Nuclear Plant Journal

An International Publication
Published in the United States

New Plants & Vendor Advertorial

July-August, 2014
Volume 32 No. 4

Oskarshamn, Sweden

ISSN: 0892-2055

Advertorial

Industry-Best Used Fuel Storage Technology and Team

AREVA TN offers a dedicated cross-disciplinary team of experts that will ensure your used fuel storage system is designed, installed and integrated with your plant infrastructure, topography and systems.

AREVA TN's NUHOMS® dry fuel storage system offers the highest demonstrated shielding and seismic capability in the industry and a low-risk, low-dose transfer process. Our loading teams are trained and practiced and have stringent human performance milestones that ensure safe "like clockwork" one-week loadings.

AREVA TN offers the right technology today and anticipates your future needs, providing all of the engineering, project management, fabrication of the storage modules, fabrication of the canisters and pool to pad teams as a "one stop shop." Plus, requirements such as ISFSI security, inspection and aging management are integrated so that you get what you need today ... and tomorrow ... from one source!

Safety is a corporate priority that is communicated, reinforced and rewarded at every level of the company. Zero safety challenges will be our number one priority at your plant site as it is with every customer site and in every single AREVA facility.

Transparency in our proposals and contracts is a cornerstone of our business strategy, as we pride ourselves on all-inclusive offers that take into account all engineering fees and plant modifications that we predict will be needed to successfully prepare and execute your used fuel program. Products, services and fees are all clearly spelled out so that you know exactly what you are getting.

The AREVA TN team is committed to your peace of mind. Because that is the end-result of working with our industry-best used fuel storage system and highly trained experts who you can trust to deliver the safest and lowest cost solution, the lowest risk and the highest integrity of service and performance.

To learn more about AREVA TN's solutions and commitment to operational excellence, visit: **us.areva.com/AREVATN**

AREVA

forward-looking energy

Field Report

Topic | **Dry Fuel Storage**

Location | **North America**

AREVA
forward-looking energy

"This is what excellence looks like!"

This is what one CNO told his plant after AREVA TN completed a 10-canister BWR used fuel loading campaign. The dose rates during the campaign were nothing less than record-breaking. The loading team set a new industry best for low dose for a NUHOMS® BWR canister several times during the campaign, with the ninth loading being the lowest at 200.5 mRem. The project was completed 30 percent under its project dose budget. This showcases the capability of the horizontal NUHOMS® technology and the high level of performance of the NUHOMS® University-trained team.

As our customer noted, "AREVA TN's performance and teamwork demonstrated throughout the project has indeed raised the bar for the nuclear industry!"

The used fuel loading campaign also featured:

- Zero safety or human performance events
- 10 canisters loaded in 10 weeks
- $200,000 under budget
- 26,329 Safe Work Hours
- No schedule impacts

Find out more:

us.areva.com

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- **Underground Pipe & Tank Integrity** program development, data management, inspections, evaluations and monitoring
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- **License Renewal** programs and support
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- **Training** programs on-site or online from industry experts

Nuclear power plant operating practices/experience and related decision making are highly scrutinized by many stakeholders. At the same time, your customers rely on you to keep the power on. Structural Integrity can provide engineering, NDE and training solutions to help you meet your demands so you can focus on delivering power.

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Nuclear Plant Journal®

July-August 2014, Volume 32 No. 4

32nd Year of Publication

New Plants & Vendor Advertorial Issue

Nuclear Plant Journal is published by EQES, Inc. six times a year in January-February, March-April, May-June, July-August, September-October, and November-December (the Annual Directory).

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31 years of Journal issues are available online through the Journal website **www.NuclearPlantJournal**.com (search box on the right-top) for a nominal fee of $25 per issue. Contact: Anu Agnihotri, email: anu@goinfo.com

ISSN: 0892-2055

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Articles & Reports

Industry Innovations

Plant Profile

Departments

Journal Services

On The Cover

OKG, Sweden has decided to extend the safety modernization of its Oskarshamn 2 nuclear power plant. See page 68 for a profile.

Mailing Identification Statement

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List of Advertisers & NPJ Rapid Response

Page	Advertiser	Contact	Fax/Email/Website
30-31	American Crane & Equipment Corporation	Karen Norheim	(610) 385-6061
2-3	AREVA Inc.	Donna Gaddy-Bowen	(434) 832-3840
14-15	ASI Marine	Carmen Sferrazza	carmen@asi-group.com
11	Birns	Eric Birns	(805) 487-0427
42-43	Black & Veatch	Michael Wadley	(913) 458-2492
58-59	Burndy	Angela Toppazzini	(603) 647-5205
22-23	Candu Energy, Inc.	Katherine Ward	(905) 403-7420
35, 72	ENERCON	Michael Manski	(724) 733-4630
7, 55	GE Hitachi Nuclear Energy	Julia Longfellow	julia.longfellow@ge.com
39	HukariAscendent	Matthew Hadacek	(303) 277-1458
8-9, 62-63	HydroAire Service, Inc.	Faisal Salman	fsalman@hydro-aire.com
45	Konecranes Nuclear Equipment & Services, LLC	Cassandra Dale	(262) 364-5701
17	OTEK Corporation	Otto Fest	sales@otekcorp.com
18-19	Rolls-Royce	David Hall	www.rolls-royce.com
48-49	Sargent & Lundy LLC	Patricia Andersen	(312) 269-3680
25	SGS Herguth Laboratories, Inc.	J. Michael Herguth	(707) 554-0109
36-37	Siempelkamp Nuclear Services, Inc.	Holger Spann	sns@siempelkamp.com
4	Structural Integrity Associates, Inc.	Bud Auvil	bauvil@structint.com
70-71	Westinghouse Electric Company LLC	Jackie Smith	(412) 374-3244
69	World Nuclear Exhibition	Laurence Gaborieau	visitors.wne@reedexpo.fr
52-53	Zachry Nuclear Engineering, Inc	Bob Atkisson	AtkissonR@ZHI.com

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Nuclear Plant Journal Rapid Response Fax Form

July-August 2014

To: _____ Company: _____ Fax: _____

From: _____ Company: _____ Fax: _____

Address:_____ City:_____ State: _____ Zip:_____

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I am interested in obtaining information on:_____

Comments: _____

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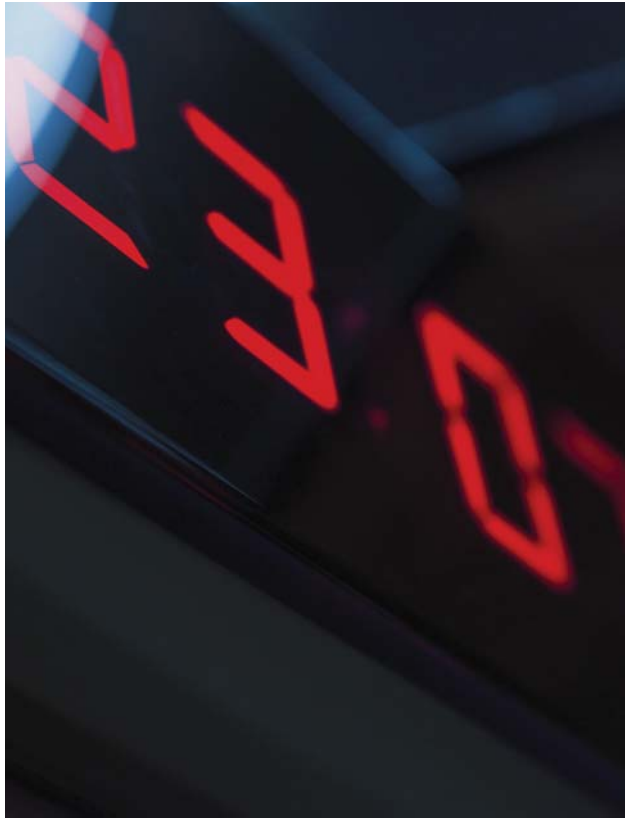


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Hydro Provides Emergency Response Pump Services So You Can Be Back Online In No Time.

We understand that when an emergency occurs, you need to get your process or your plant back up as quickly as possible. Hydro is there with you on the job 24 hours a day, 7 days a week supporting you with both on site field service and emergency response capabilities in the shop.

ITT Goulds Pumps and HydroAire have joined forces–creating a powerhouse for pump reliability. HydroAire is now the exclusive licensee for manufacturing ITT Goulds pumps and replacement parts, providing the nuclear power industry with superior ASME code and safety related pumps, parts and aftermarket services.

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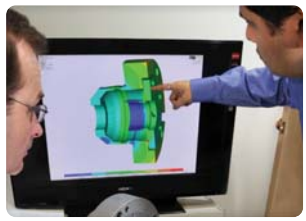

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New Energy

Moorside

Toshiba Corporation and GDF SUEZ have completed a deal that will boost development of the Moorside new nuclear power project on the West Cumbria coast in northwest England – the largest, single proposed nuclear power plant construction project in Europe.

The agreement sees Toshiba acquiring a 60-percent stake and GDF SUEZ retaining a 40-percent holding in NuGeneration Ltd (NuGen), the U.K.-based nuclear energy company that plans to build three Westinghouse AP1000 reactors in West Cumbria. Each reactor will take approximately four years to build. When fully operational, the Moorside site is expected to deliver around seven percent of the U.K.'s future electricity requirements.

A deal has also been concluded with the Nuclear Decommissioning Authority (NDA) on the extension of a land option agreement for the Moorside site.

The Moorside plant is targeted to come online in 2024. When fully operational, it will have a combined capacity of 3.4GW, enough to deliver power to six million homes. The project supports the U.K. Government's low-carbon and energy security objectives at a time when existing power plants are retiring and low−carbon generation is required to meet national and international commitments. The Westinghouse AP1000 reactor – a pressurised water reactor – is licensed by the U.S. Nuclear Regulatory Commission. Currently, eight AP1000 reactors are under construction globally.

Before the final investment decision which is forecast to be taken by the end of 2018, NuGen will be undertaking a broad range of preparatory works, including regulatory, permitting and commercial activities. The management team's focus in 2014 will be on site investigations, preliminary studies for site layouts and stakeholder engagement and preparation for stakeholder consultations.

Westinghouse intends to utilise its Springfields facility, a UK-licensed fuel manufacturing facility near Preston to manufacture the fuel for AP1000 reactors built in the UK, thereby securing indigenous fuel supply. The facility currently manufactures fuel for the entire U.K. fleet of advanced gas-cooled reactors, and pressurised water reactor fuel for export.

Contact: Midori Hara, telephone: 81-3-3457-2100, email: media.relations@toshiba.co.jp.

