations. Whether it's for condensate polishing, rad waste, RO or other nuclear applications, our cutting edge products meet the highest standards. Learn more at lpt.lanxess.com/.

X Lewatit®

X Lewabrane®

**QUALITY
WORKS.**

LANXESS
Energizing Chemistry

Keep Your Power Transformers Powering On With Transformer Clinic™

Did you know that the average age for power transformers in the United States is over 40 years, with 70% being over 25 years old?

Aging infrastructure, lack of spare transformers, and irregular maintenance create an environment where unplanned outages, underperformance, and unreliability in power transformers can result in lengthy inspection/repair processes and revenue stagnation.

Sound familiar? Meet MISTRAS Group Inc.'s (NYSE: MG) Transformer Clinic™.

Transformer Clinic™ maximizes transformer availability and reliability by using a combination of in-service diagnostic testing and long-term 24/7 condition monitoring to determine and keep track of what's troubling your transformer.

Transformer Clinic™ represents an industry benchmark for determining the fitness and health status of your power transformers. Backed by MISTRAS' decades of substation reliability and transformer monitoring experience, Transformer Clinic™ offers four phases of in-service diagnostic testing and monitoring: **Sample**, **Screen**, **Observe**, and **Monitor**.

After an initial test **Sample** is taken and analyzed as a first indicator, the results may necessitate further investigation into areas of concern, calling for an on-site **Screen** spot inspection.

Utilizing industry-leading acoustic emission (AE) technologies, Transformer Clinic™ specialists screen transformers for instantaneous fault detection. Technicians are able to locate a variety of issues, including loose connections, arcing, partial discharge, blocked radiators, and more.

If symptoms are sporadic, Transformer Clinic™ specialists may recommend a 24-hour **Observation**. This results in a comprehensive condition ranking summary, providing a clear overview of the transformer's condition and outlining a recommended course of action if a problem is found.

Long-term **Monitoring** is prudent both for transformer operators whose assets require continued maintenance, and for those who simply want an extra layer of peace of mind. MISTRAS' proprietary AE sensors continuously detect and monitor abnormalities, organizing the data through a web-based application to generate real-time health and condition-based summaries to maximize


your transformer's in-market availability.

MISTRAS' Transformer Clinic™ solutions provide myriad benefits, including determining transformer conditions in real time, reduction/avoidance of Environmental Protection Agency fines due to environmental contamination, unplanned outage prevention, and asset life extension. Safety is paramount in the nuclear industry, so early detection of faults is essential to avoid catastrophic fail-

ures, which maximizes the safety of personnel.

As transformers in nuclear plants continue to age, the need for close inspection and monitoring grows along with them. With Transformer Clinic's™ help, operators can enable their power transformers to Keep Powering On™.

For more information, visit www.transformer.clinic or call 1-609-716-4000.



Keep Powering On™

POWER TRANSFORMER HEALTH SCREENING SERVICES AS LOW AS \$499* /UNIT <small>INCLUDES ▶</small>	SAMPLE <small>Onsite and Laboratory Testing</small>	SCREEN <small>Spot Inspection Testing</small>	OBSERVE <small>Overnight Baseline Testing</small>	MONITOR <small>24/7 Continuous Health Status</small>
				<ul style="list-style-type: none"> • Acoustic Emission (AE) • Onsite Dissolved Gas Analysis (DGA) • Electrical Detection (HFCT) • Vibration • Oil Quality Tests • Visual Inspection • Infrared • Leakage Current

*please contact us for details www.transformer.clinic



One Source Solutions for POWER Inspection & Engineering

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  FOSSIL
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Services | Systems | Products | Monitoring

MISTRAS Group specializes in Power Generation inspection and engineering services and develops products and systems that support these services. This innovative one source capability uniquely qualifies MISTRAS as a global industry leader.

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We are SECUR

An independent, asset-based, transportation, packaging, technical services and waste management firm

With more than 35 years of experience, **SECUR** offers the nuclear and radioactive waste industry innovative, turnkey waste management solutions.

SECUR manages a private fleet of more than 600 intermodal containers, all latest generation and water-tight tested.

We also maintain strategic partnerships with US manufacturers of proprietary and custom-made metal and flexible packaging that give our customer the most favorable pricing.

Our private railcars maximize capacity with configurations you can't get from the railroads.

SECUR's waste management experts orchestrate innovative solutions that keep your projects on schedule and on budget.

We have saved the nuclear decommissioning industry millions of dollars.

All services are performed in strict accordance with ASME NQA-1-2008 and DOT 49 CFR quality assurance requirements.

Our robust safety program integrates safe practices into every task and empowers all employees with stop-work authority.

Looking for an innovative partner to help orchestrate your next waste management project?

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SECUR's innovation in action:



*Our **Waste Management Simulation Model** accepts input and validates resource requirements for every stage of the project from demolition to packaging, shipping and disposal.*



*SECUR's **Transportation Plan** ensures compliance with DOT Hazardous Material regulations, 49 CFR, NRC regulations, and applicable DOE orders.*



*SECUR is the exclusive North American distributor of the **ATOM container line**, the most popular choice on decommissioning sites in Europe.*

Orchestrating calm even when surrounded by complexity.



Count on SECUR to orchestrate asset-based logistics, packaging, technical services and waste management to simply and safely handle your most challenging jobs. Find out how we can harmonize with your team when you visit us at www.securllc.com or call 888.484.4031.

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US owned and operated



URENCO USA (UUSA) is the only domestic uranium enrichment facility in the US and North America.

Utilizing leading centrifugal technology, UUSA provides uranium enrichment, storage and management services.

Located in Eunice, New Mexico, UUSA is a strategic national asset to the US. It employs more than 220 local people, a quarter of which are US military veterans.

UUSA became operational in 2010 and was the first new nuclear build project in the US for nearly thirty years.

It was also the first facility to be licensed, built and operated under a Nuclear Regulatory Commission (NRC) combined construction and operating license.

UUSA delivers energy that powers 6% of US electricity needs. Its current annual capacity of 4.8 million Separative Work Units represents roughly one-third of US demand for uranium enrichment. UUSA's capacity is licensed to increase depending on market conditions.



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urengo.com/about-us/company-structure/urengo-usa/

Your Manufacturing Solution

We build our business around the needs of our customers

Who we are...

Pennatronics is a customer-focused Contract Manufacturing Service provider specializing in Printed Circuit Board Assembly (PCBA) and Electro-Mechanical Box Build Assembly for Original Equipment Manufacturers (OEM's). We encompass a 10CFR50 Appendix B compliant nuclear safety program as well as ISO 9001/13485 accreditation that is ready to meet your contract manufacturing requirements.

Our Capabilities

Our 70,000 square-foot manufacturing facility is state-of-the-art in every respect and operates 7 days/week to meet all of our customers needs. Every project is driven by efficient, rapid-response methodology, stringent quality control and highly skilled personnel. We deliver exceptional service, board assembly, testing, and electro-mechanical box build assembly at competitive pricing.

Exceeding Expectations

Meeting standards is a given. Exceeding them is our mandate. On-time delivery that is considered world class and defect free product that meets regulatory requirements.

The Right Partner

Although there are many CM's in the US, the pool shrinks considerably when looking for a supplier that has a fully compliant Appendix B program. We are not a transactional supplier but rather a partner with the Engineering resources providing vital feedback on manufacturability.

Greater than the sum of our Parts

When you partner with Pennatronics, you get much more than just assembled components. Our highly experienced management team and skilled workforce bring decades of electronics manufacturing expertise and problem-solving abilities to meet your biggest challenges. A

state-of-the-art manufacturing facility, the best equipment available, and extremely efficient manufacturing processes help us deliver unmatched value.

For more information, please contact:

Dave Spehar
VP of Operations
(724) 938-1800



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All delivered with close attention to detail and exceptional service — and priced competitively.

That's what you get from Pennatronics, your premier EMS supplier.

Our efficient, rapid-response methodology, stringent quality control, and highly-skilled, trained personnel enable us to deliver astonishing results. We become an extension of your manufacturing capabilities.

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- Electro-Mechanical / Box Build Assembly
- Design for Manufacturing (DFM)
- Supply chain management
- Component review & analysis
- Complex builds and quick turns
- Experience in vintage designs & re-designs
- ISO9001:2008 Certified
- ISO13485:2003 Certified
- 10CFR50 Appendix B Compliant

Call us today to see how Pennatronics makes it all come together.

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LATITUDE™

manual scans | automated results



LATITUDE™

Receiver Collar

Transmitter Probe

ZETEC Topaz™

A FIRST-OF-A-KIND NDE INNOVATION

Structural Integrity Associates, Inc. is pleased to announce the availability of a new Ultrasonic Testing (UT) service to the power generation industry. This new service offering is based on LATITUDE™, a revolutionary non-mechanized position and orientation encoding system designed for use with UT non-destructive examination (NDE) equipment, enabling our operators to collect high-quality encoded data while utilizing a manual examination process. In addition, LATITUDE requires less equipment, fewer people, shorter setup time and runs on battery power. SI provides LATITUDE UT services for the following power generation applications:

DISSIMILAR METAL WELDS

LATITUDE is the basis of a new procedure for the examination of dissimilar metal welds in nuclear power plants. The procedure, SI-UT-217, was qualified by the Electric Power Research Institute (EPRI) in accordance with the rigorous demands of the ASME Code Section XI, Appendix VIII and the Performance Demonstration Initiative (PDI) requirements.

ASME CODE EXAMINATIONS

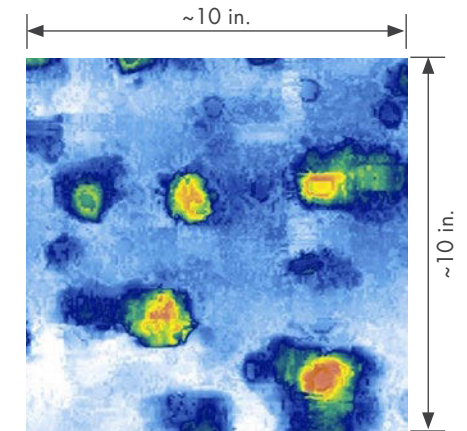
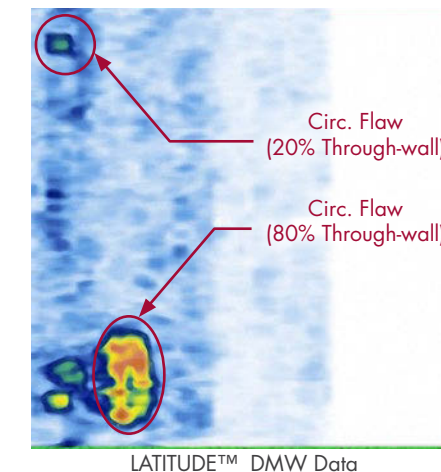
LATITUDE UT techniques meet the specific requirements specified the ASME Code, including Section III and XI, B31.1, and B31.3.

GENERIC WELD EXAMINATIONS

LATITUDE presents a new opportunity to encode manual examinations of weldments where the use of automated or other mechanical encoding methods are impractical or cost prohibitive. It has been used for the examination of girth and seam welds and can be deployed with phased-array UT (PAUT), time-of-flight-diffraction (TOFD), and a range of other NDE technologies.

FLAW CHARACTERIZATION

Structural Integrity can quickly deploy LATITUDE to confirm and characterize the size of a flaw. The encoded data can then be used by Structural Integrity to support engineering disposition of the flaw.



LATITUDE™ Corrosion Mapping collected in less than 2 minutes of scanning

CORROSION MAPPING

LATITUDE, when coupled with the use of a PAUT corrosion mapping probe, enables the encoding of high-resolution thickness data while manually manipulating the inspection probe, resulting in a composite thickness map that requires little to no post-processing for analysis.

www.structint.com/nuclear-news
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LESS EQUIPMENT

LATITUDE is compact, portable, and battery powered



SMALLER CREW

LATITUDE is designed to be set up and operated by a single person



FASTER SETUP

LATITUDE adds minimal set-up time to that required for a traditional manual examination



BETTER QUALITY

Guarantees coverage and puts the probe back into a human hand, helping to optimize coupling and indication response

Structural Integrity Associates is excited to announce the introduction of LATITUDE a revolutionary non-mechanized position encoding system for use with non-destructive examination equipment.

Why is LATITUDE revolutionary and how will it help you and your facility?

LATITUDE is an innovative alternative to cumbersome and complicated automated inspection equipment for a variety of applications.

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HOW IT WORKS

LATITUDE uses air-borne ultrasound to achieve its position tracking capabilities and does so by tracking the position of a small transmitting probe relative to a set, or array, of stationary receiver sensors. The LATITUDE transmitting probe can be attached to a variety of NDE probes and the absolute position of the NDE probe can be tracked multi-dimensionally, relative to the receiver array. Currently, the LATITUDE system can track x (axial) position, y (circumferential) position, probe rotation (skew), and can compensate for pipe (or component) curvature.

The LATITUDE system consists of three primary components: ① the electronic control unit, ② the receiver array, and ③ the transmitter probe attachment. In Phased Array Ultrasonic Testing (PAUT), the electronic control is integrated with the Zetec TOPAZ™ PAUT instrument and control of the LATITUDE system is done through the customized TOPAZ user interface. The LATITUDE enclosure is sealed, fanless, and can run for up to 10 hours off two hot-swappable batteries, eliminating the need for a 120V power supply.

Installing and calibrating the LATITUDE system adds minimal set-up time to that required for a traditional manual examination. LATITUDE has been extensively tested in the laboratory and in a power plant environment and has been demonstrated to be resilient in the presence of acoustic and electromagnetic noise.



Delivering the Nuclear Promise: Finding the savings

As ENERCON supports utilities implementing activities associated with Delivering the Nuclear Promise (DNP), opportunities for additional cost-savings through the efficiency bulletins initiatives are occurring. One of the greatest returns on investment has been found when implementing Value Based Maintenance (VBM).

Through VBM, ENERCON has helped clients identify the potential for millions of dollars in annual savings by finding the optimal balance between cost and reliability.

ENERCON Subject Matter Experts (SME) have partnered with utilities to uncover additional savings by evaluating a larger set of components. Using predictive modeling, ENERCON analyzes component failure rates and then applies cost information to the different scenarios, assisting utilities to develop Balanced Maintenance Strategies (BMS). BMS also allows

utilities to more efficiently apply resources to focus on the most critical components - an overall safety and reliability improvement.

ENERCON is also heavily involved in another key initiative,

amendment requests, performing Probabilistic Risk Assessments (PRA), and System Categorization.

There are numerous opportunities to realize substantial savings by implementing regulatory strategies

Efficient application of resources decreases costs & improves reliability and safety.

implementation of 10CFR50.69. Our SMEs help realize savings resulting from alternative treatment of systems and components considered to be of low significance to safe and reliable plant operation.

ENERCON has demonstrated industry expertise in support of writing industry guidance on these alternative treatment programs, and providing key industry support such as developing the required license

in pursuit of DNP. ENERCON has one of the deepest benches of SMEs in the industry to help utilities with all such initiatives including NFPA 805, Tech-Spec Surveillance Programs, Tech-Spec Completion Times, PRA Evaluations, and more, all resulting in cost savings including outage time savings, and elimination of forced outages.

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Supporting DNP We are more than you know

ENERCON has Engineer of Choice contracts at over 80% of the US nuclear fleet performing engineering projects for over 35 years...we have become so much more.

We have subject matter experts for all key issues facing the commercial fleet today, with *integrated services* to help you Deliver the Nuclear Promise. ENERCON personnel have performed a diverse range of projects for utilities in pursuit of the Nuclear Promise, resulting in well over \$20 million dollars in cost savings.

Reach out today and see how our expanded services reduce your total cost of power generation.

**If it is important to nuclear, it is important to
ENERCON.**

Risk-Informed Services

- Value-Based Maintenance Programs
- Probabilistic Risk Assessments
- Full and Focused-Scope Peer Reviews
- Facts & Observations Closeout by Independent Assessment
- Risk-Informed Tech Spec Implementation
 - 5b, Surveillance Frequency Control Program
 - 4b, Risk-Informed Completion Times
- Risk-Informed Categorization and Alternative Treatment per 50.69
- Risk-Informed Tornado Missile Protection using Tornado Missile Risk Evaluator
- NFPA-805 Implementation
- Licensing and License Amendment Support
- Configuration Risk Management 50.65 (a)(4)
- Risk-Informed GSI-191 Resolution



Excellence—Every project. Every day.

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Improving Material Properties Through Electropolishing

An Introduction to Electropolishing

Electropolishing is an electrochemical process by which surface material is removed by anodic dissolution. What may be envisioned as "reverse plating", electropolishing actually removes surface material, beginning with the high points within the microscopic surface texture. By removing these points, the electropolishing process will improve the surface finish, and enhance the near surface chemistry of the material.

Improving Corrosion Resistance & Reducing Product Adhesion

Electropolishing delivers a smoother, more reflective surface that reduces product adhesion and improves surface cleanability. Perhaps more importantly, electropolishing preferentially dissolves free iron, inclusions, and embedded particles from the surface of the work-piece. This process improves the near surface chemistry of the material, and promotes the formation of an improved corrosion resistant oxide layer.

Please see the full description of each of electropolishing's benefits.

The Basics of Electropolishing

Electropolishing is accomplished by creating an electrochemical cell in which the material to be polished is the anode. A cathode is formed to mirror the geometry of the work-surface and the two are submerged in a electrolyte bath. When a DC current is applied, the electrical charge forces metal ions to be dissolved from the materials surface.

The key to the electropolishing process is the difference in current density across the surface. Within the microscopic surface profile, the current density is greater at the high points and lesser at the low points. The rate of the electropolishing reaction is directly proportional to the current density. The increased current density at the raised points forces the metal to dissolve faster at these points and thus tends to level the surface material.

Electropolishing Services

Harrison Electropolishing, L.P. specializes in electropolishing, precision mechanical polishing, passivation, oxygen cleaning, and chemical cleaning of high purity and corrosion resistant processing equipment.

Our services can be provided at our Houston facility or at your jobsite, anywhere in the world. We offer full technical evaluation, quotations, sales, and consulting services with quality assurance and test certifications.



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Leading the nuclear industry from day one

Through our broad legacy of nuclear contractors, AECOM traces its history back to the very forefront of the nuclear industry. In 1947, we began work at the Brookhaven Graphite Research Reactor — the first peacetime nuclear reactor built exclusively for research. We were also one of the Manhattan Project's original six industrial partners. As the industry evolved, we continued to build upon our nuclear expertise, creating our continuous 60-year record of providing management, engineering, construction and modification solutions to virtually every commercial nuclear power plant currently operating in the U.S. and many that have since been retired.

Our legacy companies were engineer- and/or constructor-of-record for 49 nuclear power plants, including the first nuclear units in Spain, Italy, Brazil, Mexico and Taiwan. Consumers still depend on much of this nuclear baseload today. After the great build-out of the 1970s and 80s, our employees have helped to maintain the reliability of the operating fleet by accomplishing thousands of technical services tasks and life-extension modifications through a solid engineering services organization that has supported our customers as alliance partners, engineers-of-choice and consultants.

We provide complete resources for feasibility studies, costing, technical evaluation, environmental assessments, permitting and licensing, conceptual and detailed design, procurement, construction, operating services, maintenance, modifications and decommissioning.