Atucha 2

Having achieved criticality early this month, the new reactor at the Atucha nuclear power plant, Argentina, began sending 5% of its rated power to the Argentine electricity grid on June 27, 2014. The reactor is to ramp up its production in stages, reaching 30% this week and approaching full power within two to three months.

Atucha 2's rated power is 692 MWe and together with Atucha 1 and the reactor at Embalse it establishes Argentina's total nuclear generating capacity at around 1627 MWe. The Carem small reactor project should add a further 27 MWe by 2018.

Speaking at the plant to celebrate the achievement of first power, Julio de Vido, the minister of planning, public investment and services, said the new reactor would diversify Argentina's energy mix and generate clean affordable energy with nuclear power. Its contribution to diversity was in line with President Cristina Fernandez de Kirchner's goals to 'recover energy sovereignty,' said De Vido.

*Contact: **World Nuclear News**, website: www.world-nuclear-news.org.* ■

Active COL Applications with the NRC

Proposed New Reactor	Design	Applicant
Bell Bend	U.S. EPR	PPL Bell Bend, LLC
Calvert Cliffs, Unit 3	U.S. EPR	Calvert Cliffs 3 Nuclear Project, LLC and UniStar Nuclear Operating Services, LLC
Fermi, Unit 3	ESBWR	Detroit Edison Co.
Levy County Units 1&2	AP1000	Progress Energy Florida, Inc.
North Anna, Unit 3	ESBWR	Dominion
South Texas Project Units 3&4	ABWR	South Texas Project Nuclear Operating Company
Turkey Points Unit 6&7	AP1000	Florida Power and Light Company
William States Lee III Units 1&2	AP1000	Duke Energy

Source: US NRC website, New Reactors page.

BIRNS: Innovating Nuclear Lighting Technology For Three Decades

As an ISO 9001:2008 certified global leader in cutting edge lighting systems, we've been trusted to provide solutions for demanding nuclear applications since 1977. Today our innovative, rugged lights are used in more than 83% of the nuclear power stations in the U.S., and all across the globe. We deliver a full range of advanced lighting solutions, from brilliant Seismically-qualified Emergency lights, High Bay lights, and Fuel Pool lights, to Reactor Core Refueling lights and Underwater Camera lights.

Our Quality System complies to the requirements of NRC 10CFR50 App. B., "Quality Assurance Criteria For Nuclear Power Plants and Fuel Reprocessing Plants," and our custom engineered products are stringently tested to enhance safety and radically decrease downtimes during fuel movement, inspection and maintenance.

Our new Emergency Lighting Fixtures (ELFs) are helping plants worldwide achieve B.5.b (EA-02-026) Post-Fire Safe-Shutdown. These powerful systems provide up to five times more standby illumination than required by the NRC and are seismically qualified.

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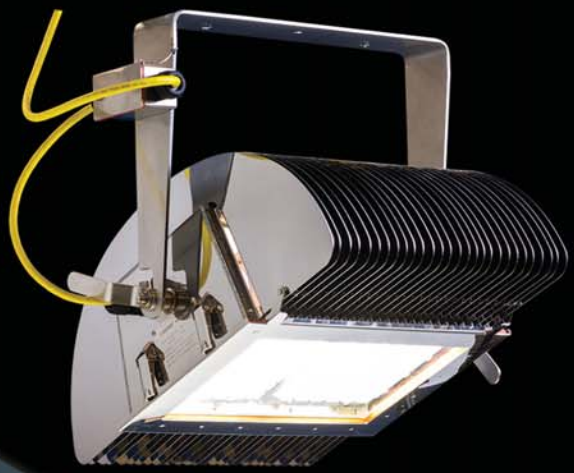

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Utility, Industry & Corporation

Utility

Refueling Outage

Operators returned Braidwood Generating Station Unit 2 to full power, marking the end of the unit's scheduled refueling outage that began May 3, 2014

More than 2,000 **Exelon** employees and highly skilled contractors performed more than 10,000 carefully choreographed activities during the outage. These activities included numerous safety inspections and equipment tests, along with plant refurbishments and improvements.

"The work performed during the refueling outage will ensure our ability to provide safe, clean and reliable electricity during the hot summer months and beyond," said Braidwood Site Vice President Mark Kanavos.

Braidwood Station Unit 1 continued to operate at full power during the Unit 2 outage.

Braidwood Generating Station is approximately 60 miles southwest of Chicago and can produce more than 2,300 megawatts of carbon free electricity – enough to power more than 2 million typical homes.

Contact: Neal Miller, telephone: (815) 417-3184.

Industry

Working Group

The Nuclear Science and Technology Committee of Japan's Ministry of Education, Culture, Sports, Science and Technology (MEXT) Council announced the establishment of a working group related to high- temperature gas-cooled reactors (HTGRs). The group's purpose is to evaluate the current R&D situation of HTGRs and discuss their future direction, based on domestic and foreign needs.

According to the 4th Strategic Energy Plan, released in April 2014 by the Agency for Natural Resources and Energy (ANRE) of the Ministry of Economy, Trade and Industry (METI), HTGR technology is believed to help hydrogen production and various other industrial applications.

Given the inherent safety of HTGRs, Japan is also planning to promote their R&D while focusing on international cooperation.

Contact: ***Japan Atomic Industrial Forum, Inc.****, website: www.jaif.or.jp*

Corporation

NDE Examinations

AREVA Inc.'s dedicated entity for non-destructive examinations (NDE), NDE Solutions, has successfully completed a record number of nuclear reactor inspections during the 2014 spring outage season in the United States.

The scope of work included nine steam generator eddy-current outages, seven reactor vessel head inspections, three reactor vessel examinations and three integrated NDE outages related to managing aging materials. These inspections, which certified the safety of the components, were all completed safely, on budget and on schedule.

NDE certify the integrity of nuclear reactor components to ensure safe, long-term reactor operation. AREVA Inc.'s NDE Solutions provides high-quality inspection services and technologies to help customers worldwide meet the stringent and highly regulated criteria for NDE.

Contact: Mary Beth Ginder, telephone: (301) 841-1703, email: Marybeth.ginder@areva.com.

Nuclear Grade Air Trap

AREVA Inc. has signed an agreement with engineering firm NUCCORP Inc. to be the exclusive supplier of NUCCORP's patented Nuclear Grade Air Trap (NGAT™) technology to the nuclear industry. This device passively monitors and accumulates air and gas in nuclear plant cooling systems.

If allowed to accumulate, air and gas can compromise the proper operation of the emergency core cooling systems. A one-of-a-kind solution, the NGAT™ continuously monitors for an accumulation of air and gas, allowing for quick ventilation of the affected system to ensure the plant's continued safe operation.

The NGAT™ system eliminates the need for periodic venting and ultrasonic testing inspections, which can increase costs and impair operational efficiency. Winner of a 2012 Nuclear Energy Institute Vendor Top Industry Practice award, the simply designed device can be easily installed in existing plants and has already been successfully demonstrated in operation.

Contact: Mary Beth Ginder, telephone: (301) 841-1703, email: Marybeth.ginder@areva.com.

Underground Storage

The construction of a 48-cavity HI-STORM UMAX storage facility at Ameren's Callaway nuclear plant is proceeding apace. The first loading campaign, consisting of six MPC-37 canisters, is scheduled to begin in mid-June 2015. The site construction is expected to end in January 2015 and the dry run is scheduled for April-May 2015.

The underground storage technology was developed by **Holtec** in the aftermath of 9/11. The storage system essentially consists of a 25 feet thick monolithic block of concrete with embedded thick walled metallic "cavity enclosure containers" fortified from above and below by thick reinforced concrete mats, making the storage system essentially indifferent to the height of the subterranean water table.

Contact: Amy Grant, telephone: (856) 797-0900, email: a.grant@holtec.com.

Full Scope Upgrade

L-3 MAPPS has added PPL Susquehanna LLC as a new customer for its leading-edge power plant simulation capabilities. Using its robust Orchid® simulation environment, L-3 MAPPS will replace the computing environment and plant models for the Susquehanna Unit 1 full scope simulator. Work is underway and the upgraded simulator is targeted to be in service by the third quarter of 2016.

Contact: Sean Bradley, telephone: (514) 787-4953.

Nuclear Safety

Lockheed Martin and State Nuclear Power Automation System Engineering Company (SNPAS), China, have signed an agreement to prototype, manufacture

and qualify nuclear power plant reactor protection systems for China's Generation III reactors. SNPAS is a subsidiary of China's State Nuclear Power Technology Corporation (SNPTC).

Lockheed Martin and SNPAS will develop a nuclear safety instrumentation and control platform, based on field programmable gate array (FPGA) technology, for a new generation of Reactor Protection Systems in China.

The FPGA-based platform will specifically address safety and regulatory concerns related to software common-cause failures in digital nuclear safety systems. These systems will autonomously and reliably monitor and detect potential failures in the system, ensuring the safe operation and function of the facility. The platform may be applied both in new plant deployment and in safety system upgrades for existing power plants.

Contact: Melissa Hilliard, telephone: (407) 356-5351, email: Melissa.hilliard@lmco.com.

Spent Fuel Pool Instrumentation

MOHR Test and Measurement LLC (MOHR), a supplier of water level and void fraction instrumentation for nuclear and other industrial applications, announced that the first 24 channels of its EFP-IL Spent Fuel Pool (SFP) Instrumentation (SFPI) System have successfully passed Factory Acceptance Testing (FAT), on-schedule and witnessed by representatives from 10 different U.S. nuclear utilities.

The EFP-IL SFPI System FAT procedure includes demonstrations of all key system capabilities including water level measurement accuracy through more than 1000 ft. of coaxial cable.

Contact: Brandt Mohr, telephone: (888) 852-0408.

Certifications

Rotating Equipment Repair, Inc. (RER), a provider of services in the performance of pump repair and replacement activities, part fabrication, and field service support has received official recommendation from ASME and National Board for the issuance of 'NPT' and 'NR' Certifications, respectively. In the two-year period leading up to certification, RER committed itself to expanding its capabilities in order to better provide for its nuclear and non-nuclear customers within the pump repair industry. RER's first-class reputation is the direct result of its strict compliance to the highest standards for safety and quality in an unrelenting effort to exceed its Customer's needs.

Contact: Katie Wilde, telephone: (262) 820-2525, email: ksw@rerpump.com.

Force Balance Accelerometers

Weir-Jones Engineering, after moving into their new facility, has increased production on its SSA series of Force Balance Accelerometers for use in strong motion applications, such as the nuclear, heavy construction and oil and gas industries. Weir-Jones took over production of all the Terra-Technology Inc. accelerometers support components several years ago, and has increased production accordingly. Total worldwide production of these hand built components exceeds 20,000 units.

Contact: Lincoln Bodner, telephone: (604) 732-8821, email: LincolnB@weir-jones.com.

Control Room Technology

Winsted Corporation announced the completion of a modular console used to aid research and development of nuclear control room technology. Partnering with the Center of Safe and Secure Nuclear Energy (CSSNE), Winsted consoles will play a significant role in the new facility, which will serve to research emerging control room technologies and educate the next generation of operators.

The CSSNE is a collaborative effort between the nonprofit Center for Advanced Engineering Research (CAER), the University of Virginia, local industry partners and other higher education institutions. At the core of the CSSNE is the Reconfigurable Main Control Room Simulator (RMCRS) designed to research the modernization and design of existing control rooms.

Winsted's reconfigurable modular consoles are key components of the RMCRS.

The system conforms to the Nuclear Regulatory Commission (NRC) NUREG standard 0700 "Human-System Interface Design Review Guidelines", ergonomic design to aid researchers in achieving safety and performance objectives.

Flat panel monitors and digital instrumentation and control (I&C) systems are slowly replacing the hard control panels, lights and dials in the shift from analog to digital controls. As a result, digital technology makes it possible for operators to access controls through keyboards instead of standing at control boards, which is a significant shift in working conditions.

Contact: Randy Smith, telephone: (952) 944-9050, email: randys@winsted.com.

World Nuclear Exhibition

The WNE **World Nuclear Exhibition** premiers its leading event for the global nuclear community. It will be held in Paris Le Bourget in France from Tuesday, October 14th to Thursday October 16th, 2014.

Resolutely "business"-oriented WNE gathers all the major stakeholders of the field. About 490 exhibitors from Europe, U.S., Asia, Russia... of all the supply chain will present their know-how and skills to 7000 international highly-qualified and decision-maker expected visitors.

An ambitious program including panel discussions led by the most eminent international speakers and technical workshops will be offered during the 3 days of the tradeshow.

Furthermore, to complete their participation in WNE, visitors can enjoy side/professional events before WNE on the opening's eve as well as visits of industrial sites and research centers on Friday, October 17th.

All of these events "inside" the event make WNE a unique platform for nuclear *appointments and business networking.*

Contact: website: www.world-nuclear-exhibition.com ■

ASI Marine

A Canadian first for ASI and Bruce Power

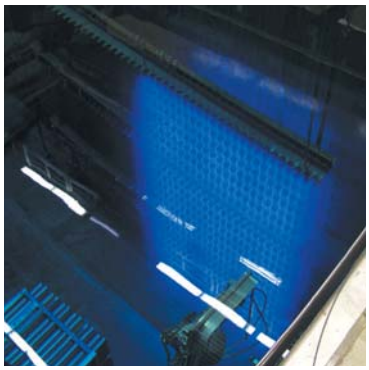
Underwater repairs in irradiated water solve the problem

ASI Group Ltd. was contracted by Bruce Power located in Tiverton, Ontario, Canada, to perform underwater repairs for the transfer cart system cable and tow bar which were damaged during a spent fuel transfer operation without a plant shutdown.

This repair had to be performed and successfully completed as soon as possible as storage space in the primary bay was limited and all four reactors were slated to be shut down within 14 days if the transfer cart system could not be repaired in time.

Radiation was present in both the primary and secondary bays. The nature of the radiation was both fixed and loose. Fixed radiation could be identified and isolated, loose radiation had to be continually monitored. All dive personnel were aware they would potentially receive some form of a radiological dose throughout the project.

This was the very first dive of its kind in Canada on a reactor system and in irradiated water.



ASI provided the following services:

- Removed and replaced 750 feet of 5/16 stainless steel aircraft cable
- Removed and replaced the transfer cart tow bar system
- Recovered old bearings from the entrance of transfer duct
- Assisted with cable tensioning
- Installed and set new limiting switch stops
- Performed Foreign Materials Exclusion (FME) in both bays
- Assisted with the testing and re-commissioning of the repaired transfer cart system

Bruce Power was very pleased with the speed of response and completion of the repair. ASI has since worked with Bruce Power on two other nuclear dive projects.

"The team at ASI Marine worked extremely well with our maintenance group and inspection and radiation protection staff. We now have valuable OPEX through accomplishing this first-of-a-kind job. I was thoroughly impressed with everyone's work."

- Andrew Bruce, Senior Technical Officer, Bruce Power L.P.

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IF ONLY THREATS TO YOUR INFRASTRUCTURE WERE THIS OBVIOUS.

With ASI technology, they are. ASI Marine has the most advanced technology in the world for finding problems that are out of sight, but should never be out of mind. We make sure you avoid costly shutdowns and delays, even while we carry out detailed inspections.

ASI Marine has been the global leader in underwater inspections, marine geophysical and hydrographic surveys for more than 25 years. By pioneering tunnel inspection technology, we were able to perform the world's longest inspection. We continue to be an innovator in projects around the globe. Our commercial divers, construction crews, engineers, ROV pilots and technicians command a fleet of state-of-the-art vessels and advanced robotic vehicles, providing the latest in 3D sonar and video imaging, and survey and inspection technologies. We have even performed live dives in the irradiated water of a nuclear facility. ASI can accurately predict the conditions of your critical infrastructure allowing you to make informed asset management plans. Find out why hundreds of companies around the world count on ASI Marine.

ASI Marine

We see what you can't.

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New Products, Services & Contracts

New Products

SMR-160

Holtec's engineers have succeeded in designing SMR-160 into a "walk-away" safe nuclear power plant, which means that if a calamity were to strike - similar to the tsunami that devastated Fukushima - the plant will passively (without human intervention) switch to and remain in a safe shutdown and cooled configuration for an unlimited period. Faced with an extenuating event, the reactor will automatically shut down and all of the plant's fuel - both in the reactor and the spent fuel pool - will remain in a safely cooled state without the need for electric power. Unlike its peers, which all have limited duration coping periods, requiring water make-up after a specific number of hours or days, the SMR-160 plant is designed to remain passively cooled indefinitely, without requiring any operator activity.

Postulating an accident leading to a sudden breach in a pressurized reactor coolant line (known as LOCA in nuclear parlance), a break in a main steam line, or a sudden station blackout, the SMR-160 plant would readily and passively respond to any of these events without any loss of its cooling capacity or risk of release radioactivity or any other adverse effect on the surrounding environment.

As a first line of defense, SMR-160's designers have eliminated the single largest plant vulnerability - large piping - entirely from the reactor coolant system and containment building through creative designs. The largest high-pressure pipe in the plant is eight inches in diameter.

A second transformative design innovation leverages gravity combined with conduction heat transfer - two unfailingly reliable phenomena in nature - to facilitate all necessary heat removal from the plant's nuclear fuel, and subsequent expulsion of heat to the atmosphere.

Patents on the innovative design features that underlie the inherent safety and stability of the SMR-160 plant have been filed with the USPTO.

Contact: Amy Grant, telephone: (213) 310-5010, email: a.grant@holtec.com.

New Technology Meters

OTEK's New Technology Meters (NTM) use nanotechnology and ultra-efficient LEDs to produce an automatic tricolor bargraph with four digit display that only requires 50mW of power from the signal.

Being able to function with such low power requirement allows OTEK to offer their NTM series with loop, signal or external power. Model NTM-5 is available in metal (nickel plated aluminum) or plastic (94VO rated) and is compatible for panel cutouts of 3" x 5.6" and bezels of 3.1" x 6".

The NTM-5 includes isolated Serial I/O (USB/RS485) to detect and alert when the input has failed. The powerful firmware includes four alarm set points, math functions, polynomials, X-Y tables, tare, scale, offset and much more for complex algorithms. The NTM-5 is available in up to 4 channels, making it ideal for display/control of pressure, flow, volume and temperature.

The NTM series offer a variety of different low power consumption meters.

Contact: telephone: (520) 748-7900, email: sales@otekcorp.com.

Services

Tank Inspections

A partnership was recently formed between **IHI Southwest Technologies, Inc.** (IHI) and Newton Labs (Newton) to meet the Nuclear Energy Institute requirements for the inspection of nuclear plant water storage tanks in accordance with NEI 09-14, *Guideline for the Management of Underground Piping and Tank Integrity*. IHI will use Inspector robots, designed and manufactured by Newton Labs, to provide the most advanced nondestructive evaluation (NDE) tank inspection services currently available in the nuclear industry.

Working underwater, without the need to drain a tank, Inspector robots can map and inspect over 90% of a tank floor with specialized NDE sensors. This includes inspecting within very close proximity to the tank wall edge. The inspection services combine the expertise of both firms; phased array ultrasonic and eddy current testing by IHI and optical inspection, underwater laser scanning, and robotics by Newton.

Inspector robots employ a combination of autonomous machine vision navigation and direct operator guidance to accurately identify and map tank floor weld locations. This is followed by a detailed inspection on a per-plate basis, thus providing XYZ coordinate locations of all flaws in the tank floor using phased array UT and eddy current systems. Locations of defects are pin-pointed to within 1/8th of an inch using additional overhead machine vision technology attached inside of the tank roof access.

Contact: Carlos Barrera, telephone: (210) 256-4104, email: cbarrera@ihiswt.com.

Outage Services

RSCS, Inc has started a new Outage Services Division led by Fred Erskine and supported by Tina Inman to focus on providing a full range of radiological specialists to nuclear power plants during outages. This division compliments their Consulting Services Division, which has an established record of providing project management and technical radiation safety services to nuclear utilities, such as routine technical support services and emergency response.

Nuclear power plants refuel their reactors on 18 to 24 month cycles. During these outage periods which typically last 3 to 6 weeks, plants shut down their reactors and perform routine maintenance and inspections. In order to accomplish all of this work as quickly as possible, plants augment their staff with hundreds of temporary workers including, engineers, laborers, technicians, supervisors, and quality assurance professionals. This temporary labor pool is supplied by a limited number of companies that focus on providing workers for maintenance and non-health physics related activities. RSCS distinguishes its services from others staffing agencies as a turnkey provider for technicians, health physicists and radiological management professionals. As a full-service provider, RSCS can streamline the management

and execution of all radiological maintenance and inspection activities to reduce operational downtime.

RSCS has extensive experience in developing comprehensive professional improvement programs and plans to implement a continuous improvement program for their technicians to ensure that clients are supported by highly qualified and experienced individuals. Committed to fostering the next generation of nuclear technicians, they envision working with operating plants to establish apprenticeship programs to build up staff experience. Additionally, as a provider of radiological services to other industry sectors outside of the commercial nuclear arena, opportunities exist for key performers to obtain additional employment at industrial, medical and environmental worksites, furthering their professional development.