Having a global focus, supported by 87,000 employees serving clients in more than 150 countries, we offer our clients a wide range of technical and engineering services including owner's engineer for nuclear new build, license renewal, alternate source terms assessments, control room habitability projects and independent spent fuel storage options for today's dry cask storage technologies.

To help vital operating assets meet today's challenges we've:

- Created a culture of safe work execution, with one site achieving 10 million man-hours without a lost time accident over a 10-year period
- Helped to reduce outage durations to less than 30 days, and at some plants, less than 20 days
- Increased power output through power uprate programs
- Mitigated component obsolescence through

digital upgrades and component replacement programs

- Enhanced human performance through empowerment, training and continuous learning
- Improved plant performance through our integrated project design and installation teams
- Continued to deliver, with joint venture partner SGT, world-class performance steam generator replacement projects and a project execution model for large nuclear plant capital projects

The no. 1 ranked* global engineering design firm, AECOM is a leading construction contractor. We combine specialties in architecture, building engineering, construction services, economics, energy, environment, government, mining, oil & gas, consulting, program management, transportation and water.

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*Engineering News-Record 2017 rankings



Imagination power.

We're partnering with visionary owners to deliver the power that energizes the world.

The nuclear power industry demands a highly specialized, diverse skillset and knowledge base. As the engineer and/or constructor of more than 39,000 megawatts, we provide support for new nuclear technologies, the small modular reactor market, operating plant technical services including major component replacements, facilities that support the nuclear fuel cycle, and D&D for facilities no longer in use.

Learn what our 60 years of nuclear experience can do for you at aecom.com or email power@aecom.com

AECOM Imagine it. Delivered.

We Build More than Just Ships. We Build Solutions.
HII Nuclear and Environmental Group Renames Business Units

Huntington Ingalls Industries (HII) is well-known as America's largest military shipbuilding company, but there is a lot more to the company than building nuclear and conventionally-powered ships for the United States Navy and Coast Guard. To demonstrate a firm commitment to non-shipbuilding services, HII formed the Technical Solutions division, home of the Nuclear & Environmental Group (N&EG).

Comprised of HII Nuclear (formerly, Stoller Newport News Nuclear (SN3)) and HII Mechanical (formerly, Newport News Industrial (NNI)) N&EG is focused on improving our nation's security. We do this by supporting the national security mission of the Department of Energy (DOE), fabricating nuclear quality components for the only new nuclear units being constructed in the country and Boiler Water Circulating Pump repairs and rebuilds for the fossil industry, as well as valve repairs and testing for the Department of Defense and commercial markets.

Changing our legal business unit names to HII Nuclear and HII Mechanical has allowed us to harmonize our branding strategy with our corporation's legacy of successfully managing simultaneous complex

nuclear projects based in shipbuilding. That knowledge is applied to the DOE and commercial nuclear markets through N&EG. We apply our disciplined nuclear operations culture, forged through decades of excellence, in the most complex projects ever undertaken in the global marketplace.

As a company, we believe that we contribute to our national security by executing with distinction every single day. We believe in being a good partner and in building relationships based on mutual trust and respect, founded in integrity. Finally, we believe in the value of open communication and the undeniable value of an ethical, diverse, inclusive and safe work environment.

Our full range of services include:

- Nuclear Management and Operations
- Site and Facility Restoration
- Environmental Services
- High Complexity Program Management
- Nuclear and Non-Nuclear Fabrication and Equipment Repair

- Nuclear and Non-Nuclear Modular Construction

N&EG consistently achieves project performance success at all levels. We offer innovative strategies resulting in safe, high-quality, on time, on budget delivery to our customers.

- VPP Star status and excellent safety performance
- 300+ nuclear projects safely delivered
- Over 2,000 projects performed for DOE

N&EG has a reputation for delivering results that go beyond expectations, creating a solid foundation of trust and reliability with our customers and partners.

To learn more about the Nuclear & Environmental Group, HII Nuclear and HII Mechanical, visit:
<http://tsd.huntingtoningalls.com>



COMPLEX PROBLEMS CRUCIAL SOLUTIONS

NUCLEAR MANAGEMENT AND OPERATIONS • SITE AND FACILITY RESTORATION • ENVIRONMENTAL SERVICES

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Nuclear & Environmental Group



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OR NEI 08-09 COMPLIANT.**

* **100% SIGNAL OR
EXTERNAL POWER.**

* **FAIL SAFE
ALARMS.**

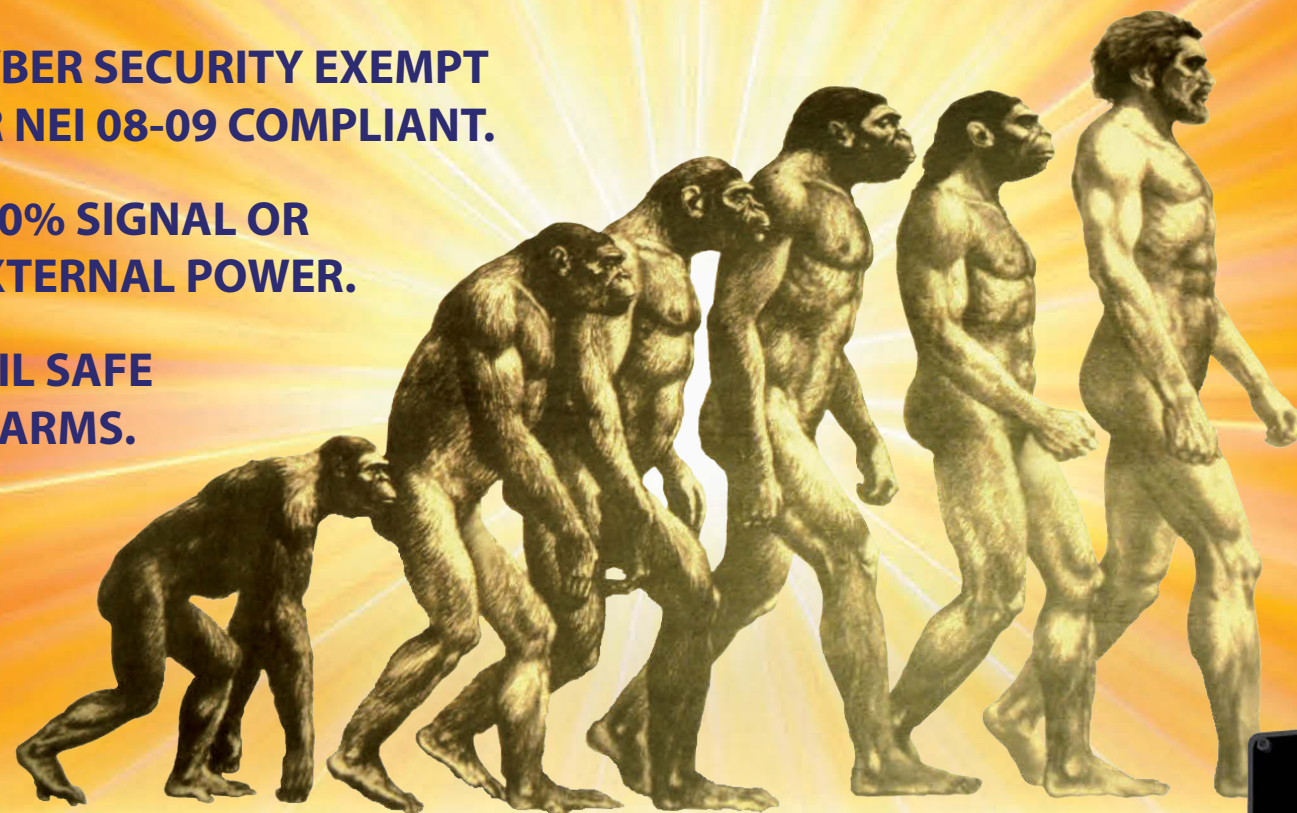
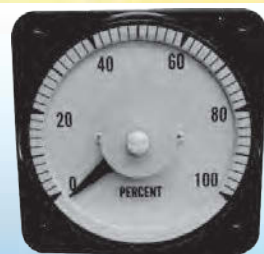
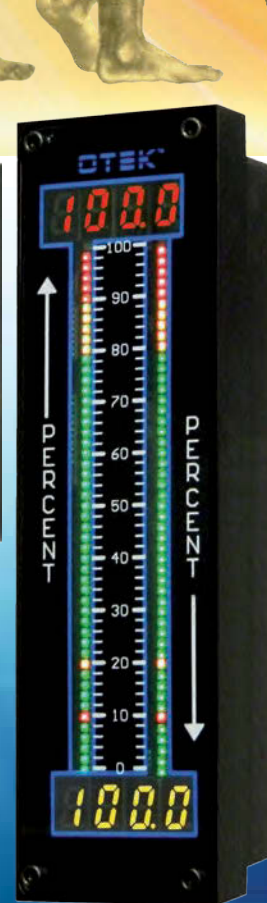


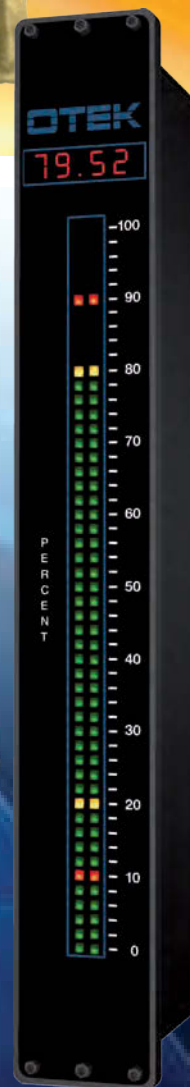
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SSAM-N



NTM-9



NTM-4

**100% form, fit and function replacement
for old analog and digital meters.**

**Otek's new quality program complies
with 10CFR50 APP. B, ASME-NQA1.**

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- 51 Segment, Automatic,
Tri-Color Bar Graph
- 20 Different Models, 100% FFF
Compatible with Many Obsolete
Designs
- Can be Externally Powered for
Additional Safety and Control
- Over 30 Different Signal
Conditioners Available
(External Power Required)
- Optional Analog, Power and
Control Outputs (External Power
Required)
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9th Degree Polynomials
- Integrable with SCADA/DCS
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Serial IO
- Cyber Security Features, Suitable
for Use as a CDA Under NEI 08-09
- Data Logging Features TBA
- Customizable to Your Needs
- Lifetime Warranty

Introducing The New SSAM Series

The **SSAM (Solid State Analog Meter)** Series features a bright 4½ digit LED display and a 101 segment bargraph to promote easy HMI readings and consistent interpretations by operators. The SSAM has no critical digital assets (CDA), therefore, it does not need to comply with NEI 08-09 (Cyber Security requirement). The **SSAM** is ideal for replacing existing obsolete analog and digital instruments; it is designed as a 100% Form Fit and Function (F.F.F.) replacement.



SSAM-N

Reduce/Eliminate I&C Obsolescence

Analog and Digital Instruments from the 1960s and 70s are no longer available from their OEM's. The OTEK **SSAM** is 100% FFF compatible with many popular models and "Obsolescence Hardened" with multi-sourced and standard components.

NO External Power Required

OTEK's Patented "Loop-Powered" design means your **SSAM** Instruments can be powered directly from the signal (mA DC/AC, VDC/AC). There is no need to design in a new power supply. The **SSAM** uses the same 2-wire connection as the analog instrument it's replacing.

Improve Safety

Solid State Design means no mechanical parts to wear out, no stuck needles and no subjective interpretation. "Loss of Signal" indication and other alarm functions support Fail-Safe operation.

Increase Data Precision & Accuracy

Analog Instruments are 2% precision at best. The **SSAM** provides up to 0.5% precision throughout its operating range, with minimal drift over time.

Reduce Maintenance Cost

Analog instruments must be frequently tested and recalibrated. Solid-state **SSAM** design means less testing, calibration and maintenance costs with a MTBF of over 25 years.

**Need H.V. relay output for annunciator
or alarm? SSAM offers "Fail Safe" &
Hi/Lo relay out, all with signal or
external power!**

**Otek maintains a
10CFR50
Appendix B Quality
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Pioneer of Passive Fire Protection for the Nuclear Industry – Now Also the Answer to Your Flood Mitigation Issues

For over 30 years PCI Promatec® has offered an unmatched library of products and designs qualified to meet the unique requirements of the nuclear industry, including high temperature, pipe movement, and radiation resistance/attenuation sealants and systems. We also continue to offer formulas and systems from Brand/Bisco, ICMS and Techsil, simplifying compliance with your plant's specifications.

As a result of the unfortunate events of Fukushima, we have worked with a number of utilities to develop thin-profile coatings which can be installed over existing seals, vastly improving their resistance to flood. These coatings are easily removable, radiation resistant, fire tested and compatible with Hypalon™ and Firewall III cable. Additionally, as the exclusive worldwide distributor of 3M

products to the nuclear industry, we have qualified 1-3 hour electrical raceway fire barrier systems that fully comply with the latest USNRC requirements. These systems have been qualified to the more rigid seismic and LOCA conditions resulting from the Fukushima incident.

Most recently, our NQA-1 Quality Assurance program has passed the rigorous audit process of the DOE and has continued to meet the requirements of NUPIC every year since its inception.

Our Target Zero safety program is one of the best in the industry. Our EMR is one of the lowest in the country. As part of Performance Contracting Group (PCG), we offer the resources and financial stability of "one of the Top 10 Specialty Contracting Firms in the USA," as ranked by *ENR Magazine*.

Our customer base includes the vast majority of nuclear plant owners in the USA, DOE, and a number of international utilities in Asia and Europe. In an average year, we do business with over 50 facilities worldwide with services ranging from technical support to full turnkey contracts. Our products are installed at 74 sites within the United States and 119 worldwide. With contracts successfully completed from \$1,000 to \$20,000,000, no job is too large or too small.

If you have a need, we have a solution. For more information or technical support, call PCI Promatec at 281-807-3318, email us at info@promatec.com or visit us online at www.promatec.com.



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- **EASILY REMOVABLE**
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- **RADIATION RESISTANT**

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NUCLEAR CONTAINMENT SYSTEMS FOR NEW CONSTRUCTION, MAINTENANCE, AND OUTAGE PROTECTION

GRIFFOLYN® CONTAINMENT PRODUCTS

Griffolyn® internally reinforced polyethylene laminates have been designed for a wide range of prospective applications. For more than 30 years, Reef Industries has been providing the nuclear industry with construction, maintenance, and outage protection with a variety of contamination control products. Griffolyn® is performance engineered to be highly resistant to tears and punctures with an exceptional outdoor service life. Whether storing or protecting equipment or isolating and containing contaminated materials, Griffolyn® products can be designed and fabricated to your project requirements.

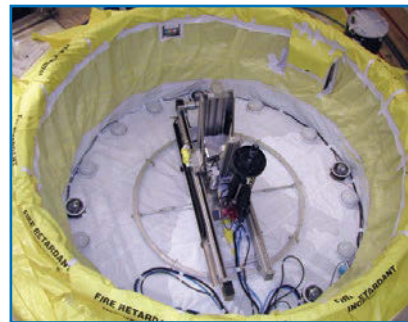
ADVANTAGES

- Maintain schedule
- Stay on time and within budget
- Reduce cost

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materials or work areas, or anti-static and corrosion protection for sensitive equipment. Cover your investment and protect it with Griffolyn®.



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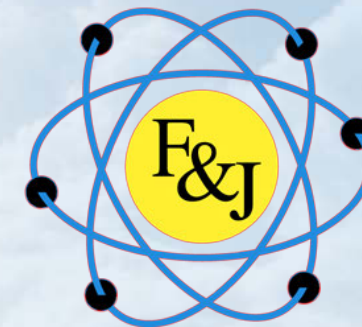
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WIPP Space Faces TRU Waste Disposal Limits: THE VOLUME REDUCING SOLUTION

By Steve Chunglo, Central Research Laboratories

Transuranic (TRU) waste packaging for removal from a glovebox has for many years involved the use of bags as the primary containment. In many cases, many hydrogenous layers of bags, yards of tape, and multiple filters are added to the waste stream in order to get the TRU waste

into the final 55 gallon drum package to be shipped and buried at the Waste Isolation Pilot Plant (WIPP).

The WIPP is currently limited to a total finite disposed volume of Contact Handled (CH) and Remote Handled (RH) TRU waste. As of early 2014 over half of the allotted WIPP volume

had been filled with mainly CH-TRU waste. Based on current bag operation packaging methods used, the Department of Energy's (DOE) remaining CH and RH waste will not fit in the remaining limited WIPP space.

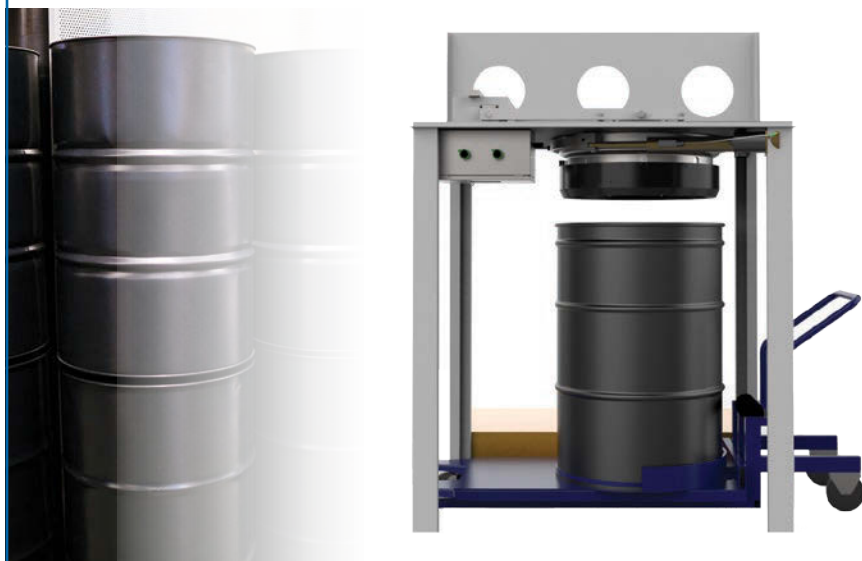
Bag operations, can be performed safely by good operators following tedious repetitive processes and many Administrative Safety Controls. Since the bag is the only confinement layer between the contamination and the operator, contamination incidents can occur. Bag-out operations require close proximity to the waste to perform the process. With some waste streams, this close to waste proximity increases operator radiation dose.

Central Research Laboratories (CRL), based in Red Wing Minnesota, who for many decades has developed proven engineered material transfer solutions based around their Rapid Transfer Port (RTP) technology, has worked with DOE sites to develop a TRU Waste Management Solution. The solution is a single filtered large Polyethylene (PE) or Stainless Steel (SST) Rapid Transfer Port container in a standard Department of Transportation (DOT) 7A, Type A drum, which allows for loading of TRU waste directly from the operational glovebox without the use of bags, sleeves or tapes to provide leak tight containment. All operator interventions to connect and disconnect a drum to and from the glovebox are achieved in an upright ergonomic position by one (1) operator in less than three (3) minutes. Minimal As Low As Reasonably Achievable (ALARA) levels are achieved during connect and disconnect of the drum, due to the engineered safety controls of the RTP.