Contact: Michelle Valdivia Ayala, telephone: (305) 374-4404, email: michelleayala@maxborgesagency.com.

Contracts

Mitigation Equipment

AVANTech Inc has received its first order for its Boric Acid Tank (BAT) mobile mitigation equipment in response for the Fukushima Update requirements. As a part of the Nuclear Energy Institute's (NEI's) FLEX Strategy, AVANTech will design and manufacture the portable equipment that provides means of obtaining borated water to maintain or restore key safety functions for reactors in the event of emergency. The AVANTech BAT is a 15 foot trailer containing a 1000 gallon poly boric acid mixing tank with internal heaters and linked to a skid mounted valve/ pump/control system for rapid deployment.

FLEX is a strategy developed by the NEI to implement the NRC's Fukushima task force recommendations quickly and effectively. FLEX addresses the main safety challenges at Fukushima—the loss of cooling capability and electrical power resulting from a severe natural event—to make US nuclear facilities even safer. The strategy is "flexible" in that it relies on portable equipment to protect against even the most unlikely events — events that go beyond the plant's design basis.

AVANTech, Inc. provides comprehensive radioactive and industrial water treatment solutions. They have extensive experience in engineering process systems enabling them to create integrated solutions that can dramatically improve operations in industrial, commercial and nuclear power applications. AVANTech also developed and manufactured a unique patent-pending water treatment system that is currently in operation with the disaster recovery efforts at TEPCO's Fukushima Daiichi Nuclear Power Station.

Contact: Gary Benda, telephone: (803) 317-1116, email: Gbenda@AVANTechinc.com.

SMR Technology

Fluor Corporation announced that NuScale Power, in which Fluor is the majority investor, officially signed a contract agreement with the U.S. Department of Energy (DOE) for funding that will support the development, licensing and commercialization of the company's nuclear small modular reactor (SMR) technology.

The DOE would provide up to $217 million in matching funds over five years to help the Oregon-based nuclear power company develop its SMR design, which is set to revolutionize the next generation of nuclear power plants. The reactor technology can deliver the energy diversity needed to replace aging coal plants, to power growing populations and to reduce emissions, all while proving to be a safer, more flexible and cost-effective nuclear power solution.

Kicking off the five-year public-private partnership with DOE, this month NuScale will open an operation and engineering center in Charlotte, N.C. and plans to hire 70 employees at the new office.

Backed by DOE and Fluor, NuScale aims to submit its design certification application in the second half of 2016 with expected certification in 2020 if the Nuclear Regulatory Commission's schedule is maintained. Over the last five years, NuScale has been engaged extensively with the NRC regarding the SMR technology and will continue to work closely to ensure the success of the project.

Contact: Brian Mershon, telephone: (864) 281-6484, email: brian.mershon@fluor.com. ■

SPECIAL ADVERTISING SECTION

RE-DEFINING STEAM GENERATOR INSPECTION

Rolls-Royce Inspection Technologies Enable Top to Bottom Steam Generator Inspection Capabilities

- Secondary moisture separators
- Primary moisture separators
- Swirl vanes
- Vents
- Tangential nozzles
- Downcomer barrel
- Feedwater ring thermal sleeve
- Intermediate deck
- J-nozzle feedwater ring
- Central drain
- Lower deck
- Transition cone girth weld
- U bend region
- Anti vibration bars
- Upper in-bundle
- Tube support plates
- Flow distribution baffle
- Tubesheet in-bundle region
- Tubesheet annulus region

Rolls-Royce Inspection Experience

Rolls-Royce inspection personnel perform nearly 200 steam generator inspections for the nuclear power generation industry on a yearly basis. Our unique capabilities, knowledge of power generation systems and experience performing specialty inspections are utilized at facilities around the world to provide customers critical information about plant health and operation.

Foreign Object Quick Facts

821 - Average number of foreign objects found in steam generator internals per year.

78% of all objects found are metal in composition.

Metallic object makeup:
49% - Wire
20% - Gasket
18% - Machining Remnant
13% - Misc. Metal Objects

Foreign Objects Search and Retrieval (FOSAR) is used by the global nuclear industry to ensure safe, reliable and predictable energy generation. Foreign objects in the steam generator of a pressurised water reactor can lead to primary and secondary side contamination leaks; increased radiation exposure, forced outages and ultimately decreased plant availability.

Reduced radiation exposure to plant personnel is of paramount importance and continues to drive the development of customised, advanced technical solutions for the inspection of steam generators around the world.

In 2012, Rolls-Royce was asked by a customer to develop remote in-bundle inspection capabilities that would not only enhance inspection quality and further reduce potential equipment damage; but most importantly would minimise the radiological hazards for inspection personnel posed by manual inspection techniques.

Project requirements included:

- The delivery of remote inspection capabilities to minimise exposure reduction when compared to typical manual inspection techniques
- The provision of the same high quality inspection images as the currently accepted industry standard
- The ability to inspect square pitched steam generator

Through technical innovation, and drawing from proven industry experience in the development and delivery of bespoke inspection and retrieval technology for areas with limited access and complex geometries, Rolls-Royce developed the REPTIL remote in-bundle inspection system.

Based on existing Rolls-Royce manual In-bundle inspection technology, the development of REPTIL focused on the automation of the following three inspection attributes:

- **Probe translation** – A robust cog assembly utilises integrated rivets on the ultra slim (2.4mm wide) Brooks In-bundle Camera System (BICS) for probe deployment and retraction; removing technicians from the inspection platform for a large majority of the inspection, maximising ALARA/ALARP techniques to reduce technician radiation exposure by up to 80% when compared to manual inspection techniques.
- **Guidetube Translation** – the BICS probe is automatically fed into new guidetube sections for increased inspection range within the steam generator; eliminating the risk of foreign object intrusion associated with manual techniques.
- **In-bundle Rotation** - Remotely operated in-bundle rotation capabilities allow for smoother inspection data collection, providing more reliable high quality data for review by subject matter experts.

These unique remote capabilities have enabled the majority of steam generator in-bundle inspections to be completed from a low dose area or outside of the containment building entirely, significantly reducing radiation exposure for plant personnel.

The REPTIL system has been successfully deployed in over 16 steam generators in France since its inception into the market in 2013.

2014 will mark a milestone for both Rolls-Royce and the US nuclear industry when the system is deployed in the US for the first time during the autumn outage season.

www.rolls-royce.com

In the dark about nuclear services? Let's switch the light on.

That's better! You see, at Rolls-Royce we know just how important it is to keep your customers operational. Because, if they can switch the light on without a second thought, then we know we're fulfilling our part as your long-term nuclear services provider. Rolls-Royce has over 40 years of experience in designing custom solutions that enable optimal lifetime performance. In addressing utilities' most complex challenges, we have established a comprehensive range of nuclear services for operational reactors across Europe, North America and Asia, from remote tool design and delivery to total fleet management solutions. It's good to shed some light.

Trusted to deliver excellence

Rolls-Royce

New Documents

EPRI

1. *Nuclear Plant Performance Programs*. Product ID: 3002003984. Published April 2014.

Nuclear power plants are complex systems that can provide engineers with many operational and maintenance challenges. The number and variety of degradation and failure mechanisms challenge high reliability, and the numerous maintenance and engineering approaches available make it difficult to determine which offers the greatest impact on plant performance. Performance and reliability often can be improved by providing engineers with access to a collaborative environment where thoughts, ideas, and solutions can be readily shared.

EPRI has coordinated the Heat Exchanger Performance Users Group (HXPUG), Service Water Assistance Program (SWAP), and Plant Performance Enhancement Program (P^2EP) for many years to support improved nuclear plant performance. These groups are now available through a single supplemental project to facilitate participant access to their diverse benefits. The groups make it possible for engineers to access the nuclear fleet's broad knowledge base and apply it to their specific issues.

2. *Steam Generator Management Program: Development of System Performance Examination Technique Specification Sheets*. Product ID: 3002002847. Published May 2014.

This report outlines the procedures for and describes the tools to begin developing Steam Generator Management Program PWR (pressurized water reactor) Examination Guidelines, Appendix I Examination Technique Specification Sheets. Work has been ongoing in this area since early 2000, and culminated with the procedures and tools described in this report.

3. *Materials Reliability Program: Finite Element Analysis of Three Mile Island RC-P-1B Drain Weld Cracking (MRP-385)*. Product ID: 3002002973. Published May 2014.

The objective of this project was to develop a detailed three-dimensional finite element analysis (FEA) model of the Three Mile Island (TMI) RC-P-1B drain line and to use that model to evaluate the influence of weld residual stress and thermal transient- and swirl penetration-related thermal loading on crack initiation and growth potential.

4. *Nuclear Maintenance Applications Center: Complete Product List, Spring 2014*. Product ID: 3002003990. Published May 2014.

Nuclear Maintenance Applications Center: Complete Product List (Spring 2014) is a comprehensive list of products, workshops, and meetings offered by EPRI's Nuclear Maintenance Applications Center (NMAC).

5. *Advanced Nuclear Technology: Alloy 690 Steam Generator Tubing Specification Sourcebook*. Product ID: 3002003124. Published June 2014.

This revised document provides requirements and recommendations for procuring Alloy 690 steam generator tubing and sleeve material.

6. *Welding and Repair Technology for Power Plants, 11th International EPRI Conference Program*. Product ID: 3002004164. Published June 2014.

This is the program for the Welding and Repair Technology for Power Plants 11th International EPRI Conference. The three-day meeting held on June 25–27, 2014 in Naples, Florida addressed the repair of nuclear, fossil, heat recovery steam generator (HRSG), and steam turbine power plant components. Topics for discussion included repair methods, performance, prior service effects, repair and welding qualifications, materials properties, advanced repair technology, corrosion, and case histories.

7. *Out-of-Reactor Corrosion Tests of Fuel Cladding Materials: Corrosion as a Function of Hydrogen Overpressure*. Product ID: 3002004140. Published June 2014.

EPRI has sponsored laboratory experiments to investigate whether an increased dissolved hydrogen (DH) level in the reactor coolant of pressurized water reactors (PWR) would result in increased hydrogen pickup (HPU) by the fuel cladding and spacer weld structure materials. This report documents exposure of clean, modern zirconium-based alloys for up to 730 days at three DH levels as well as exposure of Zircaloy 4 (Zry-4) specimens with different types of nickel contacts for 100 days at three DH levels.

8. *Comanche Peak Grid Tab Hot Cell Examinations*. Product ID: 3002003065. Published June 2014.