The CRL RTP solution allows glovebox or re-packaged TRU waste to be safely transferred to the final 55 Gallon drum container without additional bags or tape. The high diffusion coefficient filter on the CRL RTP 55G container and elimination of added hydrogenous packaging, improves the Decay Heat Limit (DHL) per drum for most TRU waste types compared with bagged drums, and in most cases allows more TRU waste to be loaded per drum. Inorganic TRU waste materials can be packaged directly into the CRL RTP SST drum container to the maximum DHL and Fissile Gram Equivalent (FGE) allowable for a drum.

TRAMPAC approved TRU waste packaging of CH and RH TRU waste can be accomplished in a safer, cost effective manner without adding any additional packaging materials to the waste stream, thus increasing the chance of placing all DOE's legacy and to be generated TRU waste in the remaining WIPP space.

Waste Management Solutions



Waste Drum Transfer System

CRL's Waste Drum Transfer System (WDTS) was developed to address the need for a safe, efficient method of transferring waste from gloveboxes and hot cells.

- Mitigates contamination incidents to facilities and operators
- Minimizes additional hydrogenous waste
- SST liner can maximize high wattage non-hydrogenous drum loading

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ANS ANNUAL MEETING

Toward the future

Session Coverage:

- *Simplifying the nuclear industry's message*
- *Developments in the area of micro-reactors*
- *Recognizing nuclear's climate-friendly attributes*
- *The importance of having "champions" for nuclear energy*
- *International views on the future of advanced reactors*

With the theme "Driving the Future of Nuclear Technology," the 2018 ANS Annual Meeting, held June 17–21 in Philadelphia, Pa., was certainly forward looking. In his welcoming remarks at the meeting's opening plenary session, however, ANS President Bob Coward asked attendees to take a look back. Specifically, Coward asked the audience to recall the remarks he gave at the 2017 ANS Winter Meeting eight months prior, when he stressed the importance of remaining optimistic despite



Coward

the difficulties facing the nuclear industry. "If we don't have optimism, we have nothing," he said. Coward tempered his optimism, however, noting that there have been many changes in the world since the first nuclear power plants were built and that the nuclear of tomorrow will not be the same as it is today. The world will demand smaller, scalable nuclear power, he said, referring to the increased interest in small modular reactors and micro-reactors. "The future is bright," he said, "but realistically, it is a different kind of bright."

In his remarks following Coward's, Krishna Singh, president and chief executive officer of Holtec International and general chair of the meeting, also looked



Singh

Regarding new, advanced reactors, Singh stressed the importance of safety, noting that it is the industry's responsibility to make power reactors walk-away safe. "Without the guarantee of unconditional safety built

into the DNA of nuclear plants," he said, "the ghosts of Fukushima and Chernobyl will continue to haunt us."

In concert with its efforts to increase safety, Singh said, the industry needs to confront antinuclear sentiment, which he called "conspicuous nonsense," and ensure that the public dialogue around nuclear remains fair and balanced. In discussing those opposed to nuclear energy, Singh made a point of distinguishing between the informed opposition of non-governmental organizations such as the Sierra Club and the Union of Concerned Scientists and what he described as the "know-nothing" antinuclear crowd, calling them "purveyors of misinformation."

The plenary session's keynote speaker, Chris Mudrick, Exelon's senior vice president of Northeast operations and chief



Mudrick

operating officer of Constellation Energy Nuclear Group, also stressed the need for nuclear advocacy. "We need to be better advocates for ourselves and for our industry," he said. Acknowledging the complexity of nuclear technology, Mudrick added that the industry needs to simplify its message to the public and lawmakers to better convey the importance of nuclear and its contributions to jobs, communities, and the environment.

Noting the social and economic challenges nuclear power faces, Mudrick said that the industry needs to take control of its own destiny. Continuing public advocacy efforts is one way to do so, he said. Another is increasing operational excellence while reducing costs. He noted that Exelon is working to reduce its nuclear power production costs by 30 percent, to \$25 per megawatt hour, by 2025.

As Coward and Singh had mentioned earlier, Mudrick said that the industry can ensure a strong future by continuing to seek growth through the development of SMRs and Generation IV reactors. He also said that the industry needs to continue to push for market reform to ensure

that nuclear is compensated fairly for the clean energy it provides. “It is up to us,” he said.

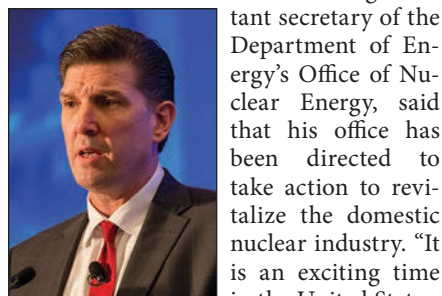
Mudrick said that while the industry faces a number of challenges, they are not insurmountable. “I am an optimist,” he said. “I think our best days are ahead of us, but we have to acknowledge reality.” By acknowledging and understanding the challenges, the industry can better plan a path forward, he added.

Turning to the international arena, Shekar Basu, chairman of India’s Atomic Energy Commission and secretary of the government of India’s Department of Atomic Energy, provided an overview of nuclear power in India, a country with 22 nuclear power reactors currently in operation, with a capacity of over 6,200 MWe. India has nine additional reactors under construction, with more planned, Basu said, adding that nuclear power in India is going to stay.

As for India’s nuclear policy, Basu said that the country intends to accelerate its civil nuclear power program. This includes closing the nuclear fuel cycle while pursuing the development of advanced fast reactors. As for challenges facing India’s nuclear program, Basu pointed to the uncertainties caused by the country’s nuclear liability laws.

Regarding the future of nuclear in India and worldwide, Basu said, “We may have to wait a few more years for the global nuclear revival.” As has often been repeated, the global nuclear industry must first get a handle on construction costs and completion schedules before real growth can be realized, he said.

As for the future of nuclear in the United States, Edward McGinnis, acting assistant secretary of the Department of Energy’s Office of Nuclear Energy, said that his office has been directed to take action to revitalize the domestic nuclear industry. “It is an exciting time in the United States.



McGinnis

We may have some challenges, but in fact, I think that is when the U.S. nuclear industry is at its best,” McGinnis said, adding that industry is well capable of adapting and innovating to overcome the challenges it faces.

While McGinnis noted the DOE’s continued involvement in current nuclear technology and the continuing operation

of the existing fleet of power reactors, he also highlighted the steps being taken in the development of new technologies, including advanced reactors and SMRs, as well as micro-reactors. “We are on the cusp of a highly transformative—I’d say disruptive—moment in the history of the U.S. nuclear sector,” he said.

McGinnis said that the DOE has a memorandum of understanding with a micro-reactor company that has a target of 2021 to build a demonstration unit at Idaho National Laboratory, in addition to its support of NuScale’s efforts to build an SMR by 2026, also at INL. McGinnis added that the DOE is not only investing in new technologies, it is proactively pushing new reactor concepts. “Time is not on our side,” he said. “We have future shutdowns, and we need to open up the pipeline for the newer advanced reactors.”

The potential of micro-reactors was also addressed by Maria Korsnick, president



Korsnick

and CEO of the Nuclear Energy Institute, who said that the new reactors are making possible “exciting new markets for nuclear power.” The size of a shipping container, micro-reactors can be transported by truck or barge to remote locations or military installations, “from Alaska to Puerto Rico,” and run for years without having to refuel, Korsnick said, adding that this could be a godsend to communities lacking direct access to reliable power sources.

While acknowledging the work the DOE and the U.S. Congress have done in supporting new nuclear technologies, Korsnick said that a stable, long-term funding mechanism is needed to help move technologies, such as micro-reactors, from the research and development phase to the marketplace. “The demand for nuclear technology is real and immediate,” she said.

Yuri Nedashovsky, president of Energoatom, Ukraine’s national nuclear energy generating company, said that nuclear energy will continue to play a key role in Ukraine’s energy profile. Speaking through an interpreter, Nedashovsky outlined Ukraine’s energy strategy out to 2035, noting that the country will seek to extend the operational life of its current fleet of

15 power reactors while pursuing the construction of new units.

Nedashovsky said that the Ukrainian government intends to zero in on the selection of reactor technology for new construction projects by 2020. As a caveat, he acknowledged the difficulties Ukraine



Nedashovsky

faces in making national policy decisions in the current political climate following the deterioration of relations with Russia. “It is very insecure to make any plans for the future in the present day’s turbulent situation,” he said.

Nedashovsky, however, noted Ukraine’s progress in pursuing small modular reactors. Energoatom signed a memorandum of understanding with Holtec International in February on the development and fabrication of Holtec’s SMR-160 reactor. Ukraine intends to construct six SMR-160 units starting in 2026, Nedashovsky said, adding that the units will replace two VVER-440 units that are to be decommissioned.

The panel’s final speaker, José Gutiérrez, president and CEO of Westinghouse Electric Company, provided a few details on the company’s eVinci micro-reactor concept. Westinghouse had announced on June 7 that it was awarded \$5 million in funding from the DOE’s Advanced Research Projects Agency–Energy to develop a self-regulating solid core block, a key component of the eVinci micro-reactor.

While Gutiérrez said that eVinci is part of Westinghouse’s efforts to innovate in order to grow its business, he admitted the project was in its infancy. “We don’t have a design yet; we have the idea, we

While acknowledging the work the DOE and the U.S. Congress have done in supporting new nuclear technologies, Korsnick said that a stable, long-term funding mechanism is needed to help move technologies, such as micro-reactors, from the research and development phase to the marketplace.

have the concept,” he said, adding that the company will need to invest “a significant amount of money” to bring the micro-reactor to market.

In addition to the eVinci micro-reactor and its SMR design, Westinghouse will continue to pursue large reactor projects using its AP1000 pressurized water reactor technology, Gutiérrez said. The company, however, will learn from its experiences, he said, referring to the terminated AP1000 new builds at the Summer plant in South Carolina. "We cannot make the same mistakes again," he said.



Gutiérrez

In closing, Gutiérrez said that Westinghouse will emerge from its Chapter 11 bankruptcy proceedings leaner and stronger, with a focus on building its business through innovation and expanding its global presence.

What nuclear needs

ANS President Bob Coward opened the President's Special Session, "What Nuclear Needs," with an unusual admission: He hadn't been involved in planning the session. "Back in November," he said, "I had what I thought was a good idea, which I have come to decide was actually a pretty damned good idea. I went to the ANS Young Members Group leadership and said, 'Here, take this and run with it.' I thought it was a chance to demonstrate to the whole society that the Young Members Group can put on a session that's worthwhile to everybody."

The resulting discussion, moderated by Duke Energy nuclear engineer Alyse Scurlock, focused on five topics: attracting private investment, accelerating the development of advanced reactors, ensuring that nuclear energy is recognized as a way to fight climate change, creating a diverse workforce capable of tackling tomorrow's issues, and building political support for nuclear.

Speaking on the subject of private investment was Johanna Wolfson, of PRIME Coalition, a nonprofit organization dedicated to bringing philanthropic capital to early-stage climate innovation. To achieve significant decarbonization of the energy sector, Wolfson said, new technologies must be developed. "At PRIME, we're focused on helping to develop and nurture the unproven technologies that could make a big difference to the climate in the coming decades," she said. "But we know that that doesn't happen quickly. To develop new, hardware-based physical tech-

nologies takes decades at minimum, and that timeline only increases in the nuclear sector."

Traditional venture capital investment methods, Wolfson said, don't work particularly well for nuclear, or for any "physical, hardware-based technology that is participating in a commodity marketplace and trying to integrate into a legacy sector, which is what we're dealing with in the energy sector. A typical venture capitalist is charged with investing capital and returning that investment within 10 years. They need to be able to see by about the seven-year mark that a company is going to return capital. And they have to do this across a portfolio of companies. So any one company that gets invested in needs the potential to return 10 times the investment, because most of them are going to fail. If I'm a venture capitalist, am I going to invest in a new data app, or am I going to invest in a new reactor design? That is the situation we are in."



Wolfson

According to Wolfson, a few trends have emerged that have the potential to advance new nuclear and other technologies to market and close the capital gap that currently exists. "The family office or foundation is an area where a new company that has a very long gestation cycle of a couple of decades could potentially get funding," she said. "We're seeing more family offices getting involved in these types of investing and new funds getting started along these lines. One that has made the biggest splash is Breakthrough Energy Ventures, funded by Bill Gates and 20 other billionaires to fund companies from inception to exit. This is a good sign. A billion dollars is not enough to solve this capital gap at scale, but it is a starter, and if that fund is successful, we hope we'll see more."

Wolfson also provided details on the PRIME Impact Fund, for which she is the principal. "We're very focused on all of the capital that sits in U.S. family foundations, donor-advised funds, and others that is charitable in nature and is actually impact-first and has no expectation of return," she said. "These are dollars that are often distributed as grants. We believe this

is actually the type of capital that can really be catalytic in supporting new, early-stage companies to underwrite risks that no one else will be willing to underwrite, that aren't appropriate yet for a traditional venture investor."

Over \$600 billion sits in U.S. family foundations, Wolfson continued, and \$50 billion is given out as grants every year. "If we were to direct just one-tenth of 1 percent of that into breakthrough, early-stage companies developing things like new nuclear technology, we could actually more than surpass all of the short funding in this category. . . . We believe it could really change the game for the starter companies that would be supported, as well as for commercial capital that would come in to follow. That is actually our long-term vision."

To date, Wolfson said, PRIME has supported seven companies across all areas of greenhouse gas emissions reduction by identifying promising firms and bringing them to philanthropists. "We're now building a small fund to do more of this type of work in a more flexible manner," she said. "In the long term, we're looking to build a larger marketplace of investing in carbon-light, carbon-neutral, and carbon-negative technologies by blending this charitable capital with return-driven investment capital."

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The session's second discussion topic, accelerating the development of advanced reactors, was addressed by Rita Baranwal, director of the Gateway for Accelerated Innovation in Nuclear (GAIN) initiative—a Department of Energy program focused on creating public-private partnerships to rapidly and cost-effectively commercialize advanced nuclear technology. Baranwal began by listing some of the expected benefits of advanced reactors. "They are intended at the going pace of development to have lower cost and faster construction," she said. "They can vary in size from megawatts to gigawatts. They have more flexible operation. They meet diverse energy needs, especially when you look at reac-



Scurlock

tors that will be operating at higher temperatures, enabling them to supply process heat for industries that currently



Baranwal

have no carbon-free option, such as fertilizer manufacturing, petroleum refining, and desalination. And there are enhanced safety features that come with the advanced reactors as well.” Baranwal, however, noted seven “challenges” that in her opinion need to be addressed prior to the actual construction of an advanced reactor. These include changing the public’s perception of nuclear energy; working on construction certainty (“making sure that we understand what the construction calls for to build these new reactors, and then working through research and development to reduce those costs”); obtaining research funding (GAIN and the non-profit organization Third Way have put together a directory containing information on companies working in the area of advanced reactors); working with the Nuclear Regulatory Commission on advanced reactor regulatory issues; working on a used fuel solution; emphasizing the value of advanced reactors while still understanding the economics of advanced reactors; and figuring out the technology needed to make these reactors a reality and how to “technologically de-risk the science of it.”

The third topic, ensuring that nuclear is recognized for its environmental benefits, was taken up by Armond Cohen, cofounder and executive director of the Clean Air Task Force (and a former antinuclear lawyer). The unfavorable views toward



Cohen

nuclear energy held by certain members of the green movement are unlikely to change, Cohen said, including the views of the “not-in-my-backyard” types, as well as the views of those who simply believe the technology to be too complex and, ultimately, uncontrollable. “This view, unfortunately, was reinforced through the incidents at Three Mile Island, Chernobyl, and, most recently, Fukushima,” he said. “So there is that narrative, which is that nuclear is just not an appropriate technology. It has nothing to do with climate. It’s purely a social, philosophical point of view. I’m not sure what you do about that.” Cohen quoted a phrase used by former U.S. congressman

Phil Sharp: “Progress follows the hearse.” “In this case,” Cohen said, “it may be that people from my generation who went through that cultural moment just have to die and let our children approach this subject more rationally.”

The views of many in the “mainstream or quasi-mainstream” green movement are changing, to some extent at least, according to Cohen. The two fundamental arguments of the green movement against nuclear as a climate change solution, he said, are that the technology is unnecessary because wind, solar, and batteries “can do it all,” and that nuclear is prohibitively expensive and cannot be built fast enough to matter for the climate. Regarding the first argument, Cohen has seen a substantial shift within the green movement in the past two years. “There are some great papers that have been put out on this topic that have really tried to highlight the difficulties of powering an entire industrial power grid on variable power due to seasonal gas and wind and solar availability and so forth,” he said. “The amount of storage we would have to build to compensate for that is extreme, so that takes you out from a cost perspective. There is increasing recognition among my peers in the mainstream environmental organizations that that analysis is correct, and that some kind of firm zero-carbon power like nuclear—or some people prefer carbon capture on gas—is going to be necessary to run an advanced power grid at some reasonable cost. I think we’re winning that discussion, actually.”

The second argument against nuclear is harder to counter, Cohen cautioned. “My colleagues of good faith are really saying, ‘I just don’t want to put any political energy into this because this is fundamentally an industry that cannot deliver,’” he said. “I have to say that I don’t necessarily disagree with that point of view. I think the industry, as it stands today—at least in Europe and the U.S.—can’t deliver a product at a reasonable cost in a reasonable time frame. We know that is not true globally, though. Recently, my colleagues at Lucid Consulting put out a report commissioned by the Energy Technologies Institute in the U.K. showing that, in fact, there are parts of the world where reactors are being built somewhere in the neighborhood of \$3,000 or \$3,500 per kilowatt in 42 to 50 months, as opposed to what we’ve

been seeing in the U.S. in South Carolina and Georgia.”

Cohen believes that in order to get more of the environmental community onboard with the notion that nuclear is climate friendly, the nuclear industry needs to “take a cold, hard look in the mirror and ask what this industry can do to learn from its mistakes and deliver a credible product at some reasonable cost that proves that it can be relevant to solving the climate problem.” More specifically, nuclear needs a \$3,000-per-kilowatt reactor that can be delivered in four years from ordering, on normal commercial terms, he said.

Fiona Rayment, executive director of the Nuclear Innovation Research Office, a

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Rayment

division of the United Kingdom’s National Nuclear Laboratory, spoke on diversity in the nuclear workforce. In Rayment’s view, diversity is not simply about ensuring representation of such groups as women or minorities, but also about embracing different views and ideas. As to why it matters, she cited studies showing that 15 percent of companies in the top quartile will have financial returns higher than their competitors if they employ gender diversity within their workforce; that companies practicing diversity have 22 percent lower turnover rates due to increased morale and 39 percent higher customer satisfaction figures; and that for every 10 percent increase in gender diversity, earnings before interest and taxes increase by 3.5 percent.

“Diversity and inclusion increase innovation, and we definitely need that within [the nuclear] sector,” Rayment said. “And diversity increases productivity. In short, diversity builds better business.”

Rayment also noted that in the United

Kingdom, women make up 51 percent of the overall population, but only 22 percent of the nuclear industry. "I'm not saying the answer is 51 percent, but surely it's not 22 percent," she said. "Of course, diversity is not just about gender, but we need to start somewhere, and we need to start where there is a large proportional difference. Women today are working as nuclear engineers, project managers, inspectors, chemists, senior managers, and so on. But in the U.K., the proportion of nuclear sector board seats held by women is only 8 percent. What is quite interesting is that only 9 percent of the female public, in general, claims to understand the need for nuclear energy. I think there is a correlation there."