ZIRLO grid tabs from a U.S. pressurized water reactor (PWR) were analyzed for hydrogen pickup and oxide thickness as a function of operating parameters and axial position. Grid tab samples were obtained from two assemblies, each exposed for three cycles: one fuel assembly that was exposed to elevated Li (pH) for all three cycles and another that was exposed to elevated Li (pH) for one cycle. The two issues addressed by this project were: the potential for excessive rod corrosion and the possible embrittlement of tabs resulting from grid oxide and hydrogen absorption. In this report, the hot cell analysis results of the grid tabs are presented to help address grid tab embrittlement. Previous work eliminated concern for excessive rod corrosion (EPRI report 3002000693).

9. *CORAL Design Review*. Product ID: 3002002909. Published July 2014.

The EPRI Fuel Reliability Program has been developing a boiling water reactor (BWR) crud deposition model and risk assessment tool (CORAL) to predict tenacious crud deposition and to assess the risk for crud-induced fuel cladding corrosion issues. CORAL development is near completion, and CORAL should be delivered to utilities in the near future. As part of the code development process, an expert review meeting was conducted on August 20–21, 2013, by independent industry experts to review and critique the CORAL models and to develop ideas for improvements for future revisions. The purpose of this report is to summarize the expert review meeting and list the independent expert recommendations.

The above EPRI documents may be ordered by contacting the Order Center at (800) 313-3774, Option 2, or email at orders@epri.com. ■

Meeting & Training Calendar

1. **Korean Nuclear Society** International Symposium on Future I&C for Nuclear power Plants (ISOFIC)/International Symposium on Symbiotic Nuclear Power Systems (ISSNP), August 24-28, 2014, International Convention Center Jeju, Jeju, Republic of Korea. Contact: Dr. Gee Yong Park, telephone: 82-42-868-4653, fax: 82-42-868-4653, email: isofic2014@gmail.com.

2. 19TH Pacific Basin Nuclear Conference, August 24-28, 2014, Vancouver, Canada. Contact: **Canadian Nuclear Society**, telephone: (416) 977-7620, fax: (416) 977-8131, email: cns-snc@on.aibn.com.

3. 38th Annual CNS/CAN Student Conference, August 24-28, 2014, Hyatt Regency Vancouver, Vancouver, Canada. Contact: **Canadian Nuclear Society**, telephone: (416) 977-7620, fax: (416) 977-8131, email: cns-snc@on.aibn.com.

4. The Annual Radwaste Summit, September 2-5, 2014, Summerlin, Nevada. Contact: **Exchange Monitor**, telephone: (877) 303-7367, email: forums@exchangemonitor.com.

5. 23rd International Conference Nuclear Energy for New Europe, September 8-11 2014, Portoroz, Slovenia. Contact: **Nuclear Society of Slovenia,** telephone: 386 1 588 53 02 email: nene2014@ijs.si.

6. **World Nuclear Association** Symposium 2014, September 10-12, 2014, London. Contact: email: events@world-nuclear.org.

7. **International Atomic Energy Agency** General Conference, September 22-26, 2014, Vienna, Austria. Contact: Christina Kulur, email: Christina.kulur@unvienna.org.

8. PHYSOR 2014, September 28-October 3, 2014, The Westin Miyako, Kyoto, Japan. Contact: email: contact@physor2014.org, website: www.physor2014.org.

9. Facility Decommissioning Training Course, October 7-11, 2014, Virginia Beach, Virginia. Contact: Lawrence Boing, **Argonne National Laboratory**, telephone: (630) 252-6729, email: lboing@anl.gov.

10. World Nuclear Exhibition, October 14-16, 2014, Le Bourget, Paris. Contact: Claire de Berny, **Reed Expo**, telephone: 33 1 47 56 24 09, email: Claire.de-berny@reedexpo.fr.

11. International Uranium Fuel Seminar, October 19-22, 2014, Hyatt Regency Atlanta, Atlanta, Georgia. Contact: Linda Wells, **Nuclear Energy Institute**, telephone: (202) 739-8091, email: ljw@nei.org.

12. 2014 **American Nuclear Society** Winter Meeting and Nuclear Technology Expo, November 9-13, 2014, Disneyland Hotel, Anaheim, California. Contact: telephone: (708) 352-6611, fax: (708) 352-0499.

13. Facility Decommissioning Training Course, November 17-20, 2014, Las Vegas, Nevada. Contact: Lawrence Boing, Argonne National Laboratory, telephone: (630) 252-6729, email: lboing@anl.gov.

14. International Conference on Occupational Radiation Protection: Enhancing the Protection of Workers – Gaps, Challenges and Developments, December 1-5, 2014, Vienna, Austria. Contact: Martina Khaelss, **International Atomic Energy** Agency, telephone: 43 1 2600 21315, email: M.Khaelss@iaea.org.

15. 9th International Conference on Nuclear Plant Instrumentation Control, and Human-Machine Interface Technologies, February 21-26, 2015, Westin Hotel, Charlotte, North Carolina. Abstracts due July 10, 2014. Full papers due November 10, 2014. Contact: H.M. Hashemian, **NPIC-HMIT-2015**, telephone: (865) 691-1756, email: hash@ams-corp.com.

16. Nuclear Fuel Supply Forum, January 21, 2015, Renaissance Mayflower Hotel, Washington, D.C. Contact: Linda Wells, Nuclear Energy Institute, telephone: (202) 739-8091, email: ljw@nei.org.

17. World Nuclear Fuel Cycle, April 21-23, 2015, Marriott Prague Hotel, Prague, Czech Republic. Contact: Linda Wells, Nuclear Energy Institute, telephone: (202) 739-8091, email: ljw@nei.org.

18. 2014 International Congress on Advances in Nuclear Power Plants (ICAPP), May 3-6, 2105, Nice, France. Contact: Sylvie Delaplace, **SFEN**, email: icapp2015@sfen.org.

19. Annual Nuclear Industry Conference and Nuclear Supplier Expo: Nuclear Energy Assembly (NEA), May 12-14, 2015, Marriott Marquis, Washington, D.C. Contact: Linda Wells, Nuclear Energy Institute, telephone: (202) 739-8091, email: ljw@nei.org.

20. GLOBAL 2015, September 20-24, 2015, Paris, France. Contact: website: www.sfen.fr/global-2015. ■

CANDU technology features fuel flexibility

While nuclear power is widely recognized as a viable source of energy to help combat climate change and increase energy security, uranium reserves remain finite, forcing countries to maximize the energy efficiency of the nuclear fuel cycle.

Candu Energy's Generation III 700 MWe Enhanced CANDU 6® (EC6®) reactor is a secure and economical solution to fuel cycle management due to its ability to use not just traditional natural uranium but also advanced and recycled fuels including mixed oxide (MOX). The fuel channel layout of CANDU® reactors coupled with on-power refuelling and neutron efficient design, make them optimal to produce safe, reliable, economic power using alternate fuel types.

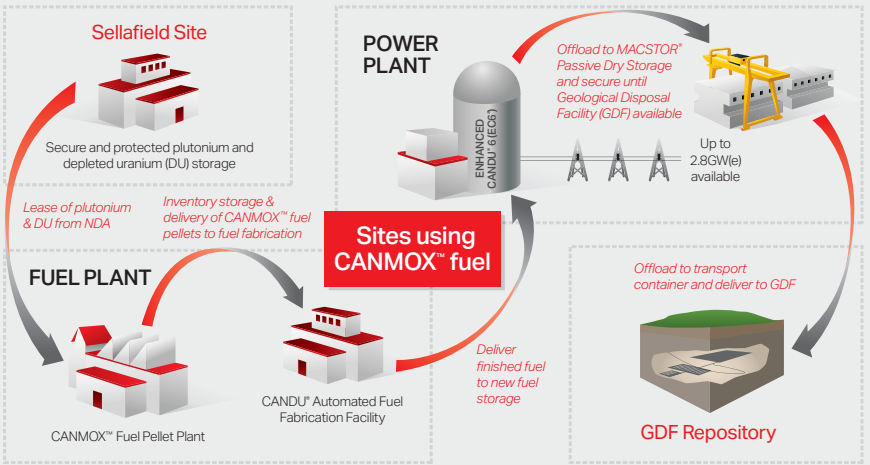
The EC6 Control Room features touch-enabled video display units.

The EC6 is a safe, proven and economically competitive solution for plutonium lifecycle management with technically superior performance when compared to other thermal reactor technologies. Coupled with CANMOX™ technology, the EC6 is a tailored, proven, MOX-capable solution for plutonium disposition objectives. It can be deployed without first-of-a-kind (FOAK) risk.

The simplicity of CANDU technology makes it inherently fuel flexible.

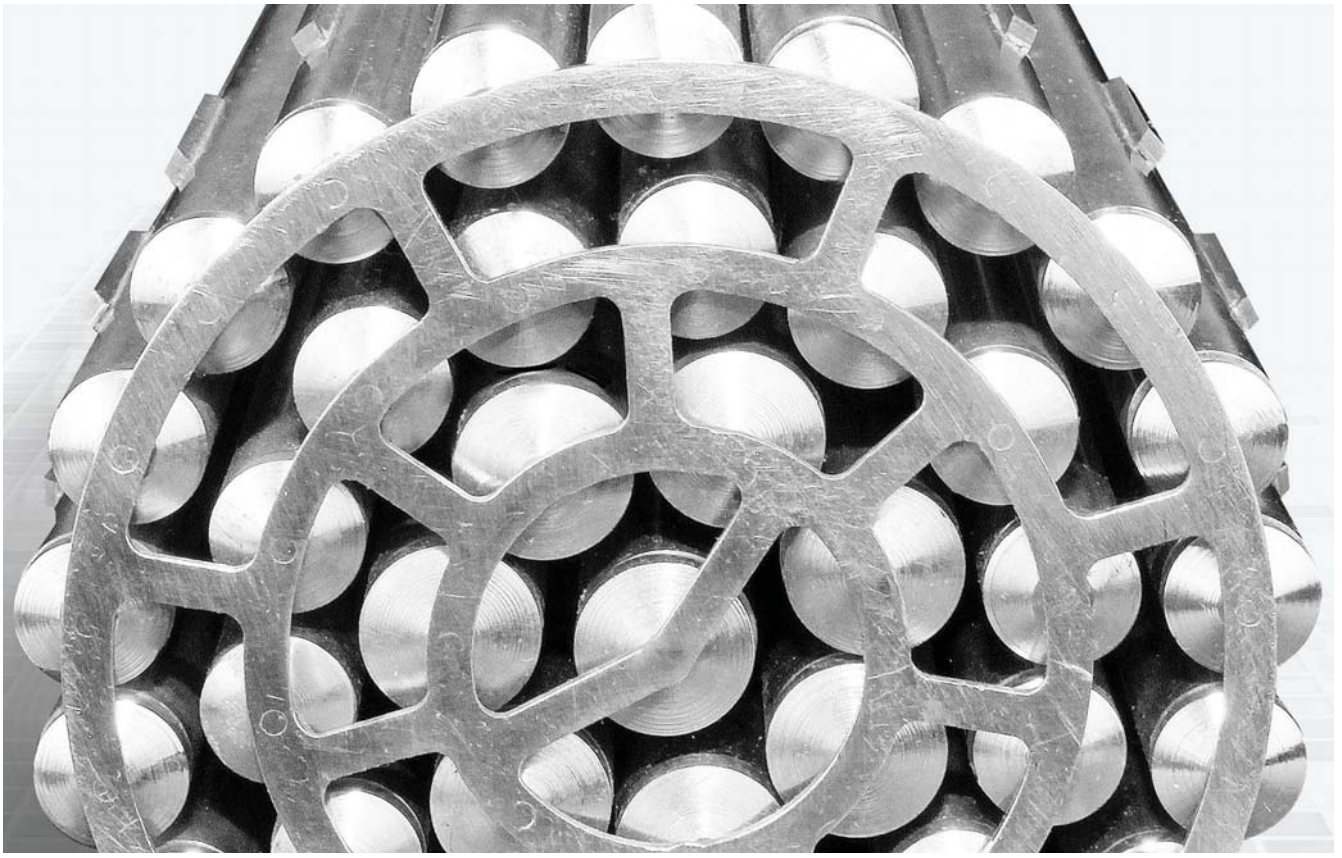
Over five decades of research and development, including irradiations in research reactors, prove that Candu Energy's EC6 can safely and efficiently burn MOX fuels with only incremental design enhancements. This Generation III reactor advances the CANDU design to a new level of performance, incorporating fuel-related advantages while retaining the provenness of the reactor fundamentals. The EC6 incorporates the inherent safety features of globally-deployed CANDU reactors that have safely operated for decades.