The session's final speaker was David Fein, Exelon's senior vice president for state governmental and regulatory affairs, who offered his thoughts on how to build political support for nuclear. According to Fein, the most important starting point for developing

that support is education. "People don't really understand our industry," he said. "They take for granted so many things. . . . I live in Illinois, where there are more nuclear power plants than in any other U.S. state. Before we set out on a campaign to educate lawmakers, stakeholders, and constituents about the challenges facing the merchant nuclear fleet in Illinois, we went through a cold, sobering polling experience: We found that a high percentage of Illinoisans had no idea there was even a single nuclear power plant in the state, much less that Illinois leads the country in reliance on nuclear power. At that point, I knew that we had a problem and that we had a lot of educating to do before we could start talking about policies and building a coalition."

Having "champions" for nuclear energy is also key, Fein said, noting that they should preferably come from outside the industry. He pointed to Illinois Gov. Bruce Rauner and New York Gov. Andrew Cuomo as examples, giving them much of the credit for rescuing at-risk nuclear facilities in their states. "The same thing happened in the state of New Jersey," Fein continued, referring to S. 2313, the bill signed into law in May that saved Hope Creek and Salem from premature retirement. "Senate President Steve Sweeney, a labor official and the most influential Democratic politician in the state, took on the issue as his priority. He made sure he was the sponsor of the bill, and he really drove the process." Champions can come from other areas as well, Fein added, including labor, environ-

mental groups, and industry vendors.

In addition, Fein underscored the need for advocacy, praising organizations such as ANS, the Nuclear Energy Institute, and Nuclear Matters for their efforts in this area. "And now we're using technology and social media," he said. "I can say that when I started this a few years ago, I had no idea what that was or how it operated. It really drives these issues. And it's really easy to get involved. A lot of tools that the industry is now utilizing, just like all other areas of political discourse, are helping us to build those coalitions and be more effective advocates."

SMRs: Benefits and challenges

Krishna Singh opened the General Chair's Special Session, "Benefits and Challenges of Shrinking Large Nuclear Units to Small Modular Reactors," with a twofold challenge to the SMR community. "First," he said, "we have to make sure that small modular reactors per kilowatt will be cheaper—cheaper installed costs, cheaper operating costs. Second, safety is not negotiable. We have to show deterministically that there will be no failure. We have to demonstrate that at the end of any credible scenario, the reactor will not go berserk. That is the challenge we face."

Singh was followed by Sekhar Basu, the session's chair and head of the Atomic Energy Commission of India, who, after brief remarks of his own, introduced the session's lead presenter, Stuart Crooks, managing director of EDF Energy. Crooks discussed the company's Hinkley Point C nuclear project in Somerset, England, as well as the lessons learned from such an undertaking and how they might be applied to SMRs.

Hinkley Point C, Crooks said, will be the first new nuclear plant in the United Kingdom since Sizewell B, which was commissioned in 1995. "It's a seminal moment for the U.K.," he said. "It's the rebirth of our nuclear industry. . . . But it's not just big reactors. The U.K. is interested in delivering small modular reactors."

Based on the challenges encountered by EDF with regard to the funding, design approval, and licensing of Hinkley Point C, Crooks said that he believes the main

issues facing SMR developers include the following:

- All SMRs are in the early design phase, with unproven technology; the economics depend on making a series with a stable design.

- Economics depend on replication and delivering on the series' effect to reduce costs from the first-of-a-kind investment. To be effective, this requires commitment to a fleet of stations.

- Funding of design development through to completion of first prototype is a high-risk investment that needs to be committed to before committing to building a series.

- A holistic approach is needed to focus on both the capital cost and the through-life costs; financing the capital cost is one side, and guaranteeing the revenue for the series is the other.

- Experience has shown the importance

"First, we have to make sure that small modular reactors per kilowatt will be cheaper—cheaper installed costs, cheaper operating costs. Second, safety is not negotiable. We have to show deterministically that there will be no failure."

of building a prototype to underpin "buildability," as well as operability and reliability; prototyping takes time, which is not helpful when justifying investment.

- For the duration of the project, a highly qualified team is needed to develop the design, secure the safety case, plan the procurement, and build the schedule in detail in collaboration with main contractors.

- Subcontractors must be high quality and experienced in nuclear construction or trained in the necessary specialist skills and requirements for quality, tractability, and documentation.

- Good communication with the community local to the site needs to be established and maintained. The station will be part of the community for a long time.

- Design maturity is key, with all licensing issues resolved prior to the start of construction. Design maturity also underpins the value of the United Kingdom's Generic Design Assessment process, which is used by U.K. nuclear regulators to assess new nuclear power station designs.

Kathryn McCarthy, vice president of research and development at Canadian Nuclear Laboratories, addressed CNL's efforts to enable a future for SMRs. The current risks to SMR deployment, she said,



Fein



Crooks

fall into three categories: technical, regulatory, and financial. All SMRs feature



McCarthy

new or unproven technology, she noted, echoing Crooks. “In some cases,” she said, “there are unconventional coolants, and that increases the technical risk.” The regulatory risks exist, she said, because SMR developers have not exercised “any regulatory process, and regulators tend to like to do what they’re used to doing,” while the financial risks are due to funders’ wariness of first-of-a-kind concepts. “You see a lot of private investment in SMRs now, and that’s a really good thing,” McCarthy said. “What remains to be seen is if one of those private funders is willing to actually fund the construction of one of these plants. And investors are not typically geared to return over a long period of time. Typically, nuclear return on investment is relatively long.”

To help reduce these risks, McCarthy continued, CNL has set itself the following goals: to demonstrate the commercial viability of the SMR by 2026, to be recognized as a global leader in SMR prototype testing and science and technology support, to be recognized as a hub for SMRs, where multiple vendor-supported prototypes are built and tested, and to host a prototype within the next 10 years. “One of the things we did last fall was to

CNL received 80 responses, McCarthy said, 19 of which were for potential SMR demonstrations at a CNL-managed site. While many responses were from within Canada, a number of others came in from Asia, Europe, and South America—an indication, according to McCarthy, that Canada has an internationally respected regulatory approach. “And it’s a technology-neutral framework,” she said. “If you want to come in with a technology that is non-water-based . . . there is a belief that it’s easier to go through the [Canadian Nuclear Safety Commission] process because you don’t have to show why a certain regulation isn’t applicable. The process is outcome oriented. You have to prove certain things, but the way that you actually do it is up to you. Of course, you have to convince the regulator. CNSC is a strong regulator.”

The responses to CNL’s request for expressions of interest reveal other Canadian strengths as well, McCarthy said, including a capable, established supply chain, favorable market demand, and policy alignment. “Canada is a country that values mitigation of climate change and has in place legislation—for example, a carbon tax—that favors clean energy,” she said. “I think that’s really a refreshing thing, especially when you’re coming from the United States, where perhaps now that sort of thing isn’t valued quite as much. In the province of Ontario, they have legislation in place that actually forced the shut-down of coal plants.”

McCarthy also mentioned CNL’s recent

generic siting activities for SMRs. “Based on input that we got from the expressions of interest, we looked first at the Chalk River site to identify sites that would be technically capable of hosting an SMR,” she said. “We identified at least 10 areas. Many of those areas could host more than one SMR. Some of these sites are more suited to one technology versus another. So the number

of SMRs at Chalk River is not likely to be limited by the number of sites, and we also can manage more than one site.”

Jose Reyes, cofounder and chief technology officer of NuScale Power, presented an overview and status update on the NuScale Power Module, perhaps the highest-profile SMR currently in development. Each module is a self-contained unit that operates independently within a multi-module configuration that can be monitored and operated from a single

control room. NuScale is working with Utah Associated Municipal Power Systems on a planned 12-module SMR plant to be sited at Idaho National Laboratory.

The SMR project began in 2000 with funding from the Department of Energy,



Reyes

Reyes said, followed by the construction of a one-third-scale prototype facility in 2003 and the formation of NuScale, by Reyes and Paul Lorenzini, in 2007. In 2011, NuScale partnered with Fluor Corporation. “That was a big event for us,” Reyes said. “They are a great partner to work with. They are our primary investor. Later on, the DOE came back and we received a \$226-million matching grant. So essentially, for every dollar that DOE put in, we had our investors match that. That was a significant boost to the company. It allowed us to move forward.”

NuScale completed its design certification application (DCA) at the end of 2016, Reyes said, and submitted the 12,000-page document to the Nuclear Regulatory Commission in January 2017. Producing the DCA involved approximately 43,000 review hours, according to Reyes, as well as 119 formal meetings, 14 topical reports, over \$500 million in design development and testing, and more than 2 million labor hours, with some 800 people working in five U.S. offices. The NRC accepted the DCA for docketing in March 2017, and in April 2018, the agency announced that it had completed Phase 1 of its review (NN, June 2018, p. 15).

Reyes provided information on some specific NRC approvals, including the agency’s July 2017 approval of NuScale’s Highly Integrated Protection System platform, a protection-system architecture jointly developed by NuScale and Rock Creek Innovations, and its December 2017 approval of the company’s licensing topical report, *Safety Classification of Passive Nuclear Power Plant Electrical Systems*, which establishes the bases of how a design can be safe without reliance on any safety-related electrical power.

“The company continues to grow,” Reyes said. “It’s a very exciting time. We have very young, innovative engineers working with senior design mentors, and it’s a great environment to work in. We’re at 450 employees working in six offices in the U.S., and we’ve opened an office in London because of the interest in SMRs in the U.K. We’re around \$750 million into the project at this point. We expect to be over \$1 billion when we’re at the end of the design and ready for construction. That’s a fairly high barrier to entry. So, if you’re de-

“Canada is a country that values mitigation of climate change and has in place legislation—for example, a carbon tax—that favors clean energy. I think that’s really a refreshing thing, especially when you’re coming from the United States, where perhaps now that sort of thing isn’t valued quite as much.”

begin a conversation around SMRs by asking questions,” she said. “We put out a request for expressions of interest. We asked for input from, yes, the vendors, but also from the supply chain, and also from potential host communities. That’s something that the nuclear industry, I think, hasn’t done very well—ask the potential host communities what their interest is and what their questions are. We also asked for input from educational institutions.”

veloping a new design, this is really quite challenging. But we're on our way. The goal is to get that first module delivered by 2025 and have the 12-module plant fully operational by 2026. We're still on track, and we're very excited about that. We will be announcing our manufacturer later this year."

Currently, Reyes said, NuScale is conducting Integrated System Validation, a performance-based evaluation of hardware, software, and personnel. "We've hired 22 reactor operators to work with us for a period of about two years," he said. "We have three crews of six licensed operators who have gone through training just like they would go through at a regular-size plant. Fifty-six classroom lectures over nine weeks for the crews. Thirty-six simulator sessions for each of the crews over

a 10-week period. And then we'll go to 12 full-scope evaluated scenarios over 11 weeks, where we gather that data. We have video cameras. We have recordings. We're watching all that can happen in a control room to develop the data we need to support our assertions that we need only six operators to safely operate this 12-module plant."



Marcille

The next speaker was Holtec's senior vice president and chief nuclear officer, Thomas Marcille, who offered a closer look at the company's SMR technology, the SMR-160. According to Marcille, Holtec's business projection indicates that unconditionally safe and cost-competitive SMRs will be called upon to serve a vast global market, with an expected business volume in excess of a trillion dollars. "There is this massive need for expansion of power around the world to facilitate economic development in those countries that strive to increase the gross domestic product and the quality of life of their people and their economies," he said. "And we have undertaken this journey not by ourselves, but with some critical investing partners, specifically with Mitsubishi Electric Corporation and its North American affiliate, and our partners in Canada, SNC-Lavalin and CANDU Energy."

Holtec's SMR-160 is a 160-MWe light-water reactor that uses low-enriched uranium in the form of uranium-oxide

in fuel rods that are available from many suppliers around the world, Marcille said. It is intended to serve as a distributed energy source that dispenses with the need for expensive high-capacity transmission lines over long distances, making the electric grid more resistant to natural disasters or acts of sabotage. And while the typical unit uses cooling water from a local natural source to condense its exhaust steam, he noted, the SMR-160 can also be deployed in water-challenged regions by using air as the condensing medium. Fur-

While the typical unit uses cooling water from a local natural source to condense its exhaust steam, the SMR-160 can also be deployed in water-challenged regions by using air as the condensing medium.

ther, because the SMR-160 is "walk-away safe," Marcille said, it can be sited next to population centers without any threat to the local environment or populace. Placing the unit in close proximity to cities will reduce transmission losses and enable the plant's workers to live in the local community, he added.

"We've eliminated many of the vulnerabilities that have plagued prior plants by insisting that all safety-significant systems run entirely by gravity," Marcille said. "They require no power whatsoever. This is not unique in the small modular reactor world. People understand that if these reactors and these power systems are going to penetrate markets and find their real potential, they can't have core-damage frequencies that might be acceptable to risk-informed societies. The 70 percent of the world that has little or no power also has little or no experience with nuclear power plants. We cannot assume they will have the knowledge and the infrastructure to maintain, manage, and control assets that are not immune to these types of accidents. Inherent safety is just an absolute, fundamental, critical aspect of this. Absent implicit, absolute walk-away safety, we don't believe any SMR truly is a viable product for the world today.

"The plant is self-coping," Marcille continued. "It takes care of itself. There is no postulated accident that can lead to a core upset or a core uncover. It has a long service life, estimated to be well over 100 years. . . . One hundred years and beyond is extraordinarily reasonable, based on what we understand about plant construction techniques and materials."—Tim Gregoire and Michael McQueen **NW**



ANS Meetings

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TOPICAL MEETING

Advances in nuclear fuels and structural materials

Meeting the needs of the next generation of nuclear reactors was the focus of the NFSM topical meeting.

The 2018 ANS Annual Meeting included the Topical Meeting on Nuclear Fuels and Structural Materials for Next Generation Nuclear Reactors, sponsored by the ANS Materials Science and Technology Division. The meeting opened with a plenary session featuring speakers Suzanne Jaworowski, a senior advisor in the Department of Energy's Office of Nuclear Energy (NE), and Kemal Pasamehmetoglu, of Idaho National Laboratory.

Jaworowski, who serves as the political liaison between NE and the White House, provided an update on the obstacles and opportunities for civil nuclear. "The stars have really aligned for nuclear," she said. The United States is at a historic moment,



when much is happening in new technology development, Jaworowski said, adding that the U.S. government is "fully in support of the civil nuclear industry," as demonstrated by President Trump's directive to the DOE to "revive, revitalize, and expand" nuclear energy, as well as the administration's nuclear and coal resiliency initiative.

Jaworowski pointed out that among the actions the DOE is taking to promote and advance nuclear energy are the Nuclear Innovation Clean Energy (NICE) Future initiative, launched in May at the Clean Energy Ministerial (CEM9) in Copenhagen, Denmark, and the award of nearly \$64 million to fund advanced nuclear energy technology, which the DOE had announced earlier that day (NN, July 2018, p. 17). According to Jaworowski, the NICE

Future initiative, which aims to ensure that nuclear energy is represented in high-level political discussions of clean energy, was "warmly accepted" at CEM9, with Japan and Canada offering to cosponsor the initiative. The advanced nuclear technology funding, meanwhile, will go to U.S. national laboratories, universities, and industry to fund nuclear energy research, facility access, and crosscutting technology and infrastructure development.

In addition to highlighting DOE programs and funding aimed at furthering nuclear technology, Jaworowski spent much of her time discussing NE's efforts to increase its engagement with the public. Acknowledging that the public's perception of nuclear energy is often an obstacle to expansion of the technology, Jaworowski maintained the importance of education and outreach. "Until we can tell our story really well, it is going to be difficult for us to achieve our goal of reviving, revitalizing, and expanding the industry," she said.

In discussing outreach initiatives in which NE is involved, Jaworowski called attention to the DOE's Millennial Nuclear Caucuses, which are aimed at increasing the participation of young people in the nuclear industry. Millennials are a key audience for NE, she said, and the caucuses provide an opportunity for dialogue to ensure that they have factual information regarding nuclear science and technology.

Jaworowski said that NE is facilitating communications with congressional leaders and staff through its Atomic Wings Lunch and Learn initiative, which offers members of Congress and their staffs the opportunity to learn about current nuclear technology in a relaxed, bipartisan setting.

Continued

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On the subject of communications, Jaworowski stressed the importance of communicating in a simple, clear manner, providing information in “an easily understandable, digestible way.” As an example, Jaworowski said that when she speaks to groups outside the nuclear industry, she refers to accident-tolerant fuels as “smart fuels.” While the term “smart” has certain computer-based connotations and conceivably could confuse people regarding the nature of accident-tolerant fuels, Jaworowski argued that the simplified term was apt. “They really are smart fuels,” she said. “They help improve efficiency, economics, and safety.”

Following Jaworowski, Pasamehmetoglu provided an overview of the DOE’s program to build a fast neutron test reactor



Pasamehmetoglu

According to Pasamehmetoglu, the VTR has its roots in a series of independent surveys of poten-

tial users of such a test reactor that was conducted by the DOE’s Nuclear Energy Advisory Committee (NEAC). In 2017, NEAC released a report, *Assessment of Missions and Requirements for a new U.S. Test Reactor*, which recommended that NE begin planning activities in support of the VTR. With limited global access to fast spectrum nuclear testing and with growing interest from industry in advanced reactor technology, the VTR is needed in the United States, Pasamehmetoglu argued.

NE is currently conducting a three-year analysis of the VTR concept, including cost and schedule estimates. Once the analysis is completed, an acquisition decision will be made and, if approved, the VTR would be built and fully operational by 2026, Pasamehmetoglu said. While the final cost of the VTR will depend on its size and the need for new supporting infrastructure, he noted, it will be over \$750 million. The DOE’s approved 2018 budget included \$35 million to support VTR activities.

In discussing the potential design of the VTR and what potential users would require, Pasamehmetoglu said that it is envisioned that the VTR would be a 250–300-megawatt sodium-cooled fast reactor capable of reaching high flux rate (4×10^{15} n/cm² per second). The reactor would also have a high load factor,

would provide flexibility for experimental techniques, and would have the ability to perform a large number of experiments simultaneously.

Pasamehmetoglu said that in developing the reactor design, the DOE will engage the commercial nuclear industry using a three-pronged approach. First, the DOE wants to learn as much as it can about what private companies have done in the past in designing and developing sodium-cooled reactors. Second, the department wants its industry partners to be engaged in the experimental program development “so they can tell us exactly what kind of experimental [capabilities] they will need,” he said. Third, the DOE will eventually involve an architectural and engineering firm to help with the final reactor design.

Pasamehmetoglu said that while the commercial industry is and will continue to be heavily involved in the VTR project, he wants universities to play a major role as well. Given that it will be nearly a decade before the VTR will be operational, if all goes as planned, having students involved will ensure an experimental pipeline for the reactor, he said. “I am fairly certain that the first experiment that we are going to run in this reactor is not going to be my experiment. It is going to be the experiment of one of today’s students,” he said.—Tim Gregoire

N

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Photo: DOE

Crews began tearing down the K-633 Test Loop Facility at the DOE's Oak Ridge Reservation in May and completed the project in June.

OAK RIDGE

K-633 Test Loop Facility demolition completed

Demolition work in the Poplar Creek area of the Oak Ridge Reservation is expected to be completed by the end of 2019.

The Department of Energy's Oak Ridge Office of Environmental Management (OREM) and its cleanup contractor, URS-CH2M Oak Ridge (UCOR), completed the demolition of the K-633 Test Loop Facility at Tennessee's Oak Ridge Reservation in June. According to the DOE, the project eliminates one of the most contaminated buildings remaining at the East Tennessee Technology Park (ETTP), site of the former Oak Ridge Gaseous Diffusion Plant.

Building K-633 is the fourth building that OREM's program has removed from ETTP's Poplar Creek area since last year. Prior to those teardowns, the area contained 11 large buildings and numerous structures built in the 1940s and 1950s to support the site's former nuclear program and operations. According to the DOE, the Poplar Creek area contains the most con-

taminated facilities left at the site, following the demolition of five massive gaseous diffusion uranium enrichment buildings (K-25, K-27, K-29, K-31, and K-33). Crews began taking down K-633 in early May, and they finished removing debris on June 14.

The building consisted of four separate and independent testing loops, the first three of which were built to test and evaluate gaseous diffusion equipment performance under production conditions. The final loop was installed in 1981 to evaluate prototype equipment designed for gas centrifuge enrichment. The DOE ultimately shut down the 18,100-square-foot facility in 1984. To allow for the safe demolition of the K-633 structure, radiological contaminants in the building were immobilized inside piping and equipment using fixatives and foam.

Continued

Karen Deacon, acting ETPP portfolio federal project director, said in a statement, “We began demolition last year, and the area already looks drastically different. The latest completion moves us closer to achieving our goal to finish the Poplar Creek area demolitions by the end of next year.”

The DOE also announced on July 3 that OREM and UCOR have begun demolition of the Toxic Substances Control Act (TSCA) Incinerator at the ETPP site. The incinerator, which was capable of burning hazardous and radioactive waste that contained polychlorinated biphenyls (PCB), treated more than 35 million pounds of liquid and solid waste during its operation from 1991 to 2009.

After stabilization and closure activities were completed in 2013, workers decontaminated equipment and areas within the facility, and applied fixatives to ensure contaminants remain in place during the teardown. The DOE expects that the demolition of the TSCA incinerator will be completed this fall.

OREM and UCOR are working to remove former uranium enrichment structures and legacy contamination at Oak Ridge, transferring the remediated property to the ETPP, a private sector industrial park. To date, OREM has torn down more than 400 facilities and transferred more than 1,000 acres.

HANFORD SITE

Washington approves WTP lab permit

An operating permit for the Analytical Laboratory at Hanford’s Waste Treatment and Immobilization Plant (WTP) project has been approved by the Washington State Department of Ecology, the Department of Energy announced on July 3. The laboratory supports the DOE Office of Environmental Management’s plans to begin treating Hanford tank waste as part of the department’s phased approach to starting WTP vitrification operations, known as direct feed low-activity waste (DFLAW).

According to the DOE, approval of the permit marks the first major WTP facility to complete all phases of the state’s mandated permit life cycle: from initial design, through groundbreaking and construction, and now to the issuance of an approved operating permit. The key function of the laboratory is to confirm that the vitrified waste (glass) produced by the WTP low-activity waste (LAW) facility meets regulatory requirements. The laboratory will analyze approximately 3,000 WTP process samples each year. Samples of incoming low-activity tank



The Analytical Laboratory at the Hanford Waste Treatment and Immobilization Plant is the first major WTP facility to complete all phases of the state’s mandated permit life cycle.

waste will be analyzed to confirm the correct glass-former “recipe” to produce a consistent glass form suitable for long-term disposal.

The DFLAW approach is expected to enable the treatment of low-level radioactive waste to begin in advance of a court-ordered milestone date of 2023. This approach will increase available double-shell tank space and provide valuable lessons learned to aid the startup and commissioning of other portions of the WTP, the DOE said.

The DOE originally intended to begin treating all of Hanford’s liquid radioactive waste using WTP facilities at the same time. Work on the WTP’s pretreatment and high-level waste facilities was halted in 2012, however, after it was found that not all work done on the facilities could be verified to meet nuclear safety and quality requirements. The DOE subsequently implemented DFLAW so that it will be able to start treating LLW ahead of HLW, while issues with the HLW facility are resolved. As part of DFLAW, LLW waste from the site’s tank farms will be sent directly to the LAW facility for vitrification.

BUSINESS DEVELOPMENTS

EDF and Veolia to cooperate on D&D, WM

EDF and French waste management company Veolia have entered into a partnership agreement on nuclear power plant decommissioning and radioactive waste management processing, the companies announced on June 26. Under the agreement, EDF and Veolia will co-develop

technologies for dismantling gas-cooled reactors (natural uranium graphite gas) by remote control and for vitrifying radioactive waste, in France and worldwide.

EDF is currently decommissioning six gas-cooled reactors in France at Bugey (Loyettes, Ain), Chinon (Indre-et-Loire), and Saint-Laurent-des-Eaux (Loir-et-Cher). According to EDF, key milestones have already been met on all the projects, and the company said that its objective is to dismantle these nuclear facilities in the shortest time frame possible. To accomplish this, Veolia will provide EDF with its experience in remote handling and robotics technologies in an effort to design and deliver innovative solutions to access the cores of gas-cooled reactors and to cut up and extract components under optimum safety and security conditions.

In parallel, EDF and Veolia will work to develop an industrial solution for the vitrification of low- and intermediate-level waste using Veolia’s GeoMelt technology, which immobilizes the waste in a glass matrix. This, the company said, makes it ideal for radioactive waste, transforming it into a stable and durable waste form that is easy to transport and store.

The two companies said that their objective is the industrial implementation and joint commercial operation of these robotics and vitrification technologies.

OYSTER CREEK

Comments being accepted on PSDAR

As published in the June 11 *Federal Register*, the Nuclear Regulatory Commission

is seeking public comments on Exelon's post-shutdown decommissioning activities report (PSDAR) for the Oyster Creek nuclear power plant in Forked River, N.J. Exelon submitted its PSDAR to the NRC in May (NN, July 2018, p. 53). According to the PSDAR, Oyster Creek is scheduled to permanently cease operation on September 17. The NRC deadline for comments is September 10.

The PSDAR includes a description of the planned decommissioning activities and a proposed schedule for completing the work. Exelon has chosen to follow the NRC's SAFSTOR method of decommissioning, with a possible dormancy period of 53 years (2020–2073). The report also contains a site-specific decommissioning cost estimate for Oyster Creek. Exelon estimates the total cost to complete the radiological decommissioning of the plant will be \$1.1 billion, along with \$290 million in spent nuclear fuel management costs and \$60 million in site restoration costs.

The PSDAR also provides Exelon's basis for concluding that the environmental impacts associated with Oyster Creek's site-specific decommissioning activities will be bound by the impacts addressed by previously issued generic and plant-specific environmental impact statements.

Comments can be submitted through the federal rulemaking website, <www.regulations.gov>, with a search for Docket ID NRC-2018-0111, or mailed to May Ma, Office of Administration, Mail Stop: TWFN-7-A60M, U.S. Nuclear Regulatory Commission, Washington, DC 20555.

VERMONT YANKEE

State delays decision on Entergy, NorthStar deal

The Vermont Public Utility Commission (PUC) issued an order on July 6 delaying a decision on the sale of the Vermont Yankee nuclear power plant until after the Nuclear Regulatory Commission has issued its own ruling in the license transfer proceedings. Entergy is seeking to sell Vermont Yankee and transfer its operating license and decommissioning trust fund to NorthStar Group Services for accelerated decommissioning (NN, Dec. 2016, p. 48). The sale is contingent on approval from the Vermont PUC and the NRC.

During evidentiary hearings held in May on the proposed sale, the PUC asked the parties in the proceeding if the commission should wait until the NRC's decision before issuing a final decision. In addition to petitioners Entergy and NorthStar, parties in the proceeding include Vermont's Department of Public

Waste Management Briefs

THE U.K. GOVERNMENT IS TAKING OVER THE MAGNOX CLEANUP contract, the Nuclear Decommissioning Authority (NDA) announced on July 2. Magnox Limited, the company responsible for cleanup operations at the United Kingdom's 12 nuclear sites and one hydroelectric plant, will become a subsidiary of the NDA starting on September 1, 2019. In March 2017, the NDA announced that it was terminating its £6.1-billion (about \$8-billion) contract with Cavendish Fluor Partnership (CFP) to decommission the Magnox sites (NN, May 2017, p. 51). According to the NDA, in line with a recent change to the way its Sellafield nuclear site is managed, expertise from the private sector will be engaged through multiple smaller contracts, rather than through a single large parent body organization (PBO). As the site license company, Magnox Ltd. is controlled by CFP, the PBO. CFP will continue to manage Magnox Ltd. until the NDA takes over next year.

WOOD HAS LAUNCHED A NEW NUCLEAR D&D TECHNOLOGY fund, the project, engineering, and technical services company announced on June 21. According to the company, the goal of the Wood Nuclear Innovation Fund, which will invest in technologies for nuclear decommissioning developed by small and medium-sized enterprises (SME), is to bring about a step change in the decontamination and decommissioning process at nuclear facilities by finding new ways to minimize human intervention, increase productivity, and optimize waste management activities. Bob MacDonald, chief executive officer of specialist technical solutions at Wood, said that the fund will enable SMEs to grow while helping the company achieve its objective of becoming a valuable and trusted provider of waste management and decommissioning services. Wood's technical experts will assess proposals from SMEs, and those that are successful will be assisted by Wood's commercial, operations, and business development teams.

A PLASMA MELTING FACILITY AT BULGARIA'S KOZLODUY nuclear power plant has started waste treatment operations, it was announced on July 10 by the European Bank for Reconstruction and Development (EBRD), which manages the Kozloduy International Decommissioning Support Fund (KIDSF) that is partially funding the project. According to the EBRD, the new plasma melting facility is a breakthrough in the treatment and disposal of radioactive waste, capable of reducing the volume of low- and intermediate-level radioactive waste from the decommissioning of Kozloduy-1 through -4, which were shut down from 2002 to 2006. With a capacity of up to 250 metric tons per year, the facility will use plasma to melt and oxidize metals, as well as concrete debris, sand, inorganic granulates, insulation material, and asbestos, transforming the waste into a chemically inert and amorphous glassy slag. Liquids and organic materials are vaporized so that the final product is organics-free. The total cost of the plant, a joint venture of Iberdrola Ingeniería y Construcción, of Spain, and Belgoprocess, of Belgium, is about €31 million (about \$36.2 million), 35 percent of which is funded by the government of Bulgaria and 65 percent by KIDSF.

Service, Agency of Natural Resources, and Attorney General's Office, along with the Conservation Law Foundation. In their responses, the parties generally agreed that the PUC should await a decision by the NRC.

In arguing for a delay, many of the state agencies noted that an NRC decision may conflict with a memorandum of understanding signed in March among the agencies and Entergy and NorthStar (NN, Apr. 2018, p. 55). Under that MOU, Entergy and NorthStar made additional financial and radiological cleanup assurances to the state regarding the decommissioning of the plant.

In the order delaying its decision, the PUC noted that its review of the sale differs from the federal review, but that the NRC's eventual ruling may have some

relevance to issues raised by the state's case. "In addition, as the parties acknowledge in their responses, the NRC ruling may conflict with the terms of the MOU or any [Vermont PUC] order issued prior to an NRC ruling, and, as a result, may require further process and amendments to the MOU and order," the commission wrote.

Entergy filed its license transfer application to the NRC in February 2017 and the company is hoping to complete the sale by the end of the year, pending the approvals. In a statement to Vermont Public Radio, Michael Twomey, Entergy's vice president of external affairs, said that while the two companies suggested that the Vermont PUC postpone its decision, they did not expect that decision to postpone the sale. NN

LICENSING

NRC considers plan to make Wyoming an agreement state

If Wyoming's plan to become an agreement state is approved by the Nuclear Regulatory Commission, the state will assume authority over certain uranium mining and milling licenses.

The Nuclear Regulatory Commission is reviewing a request by Wyoming Gov. Matthew H. Mead to permit Wyoming, which hosts several licensed uranium production facilities, to become an agreement state. If the NRC accepts the proposed plan, Wyoming will have regulatory authority over certain radioactive materials and will become the 38th state to sign such an agreement.

According to the NRC, "Under the proposed agreement, the NRC would transfer to Wyoming the responsibility for licensing, rulemaking, inspection, and enforcement activities related to the extraction and concentration of uranium and thorium milling and the management and disposal of milling waste." The NRC would

transfer 14 specific licenses for radioactive material to the state's jurisdiction. Approval and signing of the agreement is expected to occur in September.

The proposed agreement and the NRC staff's draft assessment of the Wyoming program were published for public comment in the *Federal Register* on June 26, with comments accepted through July 26. The documents and additional information are available at www.nrc.gov/about-nrc/state-tribal/agreement-states/wyoming.html.

■ The NRC has prepared a final environmental assessment and finding of no significant impact as it considers renewing the license of the Columbia Fuel Fabrication Facility (CFFF) for a term of 40 years.

Fuel Briefs

TURKEY HAS REVOKED MINING AND EXPLORATION LICENSES for the Temrezli and Sefaatli projects and has offered potential compensation to Westwater Resources Inc., according to a June 22 announcement from Westwater, which was formerly known as Uranium Resources Inc. Christopher M. Jones, the company's president and chief executive officer, said, "We are investigating this action in order to protect our investment in the projects in view of applicable Turkish and international law. We plan to work with the relevant authorities to define a proper path forward over the coming weeks. The Republic of Turkey has been a supporter of both the Temrezli and Sefaatli projects for quite some time, and we therefore can expect a fair result." Under Turkish law, the company has 60 days to respond to the notification.

LIGHTBRIDGE WILL TEST ITS FUEL IN THE UNITED STATES and not in Norway's Halden Reactor as previously announced, the company said in a June 27 press release. Sites for irradiation testing of the company's metallic fuel will be announced later in 2018 or in early 2019. Lightbridge reaffirmed its plans to begin testing its fuel in a U.S. research reactor by 2020, and to deploy a lead test rod in a U.S. commercial reactor by 2021.

Westinghouse Electric Company applied in 2014 to renew the license of the facility, which is located near Columbia, S.C.

The CFFF receives low-enriched uranium hexafluoride, converts it to uranium dioxide powder, and processes that powder into fuel assemblies. The facility started operating in 1969, and its current license, renewed for 20 years in 2007, will expire on September 30, 2027. If the license is renewed, the new 40-year licensing term will begin immediately.

The NRC found that the renewal will involve no new construction or land disturbance. Existing groundwater contamination has not migrated off-site or into deeper aquifers, according to the NRC, and Westinghouse will be required to continue to monitor groundwater contamination, identify future unintended releases, and implement corrective actions as necessary. The NRC is also performing a detailed safety analysis.

The final environmental assessment is available online through the NRC's ADAMS document retrieval system with accession number ML18120A318.

MINING DEVELOPMENTS

Honeymoon restart strategy, other news

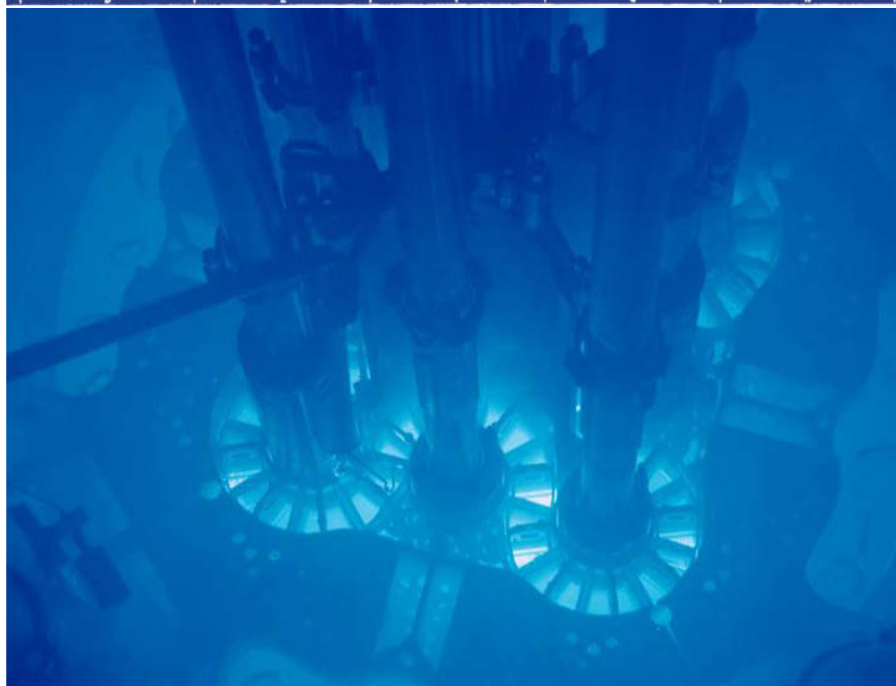
Boss Resources announced on July 2 that it has embarked on a restart strategy for its Honeymoon uranium project in South Australia.

Three key phases are planned: (1) the generation of the final data required for a definitive feasibility study, including a drilling program to quantify measured and indicated resources and an optimization program to identify cost savings, process improvements, and a preliminary execution plan; (2) the definitive feasibility study and permitting updates; and (3) detailed execution planning and operation, in conjunction with the ion exchange plant detailed design.

Work on the first phase has begun, with initial activities focused on the planning and preparation of the infill and step-out drill program. Phase 2 is planned for early 2019, with phase 3 starting later that year.

■ On July 11, Deep Yellow Limited announced an updated mineral resource estimate for the Tumas 3 deposit in Namibia, held by its subsidiary Reptile Uranium Namibia (Pty) Ltd. Following a drilling program, the uranium resource at the site has been expanded by 32 percent, with an overall inferred mineral resource estimate of 31.2 million lb U_3O_8 for Tumas 3. The mineral resource base on the Reptile project has doubled from 32.1 million lb to 63.3 million lb U_3O_8 . **■**

Nuclear News



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MOLYBDENUM-99

OPG to irradiate BWXT targets

BWXT is negotiating a deal with OPG subsidiary Canadian Nuclear Partners for the irradiation of natural molybdenum targets at Darlington to generate the Mo-99 isotope.

The production of the medical radioisotope molybdenum-99 is to return to Canada through a collaborative agreement between Lynchburg, Va.-based BWX Technologies and Ontario Power Generation subsidiary Canadian Nuclear Partners (CNP). BWXT announced on June 20 that CNP plans to provide irradiation services to support BWXT's new Mo-99 manufacturing technology. BWXT said that it will begin negotiating a definitive agreement with CNP for the irradiation services.

The irradiation of natural molybdenum targets for the production of Mo-99 will be provided in OPG's CANDU reactors located at the Darlington nuclear power plant near Clarington, Ontario. According to BWXT, the CANDU reactor's unique design and BWXT's patent-pending technology enables the insertion and removal of the targets into the reactors while in operation, ensuring OPG's ability to irradiate targets on a highly reliable basis.