Candu Energy's fuel cycle options, like the MOX-ready EC6, reduce long-lived waste quantities and generate peaceful energy by using strategically important stockpiles of nuclear materials as fuel.



The CANMOX fuel cycle proposed in the United Kingdom.

Candu™



At Candu, fuel flexibility is a given.

The Advanced Fuel CANDU reactor is inherently flexible, offering fuel technology that is unique in the world of nuclear power generation.

Producing new power using NUE, recycled uranium or thorium, CANDU technology stands at the forefront.

Our employees have an unwavering commitment to excellence to our global customers – offering environmental tools for the 21st century and beyond.

Candu
Powering prosperity.

www.candu.com

Research & Development

Machine Verification

Independent verification of the operating position of a valve or a switch is a fundamental safety expectation in nuclear plants. This task currently consumes man-hours because a separate operator must be dispatched to the component's location to verify that tasks have been completed. The verifier is often exposed to radiation, and because this task is currently performed by a person, human error is possible.

EPRI is working with TVA at the Bellefonte site to test a prototype device intended to replace the human verifier. The prototype is a tablet computer with a suitable camera. The device would support a fully independent verification process embedded in the operator's procedure, thereby avoiding the need to dispatch a second person later. For example, at each step where a valve is opened or closed by procedure, the operator photographs the component when he has completed the step, thereby documenting key data such as the exact time, place, and who performed the task. Before allowing the performer to proceed to the next step, the machine verification software analyzes the photo:

- First, the software determines the coordinates of the photo by identifying the geometry of the objects in the photo, matching the objects in the photo to the laser-scanned 3D model of the plant that is carried with the device, and applying the lens characteristics of the camera to back-fit/triangulate to the only place the photo could have been taken.
- Second, the valve of interest in the photo is isolated/matched from the procedure step, and the visual field of the photograph is analyzed to confirm that the proper equipment ID is being seen.
- Third, the valve of interest in the photo is compared to both open and closed 3D models of the valve, and the degree of matching of the photo to each of the component models is measured. The closest match is then compared to a pre-determined figure of merit, and if the match is within a defined tolerance, the computer declares the position of the valve to be known.
- Finally, if the known position matches the procedurally required position, the computer registers the position to be "verified." This allows the operator to proceed to the next step.

At the current stage of development, the software that calculates component position resides in a personal computer; the tablet and computer must be linked to generate the verification. The final version will have the analysis software, necessary 3D models, and the procedures/work packages self-contained on a tablet device. The embedded verification process would be independent of the operator, other than the fact that the operator carries the device to the job site. When the procedure calls for verification, the operator points the camera in the general direction of the component right after performing the action. The verification is automatically documented, or the operator is warned that there is something amiss before he can proceed.

Development and testing of the first prototype, funded by EPRI's Technology Innovation Program, marks the start of a multi-year effort to improve the technology using commercial off-the-shelf components and to extend its applicability to a range of verifiable components (valves, switches, etc.).

Contact: David Ziebell, telephone: (404) 316-9823, email: dziebell@epri.com.

Virtual Reality

State-of-the-art gaming technology and virtual reality could re-shape how industrial workers perform maintenance tasks in the future. In late 2012, EPRI released a first-of-its-kind virtual reality maintenance application for air-operated valves (AOV) that combines 3D modeling and animations to create an environment that mimics real-life plant conditions. With more than 500 downloads since its release, this new way of delivering maintenance best practices for power plant equipment is gaining traction. EPRI's Nuclear Maintenance Application Center (NMAC) currently has several more applications under development and scheduled for release in 2014. Moreover, the ability to use a mobile device to access EPRI products is not limited to 3D applications; several web-enabled databases, for example, are ready for immediate member use.

The AOV app includes the basics of AOV maintenance such as removal, disassembly, inspection, reassembly, bench set testing, installation and troubleshooting. A module for diagnostics testing is being added in 2014 that will help mechanics, I&C technicians, and engineers understand the importance of diagnostic testing, select testing equipment, and learn how to perform a test and conduct signature analysis. The revised AOV app will be available in June 2014 in a Windows version (3002002703) and an Android version (3002002704).

A second application on bolting, which will be available by year-end, is based on two previous NMAC reports: Bolted Joint Fundamentals (EPRI 1015336) and Assembling Gasketed, Flanged Bolted Joints (EPRI 1015337). This application demonstrates the fundamentals of assembling a bolted flange, and uses hands-on experience to integrate craft experience on bolt torquing for proper gasket engagement.

A third application due out this year targets a complex component installed at many plants: the ABB K-Line Circuit Breaker. This breaker contains more than 1500 parts that need to be assembled in the proper sequence and orientation in order to operate correctly. The application is being developed using subject matter experts so that their knowledge can be conveyed to the next generation of electricians.

A fourth application will capture the hands-on experience provided through the Terry Turbine workshops that NMAC has presented for many years. This app will illustrate the range of common maintenance activities associated with Terry Turbines, including the proper disassembly and reassembly of the turbine. The application also enables users to see the interaction of the complex parts, which supports troubleshooting.

Contact: Rick Way, telephone: (704) 595-2679, email: rway@epri.com.

NDE Techniques

Many plants around the world have begun moving used nuclear fuel into dry storage facilities as their pools near capacity. This transfer is most pronounced in the United States, where almost 2000 dry storage canisters are in use today, com-

prising several canister designs. Recent studies have indicated that canisters may be susceptible to chloride-induced stress corrosion cracking (CISCC), particularly those located in marine environments. Other degradation mechanisms such as general corrosion are also possible though considered less likely.

Nondestructive inspection of these dry storage canisters for the presence of stress corrosion cracking and other potential degradation would advance understanding of these phenomena. The limited access around the canisters, however, presents a challenging inspection environment due to high surface temperatures and radiation fields.

EPRI has developed a four-step approach to address this challenge. First, EPRI is leading collaborations among multiple universities, vendors, utilities, and national laboratories to coordinate research and planning. Second, EPRI is creating representative mockups of the canister designs of interest with embedded flaws to test nondestructive evaluation (NDE) techniques. Third, EPRI is identifying promising NDE technologies that can inspect dry storage canisters for the degradation mechanisms of concern. Finally, EPRI is investigating robotic delivery systems that could support in-situ inspections of the dry storage canister systems of interest. The end goal is to deploy NDE technologies to inspect a canister by the end of 2017.

EPRI has already teamed with vendors and utilities to perform surface inspections of canisters at three sites and is using lessons learned from this experience to inform ongoing efforts. The EPRI Report, Calvert Cliffs Stainless Steel Dry Storage Canister Inspection (1025209), describes a number of inspections performed on a dry storage system. Additional information is contained in EPRI Report 1022916 and on the NRC's ADAMS website.

Contact: Jeremy Renshaw, telephone: (704) 595-2501, email: schu@epri.com.

Nano-Sensor

Solid-state nano-sensing technology offers near-term potential for achieving a 20% reduction in existing equipment requirements for remote detection and monitoring of hydrogen in nuclear plant containment structures. EPRI is also investigating a self-powered hydrogen sensor that could withstand severe loss-of-coolant accident (LOCA) conditions inside containment.

Early detection of significant hydrogen generation during an accident scenario would provide invaluable guidance to plant operators regarding the optimal course of action for minimizing the release of radioactivity to the environment. Current hydrogen monitors require significant auxiliary infrastructure because the analyzer elements are outside containment. EPRI began exploring novel hydrogen sensing technologies and energy harvesting concepts in 2012, with the stretch goal of developing a low power, accurate hydrogen sensor suitable for continuous, self-powered operation in containment.

Through scouting efforts, two technologies were selected as the most promising for powering in-containment sensors: radiation (beta-voltaic) and thermal (thermoelectric) energy harvesting (EPRI Report 3002002107). In follow-on work, EPRI is pursuing near-term nuclear plant application of a nanostructure-based sensor fabricated from ceramic semiconductors and designed specifically for severe environments. Researchers have demonstrated accurate hydrogen sensing in conditions simulating normal operations and LOCA conditions in laboratory testing of a purpose-built prototype. This sensor initially is being designed for direct replacement of existing sensors in installed hydrogen monitoring systems. However, its lower power requirements and ability to withstand extreme environments indicate promise for future development as a self-powered sensor (EPRI Report 3002002881).

By eliminating the need for multiple flow meters, pressure regulators, and associated components, the solid-state nano-sensor could reduce equipment requirements by about 20%, and also reduce maintenance and calibration labor.

Contact: Jeff Greene, telephone: (704) 595-2666, email: jgreene@epri.com.

Source: Electric Power Research Institute's (EPRI) Nuclear Executive Update, May 2014. ■

A Closer Look on US Policy

By Danny Roderick, Westinghouse Electric Company.