BWXT's process of using natural molybdenum targets in CANDU reactors, which use natural uranium as fuel, will allow for the production of Mo-99 without the proliferation concerns related to the use of low- or high-enriched uranium, BWXT said. Subject to required Canadian regulatory reviews and approvals, production of Mo-99 at Darlington is expected to start by the end of 2019.

OPG said in a statement that the collaboration will make Darlington the world's first large-scale commercial nuclear power plant to produce Mo-99 and will help ensure the world's long-term supply of the critical medical isotope. Mo-99 is the parent isotope of technetium-99m, which is used for skeletal, brain, and organ imaging to detect and diagnose diseases, including heart disease and cancer. Canada's National Research Universal reactor ceased regular production of Mo-99 in 2016, leaving North America without a large-scale domestic supply of Mo-99, and requiring hospitals and health providers to import the radioisotope from Europe, Africa, and Australia.

Earlier this year, BWXT announced that it has developed a proprietary process to produce Mo-99 (NN, June 2018, p. 36). BWXT will use the Mo-99 produced from targets irradiated at Darlington in newly designed Tc-99m generators that are in commercial development at BWXT. According to the company, the new generators will integrate naturally into the current radiopharmacy supply chain and provide the same concentration of Tc-99m that is currently available from generators that use fission-based Mo-99 made from uranium targets.

Rex D. Geveden, BWXT's president and chief executive officer, said in a statement, "We are pleased to broaden our strategic relationship with CNP as we pursue a new technology that we expect will make this

Continued on page 128



OPG's Darlington nuclear power plant, where BWXT will irradiate natural molybdenum targets for the production of Mo-99.

Continued from page 18

to April 2018. WSDE's own 45-day public comment period was scheduled to start on August 13. The DOE asked for authorization by July 23 to begin grouting. As of this writing, WSDE was still evaluating the request.



Photo: CNSC

Velshi

► **RUMINA VELSHI WAS APPOINTED PRESIDENT AND CEO OF CNSC** for a five-year term beginning August 22. Velshi has had a long association with the Canadian Nuclear Safety Commission, having been appointed a permanent, part-time commission member in 2011 and reappointed for a second five-year term in March 2018. She replaces Michael Binder, who had served as president and chief executive officer since January 2008.

Velshi brings to her new role extensive technical, regulatory, and adjudication expertise in the area of energy. She has worked in various capacities at Ontario Hydro and Ontario Power Generation, where, in her last role, she was the director of planning and control for the planned Darlington New Nuclear Project, which has since been canceled. Velshi currently serves as a part-time member of the Ontario Energy Board, the economic regulator of Ontario's electricity and natural gas sectors.

Velshi is also very active in promoting careers in science, technology, engineering, and mathematics (STEM), especially for young women. She was one of the founding members of Canada's Women in Science and Engineering and, until recently, served as vice chair on the board of directors of Scientists in School, a nonprofit organization that in 2017 alone provided STEM-focused workshops to nearly 700,000 students. She was the recipient of the 2011 Women in Nuclear Canada Leadership Award.

THE FORMAL START OF CONSTRUCTION OF ROOPPUR-2, Bangladesh's second nuclear unit, was marked by a ceremony at the site, where the first pour of concrete for the reactor building basemat was carried out. Those attending the July 14 event included Prime Minister Sheikh Hasina and other Bangladeshi and Russian dignitaries. The design and construction license for the project was issued by the Bangladesh Atomic Energy Regulatory Authority on July 8.

The Rooppur site, which is located about 100 miles from Dhaka, the country's capital, will have two Generation III+ VVER-1200 reactors (model AES-2006). The reactor design and construction are being carried out by Atomstroyexport, part of the ASE Group, the engineering division of Rosatom, Russia's state atomic energy corporation, under the general contract signed on December 25, 2015. Atomenergomash will supply the equipment for the reactor island, as well as auxiliary equipment for the turbine island. The reference design for the plant is Novovoronezh II Unit 1, which meets all international safety requirements. All project work is on schedule, according to Rosatom's deputy director general for operations management, Alexander Lokshin, who added that Rooppur-2 is one of eight Russian-designed nuclear units in various stages of construction in South Asia.

To facilitate the project, the Bangladeshi government is extending and modernizing the railway line to the site. This entails laying about 5.6 miles of new rails and modernizing 11 miles of existing railway. According to Rosatom, the railway upgrade will be completed by 2020 at a cost of about \$40.37 million.

THE COST OF PREVENTING NUCLEAR AND COAL PLANT CLOSURES

was the subject of a report released in July by The Brattle Group. *The Cost of Preventing Baseload Retirements: A Preliminary Examination of the DOE Memorandum*, was prompted by comments and proposals made by the Trump administration aimed at preventing the further retirement of these power plants. The study was funded by an organization called Advanced Energy Economy, along with the American Petroleum Institute, the American Wind Energy Association, the Electric Power Supply Association, the Electricity Consumers Resource Council, and the Natural Gas Supply Association.

The report looks at how the cost of maintaining nuclear and coal plants might vary, depending on how the funds are distributed. For example, if every coal and nuclear plant were given \$50 per kilowatt of capacity (which is roughly the average shortfall for plants operating at a deficit), it would cost \$16.7 billion per year. Or it could cost \$9.7 billion to \$17.2 billion annually if only those plants now facing shortfalls were given payments sufficient to cover their operating losses. Finally, the report states that it would cost \$20 billion to \$35 billion annually if power plant owners were granted a return on their invested capital in addition to payments for operating shortfalls.

The report is also critical of Trump's presidential campaign claims that blamed environmental mandates for the struggles in the coal industry. "The primary driver of the current challenges for coal plants are flat power demands combined with low natural gas and wholesale power prices, not environmental rules," the report states. "These market conditions are expected to persist along with new announcements of coal and nuclear retirements."

Continued

The Brattle Group acknowledges that the study focuses only on the cost of maintaining the plants and does not address the magnitude of potential benefits, such as the claimed reliability and resilience effects or the environmental benefits associated with retaining nuclear units, nor does it assess any potential impacts on competitive markets.

The full report is accessible at <www.brattle.com/news-and-knowledge/news/report-by-brattle-economists-assesses-potential-costs-associated-with-administration-policy-designed-to-prevent-the-retirement-of-all-coal-and-nuclear-plants>.



The team of physicists who will use the NNSA funds. Back row, from left: FSU Profs. Samuel Tabor, Mark Riley, and Paul Cottle; research faculty Anthony Frawley; and Prof. (emeritus) Kirby Kemper. Front row: Prof. Ingo Wiedenhoever and Asst. Prof. Sergio Almaraz-Calderon.

(Photo: FSU)

► **FLORIDA STATE UNIVERSITY WILL RECEIVE \$1.7 MILLION** from the National Nuclear Security Administration over the next five years to help boost the nation's nuclear science workforce. FSU operates the John D. Fox Superconducting Linear Accelerator Laboratory, which has been used to educate nuclear scientists for more than 50 years. The lab conducts research on how elements are produced in stars and on the behavior of atomic nuclei. The funding is part of a \$10-million award to the Center for Excellence in Nuclear Training and University-based Research (CENTAUR), which will measure high-impact reaction observables and make reaction theory more robust, according to the Department of Energy, which oversees the NNSA. Headquartered at Texas A&M University, the CENTAUR consortium also includes Washington University in St. Louis, the University of Washington, Louisiana State University, and the University of Notre Dame (NN, Aug. 2018, p. 131).

FSU will use most of its grant to support graduate students and postdoctoral fellows performing research at its accelerator facility. A portion of the grant will be used to fund a nuclear science summer camp for ninth-grade students in the Bay County School District, introducing them to careers in nuclear science. Science teachers will be involved in developing and teaching the camp and will then be able to use their knowledge of nuclear science, along with laboratory equipment purchased through the grant, in their classrooms during the school year.

FERC HAS DIRECTED NERC TO DEVELOP MODIFICATIONS to its Critical Infrastructure Protection Reliability Standards, according to a final rule published in the July 31 *Federal Register*. The new rule is aimed at improving mandatory reporting of cybersecurity incidents, "including attempts that might facilitate subsequent efforts to harm reliable operation of the nation's bulk electric system." Under the North American Electric Reliability Corporation's current reliability standards, incidents are reported only if they have compromised or disrupted one or more reliability tasks.

The final rule directs NERC to modify its reliability standards to expand the current reporting requirements to include cybersecurity incidents that compromise, or attempt to compromise, a responsible entity's Electronic Security Perimeter or associated Electronic Access Control or Monitoring Systems. The Federal Energy Regulatory Commission is also requiring that cybersecurity incident reports be standardized, allowing the information to be more easily comparable, and that a system be developed to prioritize the most serious incidents, allowing them to be reported more quickly. FERC is also asking that cybersecurity incident reports be sent to those organizations that are best equipped to assess threats and communicate them to industry. Specifically, reports will continue to be sent to the Electricity Information Sharing and Analysis Center in Washington, D.C., and will also be sent to the Department of Homeland Security. The final rule takes effect 60 days after publication in the *Federal Register*, and the modifications are to be in place within six months of that date.

MORE THAN 935 ACTIONS TO STRENGTHEN NUCLEAR SECURITY were taken by countries participating in the four high-level Nuclear Security Summits held between 2010 and 2016, according to a joint report from the Arms Control Association (ACA) and the Fissile Materials Working Group (FMWG). *The Nuclear Security Summits: An Overview of State Actions to Curb Nuclear Terrorism 2010–2016*, released on July 17, details the voluntary actions taken by 53 states over the course of the summits initiated by President Barack Obama. "The Nuclear Security Summits' innovative use of national commitment-making significantly strengthened global nuclear security," said Sara Kutchesfahani, senior program manager of the FMWG and coauthor of the report. "Delivering on national commitments drove states to take critical steps that reduced the risk of nuclear terrorism."

The ACA is a nonpartisan membership organization dedicated to promoting public understanding of and support for effective arms control policies. The FMWG is a coalition of 80 civil society organizations from around the world that works to provide actionable policy solutions aimed at preventing nuclear terrorism. In September 2017, the ACA became the host organization of the FMWG. To read the full report, which includes specifics about the actions taken, go to <https://armscontrol.org/sites/default/files/files/Reports/NSS_Report2018_digital.pdf>.

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August 2018

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Fax: 607/562-4482
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www.mirion.com

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Jerry Dougherty
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Fax: 570/585-7658
jerry.dougherty@sandvik.com
materials.sandvik

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www.securllc.com

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Lisa Hardison
Tel: 575/394-4646
lisa.hardison@ureenco.com
www.ureenco.com

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Steve Gatcomb
Tel: 973/467-8400
Fax: 973/218-1819
nuclear@valcor.com
www.valcor.com

Veolia Nuclear Solutions

Jeffrey Stahl
Tel: 724/535-5777 x224
Fax: 724/535-1165
jeffrey.stahl@veolia.com
nuclearsolutions.veolia.com

Vigor

Brian Akin
Tel: 503/799-4831
sales@vigor.net
www.vigor.net

Westinghouse Electric Company

Emily Ammerman
Tel: 412/374-6875
Fax: 724/940-8561
ammermec@westinghouse.com
www.westinghousenuclear.com

WMG, Inc.

Dan Davis
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Tel: 432/556-7357
Tel: 914/736-7100
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important diagnostic tool more accessible and reduce production and waste costs.”

CNP President Glenn Jager also said in a statement, “Canadian Nuclear Partners is proud to work with BWXT to ensure North America has a steady, safe, and secure source of this vital product. The announcement today adds OPG’s Darlington nuclear station to this new team to supply Mo-99 for patients across the continent.”

OPG and BWXT are members of the Canadian Nuclear Isotope Council (CNIC), a coalition of Canadian science, health care, and nuclear organizations working together to ensure that Canada remains a leader in the production of nuclear isotopes. BWXT has been a supplier of critical components, fuel, and services to OPG since the early 1960s.

■ BWXT also announced on July 12 that one of its subsidiaries has signed an agreement with Bruce Power that will enable the two companies to collaborate on the development and supply of medical isotopes. Under the terms of the agreement, the companies will identify market opportunities for medical isotopes, with the intention of negotiating an irradiation services agreement for one or more medical isotopes in the future.

The agreement follows BWXT’s announcement in April that it intends to

acquire Sotera Health’s Nordion medical isotope business (NN, June 2018, p. 70). The acquisition, which is expected to close by the end of 2018, subject to the required regulatory reviews and approvals, would leverage BWXT’s current competencies in radiochemical processing to expand into the medical isotope market, the company said.

BWXT has been a supplier of critical components and services to Bruce Power, which is also a CNIC member, since the 1970s.

LUTETIUM-177

Bruce Power and ITG sign production MOU

Canadian nuclear power company Bruce Power and German radiopharmaceutical company Isotopen Technologien München announced on June 28 that ITM subsidiary Isotope Technologies Garching (ITG) and Bruce Power have signed an agreement to explore the production of the medical radioisotope lutetium-177, which is used in targeted radionuclide therapy to treat cancers such as neuroendocrine tumors and prostate cancer. Medical-grade Lu-177 destroys cancer cells while leaving healthy cells unaffected.

Bruce Power, a source of medical radioisotopes, and ITG signed a memorandum of understanding to explore the production of Lu-177 at the Bruce nuclear power plant near Kincardine, Ont. Bruce’s operating CANDU reactors have the ability to meet global supply needs through 2064, the companies said. The joint effort will explore how Lu-177 can be produced using the CANDU reactors.

ITM said that it has developed a methodology to produce a special form of Lu-177—no-carrier-added (n.c.a.) Lu-177—which the company supplies globally under the brand name EndolucinBeta. Because n.c.a. Lu-177 contains no metastable long-lived Lu-177m impurities, it provides the highest specific activity of all forms of the Lu-177 radioisotope, ITM said. According to the company, its extraordinary level of radionuclidic purity ensures more effective and economical waste management, better environmental sustainability, and the best preconditions for the radiolabeling of biomolecules.

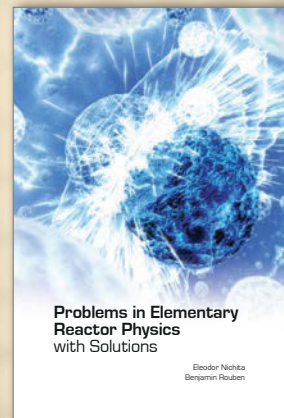
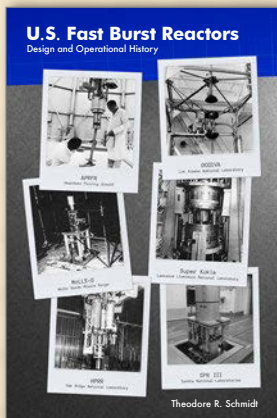
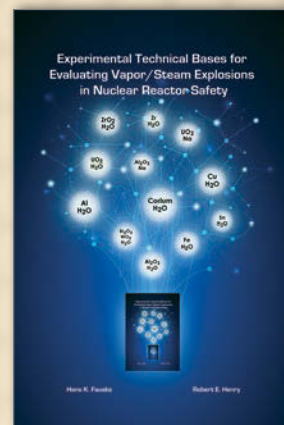
The partnership is intended to help meet the medical community’s growing demand for radionuclides for use in targeted radionuclide therapies. N.c.a. Lu-177 will be produced at Bruce CANDU reactors, and its development, processing, and global distribution will be managed by ITM.

■

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DEPARTMENT OF ENERGY

Additional funds awarded for advanced nuclear projects

Funding recipients for this latest series of awards include EPRI, GE Hitachi Nuclear Energy, Holtec International, NuScale Power, and Pacific Northwest National Laboratory.

The Department of Energy has announced a second round of funding—nearly \$20 million for nine domestic projects—under the Office of Nuclear Energy’s U.S. Industry Opportunities for Advanced Nuclear Technology Development funding opportunity announcement (FOA). An initial round of awards under this FOA, totaling some \$60 million for 13 projects, was announced on April 27 (NN, June 2018, p. 68). The DOE also intends to apply approximately \$30 million of additional FY 2018 funding to the next quarterly award cycle for proposals under this FOA.

According to a July 10 press release, these awards represent the private-public partnerships that are needed to help develop innovative domestic nuclear technologies. The projects will allow industry-led teams, which include participants from federal agencies, public and private laboratories, institutions of higher education, and other domestic entities, to advance U.S. commercial nuclear capabilities.

The DOE noted that the FOA covers three funding pathways: the First-of-a-Kind (FOAK) Nuclear Demonstration Readiness Project pathway, intended to address major advanced reactor design development projects or complex technology advancements for existing plants that have significant technical and licensing risk and the potential to be deployed by the mid-to-late 2020s; the Advanced Reactor Development Projects pathway, which allows a broad scope of proposed concepts and ideas that are best suited to improving

the capabilities and commercialization potential of advanced reactor designs and technologies; and the Regulatory Assistance Grant pathway, which provides direct support for resolving design regulatory issues, regulatory review of licensing topical reports or papers, and other efforts focused on obtaining certification and licensing approvals for advanced reactor designs and capabilities.

One project was selected under the FOAK Nuclear Demonstration Readiness Project pathway:

■ *Calendar Year 2018 Activities for Phase 2 of NuScale Small Modular Reactor*—NuScale Power, Corvallis, Ore. This project will build on Phase 1 project activities to advance the licensing and design maturity to meet a commercial operation date of 2026 for the first NuScale plant. Specific project activities include completion of the independent verification and validation licensing report; completion of the reactor building design optimization; and conduct of level sensor prototypic testing. DOE funding: \$7,000,000; non-DOE: \$7,100,000; total: \$14,100,000.

Five projects were selected under the Advanced Reactor Development Projects pathway:

■ *Conceptual Engineering for a Small Modular Reactor Power Plant Based on Lead-Bismuth Fast Reactor (LBFR) Technology*—Columbia Basin Consulting Group, Kennewick, Wash. This project aims to develop a pre-conceptual design and preliminary cost estimate for a lead-bismuth small modular reactor. DOE

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.



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Research Briefs

THE DOE HAS LAUNCHED THE LAB PARTNERING SERVICE,

described in a July 10 Department of Energy press release as an online, single access point platform for investors, innovators, and institutions to identify, locate, and obtain information from the DOE's 17 national laboratories. "The launch of the Lab Partnering Service represents a big step in reducing barriers that often limit energy investors from partnering with our national labs," said Secretary of Energy Rick Perry in the release. "The LPS consolidates information and capabilities at the national labs to increase public access, allowing industry and academia to fully utilize these vital scientific resources." Details on the new service can be found at www.energy.gov/technologytransitions/lab-partnering-service.

NUCLEAR HAS RECEIVED MORE FEDERAL R&D FUNDING

than any other energy category since the inception of the Department of Energy (at the beginning of fiscal year 1978), according to a June study by the Congressional Research Service. The study, by energy policy analyst Corrie E. Clark, found that nuclear energy received 36.6 percent of the U.S. government's energy research and development funds during that time frame, followed by fossil fuels at 23.9 percent, renewables at 17.5 percent, energy efficiency at 15.6 percent, and electric systems (such as the grid) at 6.4 percent. From FY 2009 to FY 2018, however, nuclear's share fell to 28.6 percent, while fossil fuels' dropped to 20.8 percent. All other categories' shares rose during this period, with renewables moving up to 19.5 percent, energy efficiency to 17.1 percent, and electric systems to 14 percent. *Renewable Energy R&D Funding History: A Comparison with Funding for Nuclear Energy, Fossil Energy, Energy Efficiency, and Electric Systems R&D* can be downloaded at www.fas.org/sgp/crs/misc/RS22858.pdf.

funding: \$400,000; non-DOE: \$100,000; total: \$500,000.

■ *Reactor Plant Cost Reduction to Compete with Natural Gas Fired Electrical Generation*—GE-Hitachi Nuclear Energy, Wilmington, N.C. This project will examine ways to reduce reactor plant construction and maintenance costs on the firm's BWRX-300 small light-water reactor concept through (a) elimination of loss-of-coolant accidents, (b) the use of an embedded (below-grade) design and construction, and (c) the use of pooled off-site resources that can be applied simultaneously at multiple sites. DOE funding: \$1,925,038; non-DOE: \$481,260; total: \$2,406,298.

■ *Experimental Verification of Post-Accident Integrated Pressurized Water Reactor (iPWR) Aerosol Behavior, Phase 3*—the Electric Power Research Institute, Palo Alto, Calif. This project will focus on improving the models used to estimate the post-accident radionuclide releases from iPWRs, with a goal of reducing regulatory requirements for emergency planning zones. DOE funding: \$1,119,699; non-DOE: \$279,923; total: \$1,399,622.

■ *Fluorination of Lithium Fluoride-Beryllium Fluoride (FLiBe) Molten Salt Processing*—Flibe Energy, Huntsville, Ala., and Pacific Northwest National Laboratory, Richland, Wash. This project will consider the use of nitrogen trifluoride as an agent to remove uranium from a molten-salt fuel mixture as a preliminary step for the removal of fission products. DOE funding: \$2,101,982; non-DOE:

\$525,500; total: \$2,627,482.

■ *Advancing and Commercializing Hybrid Laser Arc Welding (HLAW) for Nuclear Vessel Fabrication, Including Small Modular Reactors*—Holtec International, Camden, N.J. This project hopes to advance hybrid laser arc welding for use in fabrication of small modular reactors and other nuclear components to achieve improvements in the reliability, quality, and cost associated with traditional multi-pass welding. DOE funding: \$6,314,612; non-DOE: \$6,314,612; total: \$12,629,224.

One project was selected under the Regulatory Assistance Grant pathway:

■ *Regulatory Support for Advanced Light Water Reactor Deployment: Advanced Boiling Water Reactor Source Term Reduction*—Pittsburgh Technical LLC, Pittsburgh, Pa. This project proposes to develop a technical basis to reduce source terms associated with Level II and Level III probabilistic risk assessment for advanced boiling water reactor designs. DOE funding: \$498,000; non-DOE: \$124,500; total: \$622,500.

In addition, the DOE has selected two companies to receive Gateway for Accelerated Innovation in Nuclear (GAIN) technology development vouchers in this second review cycle: Yellowstone Energy, Knoxville, Tenn., \$160,000, and ThorCon US, Stevenson, Wash., \$400,000. Further details and descriptions of these awards can be found at the GAIN website, at <https://gain.inl.gov>, under the Funding Opportunities tab.

■

NNSA

Texas A&M to lead CENTAUR research program

The NNSA has funded a new research center, to be based at Texas A&M University, for the study of nuclear structure and reaction properties.

On July 5, the Department of Energy's National Nuclear Security Administration announced that Texas A&M University will lead a new "center of excellence" in low-energy nuclear science as part of the Stewardship Science Academic Alliances (SSAA) Program.

Texas A&M will receive \$10 million over five years to manage the Center for Excellence in Nuclear Training and University-based Research (CENTAUR), which will measure observable high-impact reactions and make reaction theory more robust.

CENTAUR will combine experimental and theoretical initiatives to measure relevant nuclear structure and reaction properties, with a focus on the use of radioactive beams and/or targets, according to the NNSA. Other partners in CENTAUR will include Florida State University, Washing-

ton University in St. Louis, the University of Washington, Louisiana State University, and the University of Notre Dame.

Roughly two dozen scientists across all partner universities will be involved in CENTAUR, along with their affiliated research groups. One of the center's major contributions will be research and development expertise related to neutron detectors, which are relevant for both low-energy nuclear science and nuclear security applications.

Launched in 2002, the SSAA program supports areas of fundamental R&D that are relevant to the NNSA's stockpile stewardship mission and works to recruit the next generation of highly trained scientists and engineers for the nation's nuclear security enterprise, according to the NNSA.

■ The University of Michigan hosted the annual University Program Review, bringing together three university-laboratory consortia funded by the NNSA's Office of Defense Nuclear Nonproliferation Research and Development. More than 280 attendees assembled for the event, held June 5–7 in Ann Arbor, Mich., including many from the three consortia.

The University of Michigan leads the Consortium for Verification Technology, one of the three consortia represented; the others are the Nuclear Science and Security Consortium, led by the University of California at Berkeley, and the Consortium for Nonproliferation Enabling Capabilities, led by North Carolina State University. Working together, the three organizations provide R&D and scientific expertise to address technology and policy issues in nuclear security, nonproliferation, and treaty compliance monitoring.

Through the consortia, NNSA directly funds 26 universities and facilitates collaboration with 10 national laboratories and sites. Each consortium offers seminars, education programs, and research opportunities to students at universities across the nation, including minority-serving institutions. Collaboration often



Photo: University of Michigan

During the University Program Review, consortia program directors presented NNSA Administrator Lisa Gordon-Hagerty with a plaque in recognition of NNSA's support of university research and education programs in nuclear security and nonproliferation. From left, Prof. John Mattingly, North Carolina State University; Prof. Sara Pozzi, University of Michigan; Gordon-Hagerty; and Prof. Jasmina Vujic, University of California at Berkeley.



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takes place through direct mentorship opportunities during summer internships and fellowships.

The University Program Review is held annually to provide a venue for students and collaborating scientists to showcase their research and to allow programmatic oversight and technical interchange between student researchers, early career scientists, national laboratories, small business, and government research managers.

IAEA

U.S., Czech Republic host 4th annual nuclear institute

The 4th Annual Intercontinental Nuclear Institute (INI), sponsored by the International Atomic Energy Agency, brought together 28 graduate students and young professionals from 16 member states for a four-week summer program that was held June 3–16 in Prague, Czech Republic, and June 17–29 in Lowell, Mass.

The INI was created to promote the long-term sustainability of nuclear power programs and prepare students for the future needs of the profession through capacity building, global dialogue, and technical engagement in the field of nuclear science and technology and nuclear power reactor technology, according to the IAEA. A variety of learning experiences are supported by subject matter experts in reactor physics, engineering, management, economics, safety and security, and nonproliferation.

The program is a joint initiative of the U.S.-Czech Civil Nuclear Cooperation Centre in Prague and the University of Massachusetts at Lowell. With major contributions from the United States, the INI is supported by the IAEA's technical cooperation program with funding from the Peaceful Uses Initiative, which was

launched in 2010 to support unfunded technical cooperation projects that promote the peaceful application of nuclear technology.

"Our support for this institute, the result of strong cooperation between the Czech Technical University and the University of Massachusetts, is just one part of our many initiatives for ensuring energy security, supporting economic development, and encouraging technology and innovation," said Stephen King, the U.S. ambassador to the Czech Republic.

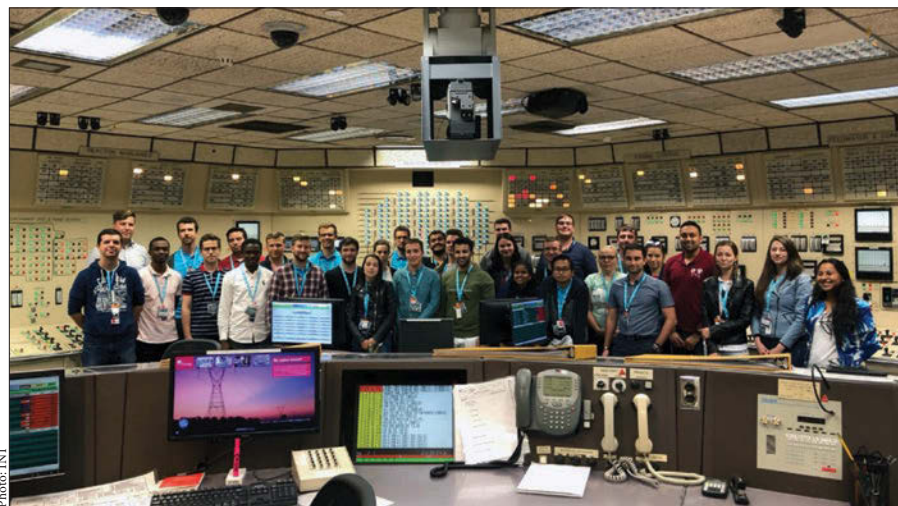
EXELON

Quad Cities opens new employee training center

On June 29, Exelon's Quad Cities generating station unveiled its expanded, state-of-the-art employee training center during an open house at the site in Cordova, Ill.

The Professional Learning Center is among \$20 million in construction and facility improvements undertaken at Quad Cities over the past year. The project created 600 direct and indirect jobs for local contractors, laborers, and suppliers, according to Exelon.

Exelon began construction on the 36,000-square-foot, \$7-million facility after the Illinois legislature passed the Future Energy Jobs Act in 2016. "This ribbon cutting is more than just the opening of our newly expanded Professional Learning Center," said Site Vice President Ken Ohr. "It represents the next chapter in Quad Cities' bright future. June 2018 was the exact month Quad Cities was to be shut down, but thanks to Governor Rauner, legislative leaders, and our many local supporters, we continue to deliver carbon-free power and good-paying jobs for Illinois families." **IN**



Attendees of the 2018 Intercontinental Nuclear Institute toured the Pilgrim nuclear power plant in Plymouth, Mass.

BUSINESS DEVELOPMENTS

Rolls-Royce signs pacts with CTEC, Bruce Power

Rolls-Royce announced on June 26 that it has signed an agreement with **CTEC**, a subsidiary of China General Power Corporation, to provide instrumentation and control integrated services to the global nuclear market. The signing took place alongside the 2018 World Nuclear Exhibition, held June 26–28 in Paris, France. The two companies have agreed to integrate their respective I&C technologies and expertise on selected projects abroad and in China. According to Rolls-Royce, the agreement will enable the future involvement of CTEC in international projects, as well as the future involvement of Rolls-Royce in upcoming projects in China. Rolls-Royce and CTEC have also committed to release a new distributed control system platform made from a combination of the companies' existing digital and analog technologies (Spinline and Hardline for Rolls-Royce, FirmSys and FitRel for CTEC). The agreement also lays the foundation for continued discussions in exploring the further development of new joint technologies, Rolls-Royce said.

On July 10, Rolls-Royce announced, along with **Bruce Power**, that the two companies have signed a memorandum of understanding to be digital partners, expanding the companies' current T-104 program that was started in 2017. Rolls-Royce and Bruce Power said they will now collaborate more deeply to blend their skills and use leading industrial technologies to improve the reliability and cost effectiveness of maintenance at Bruce's eight CANDU units in Ontario, Canada. Rolls-Royce also has agreed to be a charter partner to Bruce Power's recently announced Ontario Nuclear Innovation Institute, an international center of excellence for applied research and training.

■ On July 9, **Advanced Reactor Concepts LLC** and **ARC Nuclear Canada Inc.**—collectively **ARC Nuclear**—announced an agreement with **New Brunswick Power** and its affiliates to explore the development, licensing, and construction of an advanced small modular reactor based on ARC Nuclear's ARC-100, a 100-MWe sodium-cooled, fast

flux, pool-type reactor. ARC has agreed to collaborate with NB Power in exploring the potential future deployment of the ARC-100 at NB Power's Point Lepreau nuclear plant site and other sites in Canada and worldwide. According to ARC Nuclear, the larger objective is to establish Canada's New Brunswick Province as a center of excellence and the manufacturing hub for advanced SMR products based on the ARC-100 technology. ARC Nuclear said that it will be supported by GE Hitachi Nuclear Energy, in line with the two companies' announcement in August 2017 to collaborate on the ARC-100 development and licensing.

■ The Nuclear Regulatory Commission has approved the indirect transfer of several of **Westinghouse Electric Company's** licenses from Toshiba to **Brookfield WEC Holdings**, notice of which was published in the July 6 *Federal Register*. The NRC action covers Westinghouse's licenses that authorize the possession and use of special nuclear materials at the Columbia Fuel Fabrication Facility in Hopkins, S.C., and the Hematite Fuel Fabrication Facility in Festus, Mo., as well as 29 export licenses. Canada-based Brookfield Asset Management, parent company of Brookfield WEC, agreed in January to buy Westinghouse from Toshiba for approximately \$4.6 billion (*NN*, Feb. 2018, p. 85). The acquisition is expected to close in the third quarter of 2018. According to the NRC, there will be no direct transfer of control involved with the transaction, as Westinghouse will continue to be the licensee. There will also be no change in the management or technical personnel responsible for licensed activities. The current safety, security, and licensing organizations within Westinghouse will remain unchanged. In addition, there are no planned changes in the operational organization, location, facilities, equipment, or procedures associated with the NRC licenses, and there will be no changes in Westinghouse operating procedures, emergency procedures, or decommissioning financial assurance.

■ On July 10, **Five Star Products**, a supplier of high-performance cement- and epoxy-based products developed specifically for challenging environments and applications, announced that it has recently completed an audit of the Nuclear Procurement Issues Committee (NUPIC),

receiving NUPIC-approved suppliers list status. NUPIC evaluates suppliers that furnish safety-related components and services and commercial-grade items to nuclear utilities to ensure the highest standards of quality. Members include all domestic U.S. nuclear utilities as well as several international members. According to the company, the week-long audit was led by the Tennessee Valley Authority to determine whether Five Star has implemented an effective quality assurance program under 10 CFR 50, Appendix B, and 10 CFR 21 that meets the requirements of ANSI/ASME NQA-1-1994 and -2008 editions.

Five Star Products also announced on June 6 that it has achieved ISO 9001:2015 quality certification from the International Organization for Standardization. Five Star said that it was among the first companies in the industrial construction products industry to receive ISO 9001:2008 certification and that this latest certification demonstrates the company's commitment to quality, both in its products and procedures.

CONTRACTS

Triad to manage LANL; Bruce adds MCR contracts

The joint venture **Triad National Security LLC**, which was awarded the management and operating (M&O) contract for the Los Alamos National Laboratory (LANL), announced on July 9 that the National Nuclear Security Administration has initiated the management transition process at LANL. According to Triad, the launch of transition activities is an important milestone in the process of shifting operational responsibilities to the laboratory's new management team. Triad is

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>.

a joint venture of **Battelle, Texas A&M University Systems**, and the **University of California**. The Triad team includes two integrated subcontractors, **Huntington Ingalls Industries** and **Fluor Federal Services**, and three small business subcontractors, **Longenecker & Associates**, **Merrick-Strategic Management Solutions**, and **TechSource**. The contract includes a five-year base with five one-year options, for a total of 10 years if all options are exercised. The estimated value of the contract is \$2.5 billion annually. The current M&O contract for LANL, which is held by Los Alamos National Security, expires on September 30. Triad will assume full M&O responsibility for the laboratory on November 1, following the four-month transition period, which is intended to ensure the continuity of safe and secure operations at the laboratory. (Also see Security, this issue, page 27.)

■ Bruce Power announced in June a number of new contracts for its upcoming Major Component Replacement (MCR) Project at the Bruce nuclear power plant near Kincardine, Ontario. The project will begin with Bruce's Unit 6 in 2020, followed by Units 3, 4, 5, 7, and 8. Along with asset management, the MCR project is part of the Bruce life-extension program, which began in January 2016 and will extend the life of the site to 2064. Bruce Power said that the program remains on time and on budget.

On June 14, Bruce Power announced that it has awarded an MCR project contract to **Shoreline Power Group**, a consortium of **Aecon, AECOM**, and **SNC-Lavalin**, for the refurbishment of Bruce-6. According to SNC-Lavalin, which holds a 40 percent share in the project, the fuel channel and feeder replacement contract is worth Can\$475 million (about \$360.8 million). The work under the contract encompasses all of the planning and executing of activities for the reactor refurbishment. Planning was to begin immediately in preparation for the scheduled outage in 2020, when the actual work to replace the components will be performed. The work is expected to be completed in the third quarter of 2022. Shoreline Power also will be responsible for the management of the robotic tooling required for the work, along with full training of the workforce. Bruce Power said that based on the demonstrated success of the work, the contract has the potential to expand to the refurbishment of the remaining five units.

On June 29, **ATS Automation Tooling Systems** announced that it has received new order bookings worth approximately Can\$60 million (about \$45.8 million) from Bruce Power to design and deliver automated reactor component removal tools for the major component replacement project. According to ATS, its



CONVAL MOVED INTO ITS ADVANCED MANUFACTURING CENTER, a new 72,000-square-foot facility, on July 1, the high-performance valve manufacturer announced. Located in Enfield, Conn., eight miles from Conval's previous Somers campus, the center houses all of the company's operations under one roof. With 40 percent more capacity than the Somers campus, the facility allows for new processes to be added, future expansion of the product line, and significant company growth, Conval said. In addition to moving existing equipment from its Somers location, Conval, which provides severe-service valves to the nuclear and other industries, also invested in a number of new state-of-the-art machines.

services will enable Bruce Power to update the reactors for continued safe and long service by removing and replacing 480 fuel channels and calandria tubes from each of the six reactor units being updated. The work is expected to be delivered over the next six quarters and includes the delivery of tube removal tools, enhanced testing, and the provision of spare replacement parts for the removal tools. The order is a follow-on to the original Bruce life-extension program agreement with ATS, which named the company as a supplier for strategic tooling services in December 2016.

Bruce Power also announced on June 25 that it has entered into a 10-year agreement with Barrie, Ontario-based **Brotech Precision CNC** for the supply of shield plug assemblies for the MCR project. As part of the agreement, Brotech will set up a facility local to the Bruce plant to assemble and test components, and ultimately to perform computer numerical control or ultra-high precision metal manufacturing to support Bruce Power's long-term requirements. The value of the shield plug contract was not disclosed.

■ On July 12, the U.S. Navy awarded **Fluor Marine Propulsion**, of Arlington, Va., a \$1.2-billion cost-plus-fixed-fee contract for naval nuclear propulsion work at the Naval Nuclear Laboratory. The contract includes options that if exercised will bring the cumulative estimated value of the contract to \$13 billion. Work will be performed in

Pittsburgh, Pa. (46 percent), Schenectady, N.Y. (45 percent), and Idaho Falls, Idaho (9 percent). According to the Navy, no funds are being obligated at the time of the award. No completion date or other additional information is provided on naval nuclear propulsion program contracts.

■ The project, engineering, and technical services company **Wood** announced on July 10 that it has won a framework contract worth up to a possible \$4 million to provide design and engineering services to the Dounreay nuclear site in the United Kingdom. According to Wood, the framework will help deliver the overarching decommissioning program overseen by Dounreay Site Restoration Limited, the site license company. As the prime contractor, Wood, along with its partners Orano, GDES, and Aquila, will provide services that include design, engineering validation, environmental cases and restoration, seismic, construction management, commissioning support, software modeling, waste strategy documents, and technical support, including the provision of specialist staff. The four-year contract, with two potential one-year extensions, was effective immediately.