Danny Roderick

Danny Roderick joined Westinghouse Electric Company as president and chief executive officer on Sept. 26, 2012. He joined Westinghouse with more than 30 years of proven performance within the nuclear industry.

Before his Westinghouse appointment, Mr. Roderick was senior vice president, Nuclear Plant Projects, with GE-Hitachi (GEH) Nuclear Energy, where he managed all facets of new and existing nuclear plant projects. Mr. Roderick also was site operations director and plant general manager at Progress Energy's Crystal River Nuclear Plant. As the company's vice president of Nuclear Projects and Construction, he also managed a multibillion-dollar new-nuclear expansion program.

Mr. Roderick has a bachelor's degree from Lake Erie College and a master's degree in Operations Management from the University of Arkansas.

An interview by Newal Agnihotri, Editor of Nuclear Plant Journal at the Nuclear Energy Assembly in Scottsdale, Arizona on May 20, 2014.

1. *What were the most exciting projects in the last one year?*

This has been a really good year for Westinghouse from a couple of perspectives, and the most exciting was setting the modules and moving the AP1000® nuclear plant projects forward. The really large CA20 modules were set at Vogtle and V.C. Summer, and those plants are coming out of the ground.

We continued growing our nuclear fuel business. We created a lot of new strategic relationships, including selling in the Ukraine, a traditionally Russian market. We have also entered into an agreement with the Ontario Power Generation (OPG) to access the CANDU market. The teaming of the intellectual property of OPG and the service deployment model of Westinghouse opens an exciting new market for us.

2. *Could you put a spotlight on the status of your Bulgaria, UK and Canada projects?*

Bulgaria evaluated all of the technologies available today and reached a conclusion that they would like to eventually build a fleet of AP1000 nuclear plants to handle their in-country energy needs and possibly generate electricity for export. Since selecting Westinghouse's technology, we have been able to work closely with the Bulgarian government, moving forward into an engineering and equipment procurement type of contract. Later this year, we hope to bid out the construction part of the Bulgaria project. I think it is really important for that region to have a strong U.S. presence and to have good commitment ties between a U.S. company like Westinghouse and Bulgaria.

Primarily the contract toward which we are working with Bulgaria will encompass engineering, equipment and procurement (EEP). When it's all said and done, it will be an engineering, procurement and construction (EPC) contract.

The U.K. NuGen project is an opportunity that differs from the Bulgaria project in that it is a joint venture between GDF SUEZ and Toshiba. Westinghouse will be an EPC contractor to that consortium of 60 percent Toshiba and 40 percent GDF SUEZ. That ownership structure will change when the project enters the operational phase, at which time GDF SUEZ will take a larger share. Throughout the negotiations, we have learned much about the needs of GDF SUEZ and Toshiba, and how we can help them in the U.K. market. The land option agreement has been made with the U.K. government, and the shareholder agreement has been finalized between GDF SUEZ and Toshiba.

Westinghouse has a significant portion of the existing pressurized water reactor market. We also continue to grow our boiling water reactor market share. We took a hard look at potential growth areas in relation to our deployment models. One market that we thought was underserviced was the Canadian CANDU reactors. We needed more design information about the Canadian reactors. Ontario Power Generation (OPG) has all of that information. OPG was seeking a more global export impact. It made good business sense to combine Westinghouse's delivery model, global export experience and extensive global deployment model for nuclear energy products and services with OPG's intellectual property in order to join together to export services for the CANDU units.

In addition, we also have common interest in new build projects. OPG has expressed interest in increasing their project management expertise by working with Westinghouse. We are working on several fronts that could pull in OPG expertise, including new units, the nuclear services business supporting operating plants and also plant decommissioning. We think we can add significant value to the marketplace teaming with Ontario Power Generation.

3. *Is Westinghouse considering selling fuel in the VVER (Russian) territory?*

The Russian market is absolutely closed to the rest of the world. Westinghouse offers healthy competition in markets outside of Russia where VVER units are installed. It isn't an East versus West comparison. It's a market that has no competition right now. We think such competition will help lower the cost of fuel and encourage better fuel designs going forward. The Russians are allowed to sell uranium into the United States, but the U.S. nuclear industry is not allowed to sell anything into Russia. Where we can and where it makes sense, we would like to open up competition for nuclear fuel. It is not a threatening situation. It simply is good business in a global economy, just like

competitive bidding on uranium sales into the U.S. Russia competitively bids and can win in an open market. Similarly, the sale of nuclear fuel should be an open market for countries that so choose.

4. *What is your vision for Westinghouse for the next 5-10 years?*

I hope that we continue to evolve into a more global company. My vision is to evolve Westinghouse from a Pittsburgh-based company that sells globally to a global company that is headquartered in Pittsburgh. This is really an important transition for this company. We love the U.S. nuclear market - don't get me wrong. It is an absolute priority for us. We need it. We're going to service it. But because of the U.S. market, we are able to innovate and expand our new technologies to the rest of the world.

In the next 10 years, I want to see our accident-tolerant fuel come to fruition. It is a game changer. The prospect of finding models that work with ceramics, for example, will enable us to change the concept of a core damage frequency. Those are the operational things I want to see occur. What I really want Westinghouse to do is to continually evolve as a truly global company that has the highest safety standards, the highest business ethics and the best technology.

5. *What would you like to see the U.S. government and Exim Bank and other similar organizations do to promote export of Westinghouse to other countries?*

I think there are two parts to the importance of the future of the nuclear energy. We have to start building nuclear plants again here in the United States on a much grander scale.

We are fast approaching an energy cliff in this country - and it has the potential for a far bigger impact than any recent financial cliff.

Although the current U.S. nuclear fleet is robust, we face an aging infrastructure. Coal plants face a similarly aging infrastructure. Neither has enough new construction to offset the rate at which the aging plants reach the end of their lifecycle.

If the plants are not replaced, we will be forced into gas and other sources, creating a huge volatility in the price of gas. You just cannot make enough gas.

Every time that I hear about a new hundred-year supply of gas, 10 years later it's gone. Where did it go? Just this year in shale, gas was trading for $4 to $5 in Pennsylvania, and it was $90 in New York City. They're not that far apart geographically. Gas always will be volatile as long as its demand is drawn upon on a regular basis.

If we do not build new nuclear units, the demand for gas will go high, followed by that high price. This will drive us right back where we were in the 1980s with gas that we cannot afford because the demand is so high. Additionally, pipes are not in place that can transport the gas.

In contrast, consider an AP1000 nuclear plant that creates an infrastructure that offsets the same amount of gas as that of the state of Maine. The AP1000 plant provides a readily available supply of safe, clean, abundant and affordable energy that is scalable to meet long-term demand.

I think the U.S. must address its need for a meaningful energy policy so that this country can remain an exporter. In 20 to 25 years, we are going to face that energy cliff. We need to begin building new nuclear in the next five to 10 years. I think that it is important for the government and policy space to take a really hard look at the mix of energy that's going to happen if we do nothing.

Over the next 10 or 15 years, we're going to be forced to a mix of energy that is so volatile, our manufacturing will not be able to afford it.

In a global perspective, I really believe it is so important that we recognize that countries today are going to get nuclear energy from somebody - from Russia, France or another source - whether or not the U.S. government likes it.

One example is when France's government permitted entrance into markets that the U.S. government would not permit Westinghouse to enter. The differing rules lead to a playing field that is not level.

In reference to U.S. 123 Agreements which set proliferation rules, the question we in the U.S. need to ask is whether we want some control over what happens when a country chooses nuclear technology. I liken our current situation to the story of Rip Van Winkle, in that some of our politicians believe we are still in the 1970s when only U.S. companies offered nuclear technology. That time is long gone. Today, it is a global nuclear market.

A country has a choice of the source of its nuclear technology. If that choice is not from the U.S., then there is no control over what happens with that technology. It is so important that we look seriously at 123 Agreements to allow the U.S. government to influence the use of nuclear technology toward creating greenhouse-gas-free electricity.

6. *Will the 123 Agreements help the US vendors to sell to other countries?*

U.S. 123 Agreements must be in place for the U.S. to even enter global markets. The other part of the equation is financing. The U.S. Export-Import Bank is the export credit agency that helps American companies compete with government-supported competitors worldwide. Without it, U.S.-based companies like Westinghouse are severely disadvantaged from tapping into emerging economies around the world.

7. *Please share any concluding remarks.*

My view on Westinghouse and nuclear energy is that we are at a very critical time. We are breaking into new markets. We are continuing to grow and expand. The new plant business is growing globally. And Westinghouse is going to start hiring again this year to support that growth.

Overall, we have weathered what I would call the big storm. We still have some small storms that we are going through. But I really see that, as an organization, and really as an industry, we are getting into that global cusp.

We have a tremendous amount of political and educational work to do in the United States, and we are actively moving in that direction.

It is critical that the U.S. understand the need for a responsible baseload generation and how nuclear must be a part of the overall energy mix. Otherwise, we risk walking off of the same cliff as Germany, which overbuilt renewables and now faces an energy crisis. Nuclear needs to be 20 to 30 percent of the U.S. energy mix. If we do not get policy into place that helps us prepare and move this country forward, then we are going to be in a position from which we cannot escape, including the loss of industry to other countries. The U.S. is a great place for industry - for the nuclear energy industry in particular. Westinghouse, in its role as the global technology leader in the nuclear energy industry, can support the country's export needs, as well as help meet the county's own needs for safe, affordable and reliable energy.

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Cutting Edge Technology

By Jay Wileman, GE Hitachi Nuclear Energy.

Jay Wileman

Jay Wileman serves as Senior Vice President. Nuclear Plant Projects and Chief Operating Officer, GE Hitachi Nuclear Energy, a position he assumed at the end of 2012.

Jay most recently led GE Energy's efforts across Sub-Saharan Africa, serving as its President, since 2009. He led the team that provides integrated product and service solutions that meet Africa's needs in oil, natural gas, power generation, water, renewables and new grid modernization.

A seasoned executive with more than 25 years' experience, he has a wealth of international knowledge, having led a great number of global teams to success across the energy spectrum while on assignment.

Jay received his Bachelor of Science in Nuclear Engineering from Mississippi State University and his Master's Degree in Business Administration from the University of Alabama in Birmingham.

An interview by Newal Agnihotri, Editor of Nuclear Plant Journal, at Nuclear Energy Institute's Nuclear Energy Assembly in Scottsdale, Arizona on May 21, 2014.