■ **Orano** announced on June 27 that it has signed two new contracts with Japan Nuclear Fuel Limited (JNFL) for the support of the J-MOX mixed-oxide fuel fabrication plant, currently under construction at the Rokkasho-Mura site in northern Japan. Under the first contract, 20 experts

from Orano Melox and Orano Projets, Orano's engineering subsidiary, will provide until April 2019 a technical review of J-MOX's key equipment, with a focus on maintainability, operation, and product quality. Under the second contract, Orano Melox experts will provide experiential maintenance feedback on some Melox equipment, similar to those planned for J-MOX. According to Orano, other contracts will follow to accompany the different steps of J-MOX's construction in order to support JNFL for the startup phase and to improve its expected operational performance. The value of the contracts, which follow a December 2017 support services agreement between Orano and JNFL, was not disclosed.

■ On June 28, the Department of Energy announced that it has awarded a number of contracts through its Office of Environmental Management (EM). The DOE awarded a \$136.6-million contract to **Enterprise Technical Assistance Services** (E-TAS) of Oak Ridge, Tenn., for technical support services to the DOE's Portsmouth/Paducah Project Office (PPPO). The contract has a base performance period of three years, including a 60-day transition period, with an additional option period of two years. Under the contract, E-TAS will provide technical and administrative support to PPPO,

along with various technical engineering functions, information technology infrastructure, safeguards and security, and general administrative support for the PPPO sites. PPPO is the lead DOE project office for the cleanup activities at the Portsmouth Gaseous Diffusion Plant site in Ohio and the Paducah Gaseous Diffusion Plant site in Kentucky, as well as for operation of the Depleted Uranium Hexafluoride Conversion Project at Portsmouth and Paducah.

The DOE also awarded a 12-month time and materials contract worth an estimated \$5.2 million to **Cyber Security Professionals** of Fairfax, Va., for cybersecurity services. The company will support EM in managing various aspects of its information security program in the areas of cybersecurity and information protection at EM's Washington, D.C., headquarters, as well as its Consolidated Business Center and field site facilities.

Finally, the DOE awarded a 12-month time and materials contract worth an estimated \$3.5 million to **Edgewater Federal Solutions** of Ijamsville, Md., for information technology support services. Under the contract, Edgewater will provide EM with expert advice, assistance, and cost-effective solutions to respond rapidly to critical IT management issues with results based on current market and

technical research, hands-on experience, and IT best practices.

10 CFR PART 21

AAF issues interim report; FCI orders lack dedication

On June 20, AAF Flanders reported that it is performing an interim evaluation of an unapproved design change in a high-efficiency particulate air filter. The company said that it is evaluating a potential nonconforming condition associated with HEPA filters (Model No. 0-007-C-42-03-NU-11-13-GG FU5) supplied to Xcel Energy's Prairie Island nuclear power plant. AAF Flanders notified the plant of the potential defect, which was discovered on May 2. The company said that the evaluation could not be completed within the required 60-day period, but anticipates completion by September 15.

■ On July 5, Fisher Controls International issued a notice for hex nuts and cap screws for securing the valve body-to-actuator on eight valves (six purchased by the Cook nuclear plant and two purchased by Korea Hydro & Nuclear Power Company) that were not commercial-grade dedicated. Fisher became aware of this issue on May 7, 2018.



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ACTIONS

New standard published; comments requested

The following standard has been published:

■ ANSI/ANS-2.6–2018, *Guidelines for Estimating Present and Projecting Future Population Distributions Surrounding Power Reactor Sites* (new standard).

This standard provides guidance for suitable procedures to develop estimates and forecasts of human population distribution around commercial and government-owned nuclear facility sites. The standard is intended to provide civilian and government professionals with methodologies that are generally acceptable in the demographic community and to facilitate the regulatory authority's review of site suitability relative to population considerations. Methodologies are ranked, as appropriate, with consideration to situation and location.

Standard approved

The following standard has been approved:

■ ANSI/ANS-3.4–2013 (R2018), *Medical Certification and Monitoring of Personnel Requiring Operator Licenses for Nuclear Power Plants* (reaffirmation of ANSI/ANS-3.4–2013).

This standard defines the physical and mental health requirements for the licensing of nuclear power plant reactor operators and senior operators. It also addresses the content, extent, methods of examination, and monitoring during the term of the license.

Comments requested

Comments are requested on the following standard by September 11, 2018:

■ ANS-8.23–201x, *Nuclear Criticality Accident Emergency Planning and Response* (revision of ANSI/ANS-8.23–2007 [R2012]).

This standard provides criteria for minimizing risks to personnel during an emergency response to a nuclear criticality accident outside reactors. The criteria address management and technical staff responsibilities, planning, equipment, evacuation, rescue, reentry, stabilization, classroom training, drills, and exercises. This standard applies to facilities, locations, or activities

judged to have credible and nontrivial consequences from a criticality accident. It does not apply to nuclear power plant sites or to licensed research reactor facilities, which are addressed by other standards.

PINS

Under the Project Initiation Notification System (PINS), the following standards are being initiated:

■ 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 for measuring and indexing 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.

■ ANS-58.8–201x, *Time Response Criteria for Manual Actions at Nuclear Power Plants* (revision of ANSI/ANS-58.8–1994 [R2017]).

This standard establishes criteria and methodology for the identification, validation, tracking, and documentation of time requirements for the performance of manual actions with specific time limits associated with design-basis events and for manual actions to meet the plant licensing basis for nuclear power plants.

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.

RESPONSE TO INQUIRY

ANS answers multipart inquiry on standard

The ANS Standards Committee received a multipart inquiry on a standard. The inquiry and response are provided below.

■ ANSI/ANS-19.6.1–2011 (R2016), *Reload Startup Physics Tests for Pressurized Water Reactors* (revision of ANSI/ANS-19.6.1–2005).

Background: Korea Hydro & Nuclear Power Company (KHNP) is currently using ANSI/ANS-19.6.1–1997 (W2005), *Reload Startup Physics Tests for Pressurized Water Reactors*, for the light-water reactor (Combustion Engineering-type), and we are considering upgrading to the current standard, ANSI/ANS-19.6.1–2011 (R2016) (same title), according to the requirement of the Korea Institute of Nuclear Safety. KHNP has performed the flux symmetry test (FST) at low reactor power (30 percent) and the power distribution test (PDT) at 80 percent and 100 percent reactor power. However, as updated from the 1997 and 2005 versions, the 2011 version suggests performing the PDT before reaching over 50 percent reactor power. PDT requires equilibrium xenon (Eq-Xe); however, FST does not. Thus, if we use ANSI/ANS-19.6.1–2011 (R2016), it needs extra power stabilization time to satisfy the Eq-Xe condition. It seems hard to

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-2.35, *Guidelines for Estimating Present and Projecting Future Socioeconomic Impacts from the Construction, Operations, and Decommissioning of Nuclear Sites* (development of new standard).

■ ANS-56.1, *Containment Hydrogen Control* (development of new standard).

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

neglect the overhaul schedule delay, and it is difficult to predict the operation conditions prior to 30 percent and to produce design values based on the actual operation conditions. The following questions are asked considering these factors:

Question 1: Why do you require the PDT to be performed before 50 percent reactor power?

Response 1: The direct power distribution measurement was lowered from 80 percent to 50 percent to provide more margin to the safety limits when there was something wrong that could be revealed only by a direct power distribution measurement. For example, suppose there was a local peaking problem that could not be inferred from the FST. If the local peaking exceeded the requirement by over 20 percent and the measurement was performed at 80 percent power, there might be safety consequences. In ANSI/ANS-19.6.1-2011 (R2016), the local peaking could exceed the requirement by up to 50 percent (a

very rare situation) and no safety limits would be violated.

Question 2: Can the FST replace the PDT before 50 percent reactor power?

Response 2: The FST is intended to readily identify gross core configuration problems such as misloaded fuel assemblies or damaged/misaligned control rods and thus preclude exceeding fuel design limits and causing possible fuel damage when an asymmetric core configuration is present. The FST is unlikely to identify fuel assembly design and manufacturing issues at the level detectable through a detailed in-core power distribution measurement.

Question 3: There is no significant relative power density difference between an Eq-Xe condition and a non-Eq-Xe condition at low power. Why should xenon condition be applied to the low-power PDT?

Response 3: The xenon condition is not a requirement of the standard for intermediate power distribution measurements. The xenon condition as recommended in

the User Guide (an appendix of ANSI/ANS-19.6.1-2011 [R2016], which is not a formal part of the standard) provides typical values for rates of change and stability to help the user perform the test and evaluate the results accurately.

Although the difference between an Eq-Xe and a non-Eq-Xe relative power distribution at low power may not be significant from a calculation perspective, it can affect the interpretation of a comparison between measured results to calculated design values, depending on the core's actual power history in going from a hot zero power condition to an intermediate power condition.

Please note that the Eq-Xe condition was suggested primarily to accommodate movable detector systems that require a relatively long time to complete the measurement of the whole core. The Eq-Xe condition is less important for fixed detector systems in which the measurement of the whole core can be made very quickly. **N**



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Joseph Zwetolitz has been appointed vice president of nuclear operations at Day & Zimmermann. Over a 30-plus year career, he has worked for a number of large original equipment manufacturer and services companies, including Areva, where he served as senior vice president of nuclear services. Prior to joining Day & Zimmermann, Zwetolitz served as chief executive officer of ENEXIO, a private equity-owned, global supplier of power plant cooling solutions and services.



Zwetolitz

John A. Stewart has been named president of Nuclear Fuel Services, the sole pro-

vider of nuclear fuel for the U.S. Navy and a wholly owned subsidiary of BWXT Nuclear Operations Group. Since 2012, Stewart has served as president and general manager of BWSR LLC, a BWXT joint venture that performs decommissioning and demolition work and supports nuclear operations at Naval Nuclear Laboratory sites in Idaho, New York, and Pennsylvania. Prior to joining BWSR, he was chief of nuclear safety operations at the Y-12 National Security Complex.



Stewart

William A. Fox III, ANS member since 2014, has been named executive vice pres-

ident of SNC-Lavalin's Canadian Nuclear business unit, based in Mississauga, Ontario. He also holds the title of president and chief executive officer of Candu Energy, a member of the SNC-Lavalin Group. Fox has 39 years of experience in the energy and nuclear power industries, having served as a senior executive with BWX Technologies, Chicago Bridge & Iron, Areva NP, and Duke Energy. He has also worked with the Department of Energy on national security, environmental, and energy programs.

Garrett Ainsworth and **Blair Jordan** have joined the board of directors of Standard Uranium following the completion of the company's acquisition by Vela Minerals. Ainsworth recently left NexGen Energy, where he led the company's technical team from June 2014 to April of this year. Jordan, currently vice president of corpo-

The Nuclear Regulatory Commission recently appointed a number of resident inspectors, including **Timothy Steadham** as senior resident inspector at Grand Gulf, **Carey Read Jr.** as resident inspector at Surry, **Jackson Choate** as resident inspector at the South Texas Project, **Tom Stephen** as senior resident inspector at Browns Ferry, **Nick Hobbs** as resident inspector at Browns Ferry, **Adam Ruh** as resident inspector at Oconee, and **Natasha Childs** as resident inspector at Sequoyah. Steadham joined the NRC in 2002 as a project engineer in the agency's Region III office and has held progressively more responsible positions, including resident inspector, senior construction project engineer, and senior construction inspector in the Region II office. Read joined in 2013 as an inspector in the Division of Fuel Facility Inspection in the Region II office, later becoming a resident inspector at the Summer construction site in South Carolina. Choate joined in 2015 and has served as acting resident inspector at several plants, including Waterford-3, Arkansas Nuclear One, and Diablo Canyon. Stephen joined in 2012 and served as a resident inspector at Browns Ferry before



Steadham

returning to the NRC's Region II office as a licensed operator examiner. Hobbs joined in 2015 in the Nuclear Safety Professional Development Program as a reactor systems engineer at NRC headquarters, then transferred to Region II in 2017 to join the resident inspector development program. Ruh joined in 2012 as a project engineer in the Region II office, later serving as a resident inspector at Browns Ferry. Childs joined in 2008 as a project engineer in the Resi-



Read



Hobbs



Choate



Ruh



Stephen



Childs

dent Inspector Development Program in Region II, and after successfully completing the Resident Inspector Qualification Program, became the resident inspector at Crystal River until she was assigned to Oconee in 2013.

rate development at Ascent Industries, recently departed Echelon Wealth Partners, where he was the managing director of investment banking.

Urenco UK has named **Lynton Simmonds** interim site managing director of the company's uranium enrichment facility at Capenhurst, in northwest England. Simmonds's appointment follows the resignation of **Martin Pearson**.

The Nuclear Threat Initiative has added several new staff members. **Peggy Knudson**, previously vice president of development at ecoAmerica, is NTI's new chief



Knudson



Johnson

development officer. **Richard Johnson**, who previously served as the acting deputy lead coordinator for Iran nuclear implementation at the U.S. State Department, is senior director of NTI's International Fuel Cycle Strategies Program. **Jake Jordan**, previously a chief scientist at Booz Allen



Jordan



Severance

Hamilton, is senior director of Global Biological Policy and Programs. **Hayley Severance**, previously a senior policy advisor at Diligent Innovations, is senior program officer for Global Biological Policy and Programs.

Sharon Brady has been appointed chief operating officer of SN3, part of Huntington Ingalls Industries' Technical Solutions division. Brady has been with SN3 since 2001, serving in various corporate and government contract positions. She most recently served as director of business services for Savannah



Brady

River National Laboratory, where she was responsible for laboratory finance, contracts, procurement, project controls, asset management, procedures, and training.

Obituaries

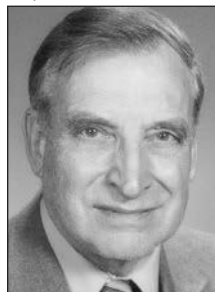
Virginia P. Denisen, 96, ANS member



Denisen

since 1962; earned a bachelor's degree from the University of Minnesota in 1943; became interested in nuclear engineering in the mid-1950s, and in 1958 began studying nuclear engineering at Iowa State University (ISU); in 1960, received a reactor operator's license for the UTR-10 research reactor at ISU, becoming perhaps the first woman to be a licensed reactor operator; received a senior reactor operator's license in 1964; in 1960-1962, served on the Committee on Objective Criteria in Nuclear Engineering Education, established by ANS and the American Society for Engineering Education; was an instructor in ISU's Nuclear Engineering Department until 1971; died December 4, 2017.

Richard Wilson, 92, ANS member since 1999; earned master's and doctorate degrees in physics from the University of Oxford; as a Guggenheim Fellow, performed postdoctoral work at Rochester University and Stanford University; returned to Oxford in 1952 as a research lecturer; in 1955, accepted a faculty position at Harvard University; specialized in experimental particle physics



Wilson

and led the upgrade of Harvard's proton cyclotron to 160 MeV; with colleagues from Harvard and the Massachusetts Institute of Technology, designed and constructed the Cambridge Electron Accelerator 6-GeV synchrotron; was involved in constructing and using the Fermi National Accelerator Laboratory (Fermilab) in Batavia, Ill., where he continued the study of nucleonic structure with high-energy muon beams; helped adapt Harvard's cyclotron for the treatment of cancerous tumors after it became obsolete for particle research; also studied electron-positron interactions with the CLEO collaboration at the Cornell Electron Storage Ring and joined a research group using the intense polarized beam of the Continuous Electron Beam Accelerator Facility in Virginia; authored 935 scholarly papers and eight books; died May 19.



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2018

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Aug 26-31, 2018

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Sep 9-14, 2018

San Diego, CA

Advances in Nuclear Nonproliferation Technology and Policy Conference

Sep 23-27, 2018

Wilmington, NC

Applicability of Radiation-Response Models to Low Dose Protection Standards

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ANS

A. PRIORI

Social media: Nothing personal?

I am a board-certified curmudgeon whose best days were in years that began with the numeral 1. Thus, I have greatly enjoyed the regrets of social media users over the widespread and unintended distribution of their personal information. Serves them right for chasing relentlessly after the original cryptocurrency, the “like”—which, in a key difference from bitcoin and the other recent forms of funny money, will never have any monetary value at all. (I guess nobody can stop someone from believing that a “like” has self-esteem value; I just hope I never meet that someone.)

It would be easy for me to keep piling on here with lines like “How can it be that a person with basically no identity can suffer from identity theft?” Nevertheless, I should treat this column as a public trust, even if nobody else does. I should be a force for good in the world, although this may no longer be possible without a YouTube channel. That is why I participated recently in an intervention to get my great-nephew Brandon off social media. It went something like this:

A.P.: *Brandon, you know why we're here today, don't you?*

Brandon: *We? There's just you, Uncle Gus.*

A.P.: *Your parents and the so-called deprogrammer had to check their in-boxes. They're supposed to be here soon.*

(There is a buzz.)

Brandon: *I gotta take this.*

A.P.: *That isn't even your phone buzzing. It's mine.*

Brandon: *Psych. Aren't you going to look?*

A.P.: *There's nothing incoming; the phone buzzes because it doesn't work.*

Brandon: *Then I've got time to crack level 37 in Nasty Medieval War That's in 3-D Somehow. Everybody I know on Facebunk is at level 40 (gazes at phone).*

A.P.: *Brandon? Brandon?*

Look, it's a process. Nobody promised miracles. To get away from social media, one has to see something in the real world that's more interesting or rewarding. Unfortunately, it's been shown many times

that the real world just can't compete. My earliest memories are of my parents yelling at me to stop watching television and go play outside. (And that was a 15-inch black-and-white TV with lousy vertical hold.) It's as true today as it has been for centuries: What the real world has to offer ranges from boring to dangerous.

If people can't be stopped from using social media, they should at least have it bashed into their heads that while they're posting and LOL-ing and whatnot, someone's profiling them and selling the relevant data. While it's been in more frequent use lately, the axiom “If you're getting something for free, you're not the customer, you're the product” actually predates the internet. It referred to come-ons related to mail order. Yes, snail-mail order.

For many social media users, the closest they come to fighting back seems to be whining about fake people and trolls, without actually leaving the sites that are allegedly so full of fakes and trolls. They seem undeterred even by scary entities such as “Cambridge Analytica” and “Mark Zuckerberg.”

Part of the problem is that the internet is so similar in its delivery to that of electricity and water that people see it as a public utility, and as such there must be some responsible, community-minded organization behind it. There are even towns that provide Wi-Fi the way they provide power and water, reinforcing the belief in public responsibility. The difference is that house current electricity and potable water don't have information content. Your town's Wi-Fi isn't responsible for the cat pictures it carries but carries them anyway. And when I say cat pictures, I don't mean cat pictures.

Rest assured, folks, my campaign for common sense in internet use won't end just because it's doomed to abject failure. Now, however, I'm on the brink of level 45 in Nasty Medieval War That's in 3-D Somehow. LOL, Brandon is such a loser.—A. Priori

A. Priori is the internet troll of former NN staffer E. Michael Blake, who insists that his cat pictures really are cat pictures.



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