1. What are the highlights of GE Hitachi Nuclear Energy activities in the past one year?

2013 was an exciting year. And we built quite a bit of momentum in a number of areas. 2013 started off with a great announcement that we were able to make in April regarding the ESBWR and the Dominion project. We announced in April jointly together that for North Anna 3 site, they'd selected the ESBWR technology. That's our Generation 3+ passive safety, natural circulation design. We started working on the specific application of that technology to the North Anna site as a joint team, along with our consortia partner. So, we are excited about an opportunity to bring that technology into the US and to move forward with that, should they choose to do the North Anna 3 project.

Throughout the year, we worked hard with the UK's Nuclear Decommissioning Authority for their plutonium disposition, which they've deemed as a national priority.

In January 2014, following a two-year review process, the NDA declared that PRISM's fourth generation nuclear power technology is a "credible option" for managing the UK's plutonium stockpile. We continue to work with the NDA to further develop their understanding of the technology as a credible option.

We were selected by the Department of Energy for our GLE, Global Laser Enrichment technology for exclusive negotiations of a potential contract to acquire depleted uranium waste and re-enrich it up to a natural uranium state to put back into the market.

Regarding the Design Control Document (DCD) for ESBWR (design certification application review) we were working through with the NRC last year to resolve some of the final open items on the steam dryer area. And so, we answered all their questions submitted in December 2013, and we're currently in rulemaking process. And so, we think that's a very important next milestone to completing the DCD, and we're looking forward to that being completed (achieving certification of the reactor's design) later in 2014.

2. *When do you expect the design criteria to be approved?*

The public comment period closes on the 5th of June 2014, and we would hope that it would get to the commissioner's desk very shortly after that. (Current Update: The comment period closed June 5, 2014 with no comments submitted).

Two of our customers submitted their Combined Operating License Application (COLA). DTE submitted last year, and then Dominion submitted, for the North Anna site, in December 2013. And so, they're going through their review process with the NRC, based on the ESBWR technology.

We just have a consortium. Our customer Dominion, and then the consortia parties, which are ourselves and Fluor Daniel. Fluor has a long experience of nuclear energy, and we work well with them across all of GE in many different technologies.

3. *What is the current status of ABWR technology?*

So, let's talk about the ABWR or Advanced Boiling Water Reactor. That's a good topic for the other technology platform that we have. There are currently four ABWRs in the World. It's the only generation 3 reactor with operational experience as of this time. Kashiwazaki 6 and 7 were the first two. Then we had two others operating in Japan, and then there are four under construction, two more in Japan and then two in Taiwan with the Lungmen project. So, the ABWR is very well proven as a great design. One other thing I should mention is Hitachi, our JV partner, purchased the Horizon project in the UK. Horizon, with the help of HGNE (Hitachi-GE Nuclear Energy) our JV partner, is going through the GDA (Generic Design Assessment) process, which for their licensing steps are the steps that they go through over three or four years. So, they're in step two right now, and of course GE Hitachi is helping them with the UK's Office of

Nuclear Regulation as well. (The Generic Design Assessment is the process through which UK nuclear regulators assess the potential suitability of a nuclear reactor design for development in the country).

4. *Are there any updates in the fuel business?*

We continue to invest in the fuel technology. Last year we had, with our BWR fuel technology, the lowest fuel leaker rate in the industry by far. So, we're very proud of being able to support our customers from that perspective, but you can't stop. So, we are now coming out with GNF 3, a new design.

We've got the debris filter at the bottom of the fuel bundle; we've got the debris filter itself. We also have just installed at Forsmark Nuclear Power Plant in Forsmark, Sweden the feedwater debris strainer as well in the feedwater system, so you don't allow any debris to come into the reactor at all.

We've been working on laser technology for the past few years. We received an NRC license for a potential Wilmington commercial facility. This is the same technology that could be applied to the depleted uranium tails in Paducah that I was talking about earlier to take those depleted uranium tails and enrich them back to natural uranium levels.

5. *How do you think the United States should handle their fuel? Including recycling?*

It's a political issue. And you know, there's a lot of dynamics behind that, but it will take political will. It will take the public understanding that geologic disposal is a safe way to go. But that's the path we've been on. I personally would take another path. I view the used nuclear fuel that we would put in a geological repository as an asset, not as waste. So, I think we're just thinking about it incorrectly. That still has 95% of the energy potential in those fuel bundles? And that's what PRISM's all about, is the ability to take that out, extract it, recycle it, and take almost all of that energy out of there. And instead of taking it, a fuel bundle, and putting it in Yucca Mountain or somewhere else, where the long-lived isotopes are around for about 300,000 years, or if you're doing the MOX solution and you've got that waste stream, that's probably 10,000 years, a little easier to understand than 300,000, but 10,000's still a long time, versus when you go into a PRISM solution, a sodium cooled fast reactor, and you completely recycle the plutonium, uranium and all those actinides that have the energy in there, the waste stream is only 300 years to get down to natural uranium.

After you recycle thoroughly through PRISM technology, you extract all that energy. So to me, I'm a big advocate of really thinking through the value of that fuel that we're putting into a repository. You know, but there are many ways to do this as well. You could have a hybrid solution, where we're talking about consolidated interim storage. I think Texas, Mississippi and New Mexico are having a public dialogue around that. Why couldn't you have a solution where you would consolidate from all the plants to one of these two or three sites with a PRISM technology installed there? And then whatever waste stream that I mentioned that there is, very, very much reduced, only have to worry about it, if you will, from a 300-year perspective.

We certainly have the technology. It's really a matter of, again, of policy and moving forward with the politics.

6. *What countries are working with GE right now?*

I just spent time in Poland just last month. Poland has been having their discussion around their energy strategy. They were talking about nuclear being the first project for them. They were talking about the viability of shale gas as well. And I think they've decided and announced just recently that they are going to proceed with the nuclear part of their energy mix. So, I'm very excited about that. I think our technology would fit fantastically for that country, both our ABWR as well as our ESBWR, and we're really happy to support them in moving that project forward.

We've had great visits from the Vietnamese delegation, and they're very excited about our passive safety system in the ESBWR. They've announced in Mexico a Laguna Verde extension. We've had our two BWRs that are operating just fantastically with CFE (Comisión Federal de Electricidad, operator of the Laguna Verde Nuclear Power Plant in Veracruz, Mexico), a great customer and a great partner of ours. And so, we are continuing to speak with them.

Last year during our interview, we talked about Saudi Arabia, and that's almost 18 gigawatts of power. That continues to go slow. I think they have a social discussion going on there as well. I visited late last year, just before WNA Conference, to talk to KA-CARE and get a good feeling for their vision. Again, that continues to move slower than you might hope, but certainly that gets a lot of people's attention with 18 gigawatts announced.

7. *What is the major technology of interest for research and development at GE or at GE Hitachi Nuclear Energy?*

If I think about the next steps of nuclear technology, I would say it all has to start with safety. So, for the ESBWR, for example, the newest technology out there, having those passive safety systems that rely on gravity, evaporation, condensation, physical things that happen without a pump, a pipe, a valve and an actuator is a very good thing. And being able to get that, that technology in place is really important. That's the first part.

The next is simplification. Sometimes the best technology is making things simpler, not more complex. So, that helps our customers with lower capital costs. It helps with a better O&M, operation and maintenance cost.

Going a little deeper, the new control systems and the control rooms, are now all digital. Everything else used to be you had to string a wire. You had analog signals for control. So now, the ability to have digital data, clearly that brings you into the world of thinking about cyber security, of course. As we've seen, it's a very, very hot topic out there. But nonetheless, there are ways to be able to have that built into the system to keep it very secure. But it gives you great opportunities to give the operators the information they need to run that plant very efficiently. In the area of information, this is a huge area for us.

It's kind of like the old versions of the car that had a red light after it was too late. The newer versions actually have gauges that tell you your oil pressure's going down? And so, a little bit of a heads up.

(Continued on page 39)

American Crane & Equipment Corporation

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Committed to Nuclear Energy's Future

By Kimberly Clark, AREVA Inc.

Kimberly Clark

Kimberly Clark serves as Chief Commercial Officer of AREVA Inc. Appointed to this position in June 2014, Clark is responsible for all customer-facing activities for AREVA in North America and reports to Gary Mignogna, Chief Executive Officer of AREVA Inc.

Prior to this appointment, Clark served as VP Customer Relations & Chief Marketing Officer of AREVA Inc., where she was responsible for customer relations and the integrated commercial activities for the entire AREVA product and services line. She ensured that customer relationship management, commercial strategy, order development, and customer satisfaction were aligned to meet corporate goals.

Clark holds a bachelor's degree in Chemical Engineering from North Carolina State University and is Lean Six Sigma Green Belt certified.

An interview by Newal Agnihotri, Editor of Nuclear Plant Journal, at Nuclear Energy Institute's Nuclear Energy Assembly in Scottsdale, Arizona on May 21, 2014.

1. *How is AREVA preparing itself for new younger generation trade workers and engineers?*

We focus heavily on outreach related to science, technology, engineering and math (STEM) by partnering with universities, high schools and elementary schools to pique students' interest early about electricity, clean energy and nuclear power. We also attract emerging talent to the industry by offering dynamic, hands-on internships as a way to expose students to the industry and to cultivate them as future hires. We have a three-year rotational program called the Voyager Program, which is geared primarily toward attracting and retaining engineering talent. A Voyager participant gains in-depth technical knowledge by exploring different business groups, processes, products and cultures at AREVA.

We spend a lot of time recruiting military veterans because military training and experience transfers well to the nuclear energy industry. In fact, over 10 percent of our employees are military veterans. We also sponsor technical training and tradesperson programs at the Central Virginia Community College in Lynchburg, Va. For example, if a high school graduate, college student or employee wants to learn how to weld, work on pumps and motors or perform refueling services, AREVA will sponsor that person so they can complete the three-year program needed to obtain certification in Nuclear Support Technologies.

We also offer a "high-stakes field leadership" training program designed to cultivate strong field leaders, qualified to deploy to customer sites, ready to lead based on our four pillars of operational excellence – safety, quality, delivery, and performance. This training has been tailored after some of our utility customers' programs to ensure alignment with our customers' expectations.

Through our Resident Engineer Program, we've identified new opportunities to help our customers keep up with changes that are affecting their plants, particularly with the changing regulatory environment. By deploying engineers to customer sites for six months, a year or however long is necessary, they become a key resource in the customer's organization. These engineers are well versed in AREVA's capabilities and can identify valuable products and services as they learn about the customer's emerging needs and challenges. The engineer is an extension of AREVA—right there in the thick of it, a few steps down the hall or in meetings, helping the customer address both short-term and long-term issues and challenges. It's beneficial to have a resident engineer on site who understands all of our capabilities, so that when they hear of the issue, they can say: "We have experience in Germany, France and Asia, and have addressed this issue at another customer's plant in the United States. Would you like us to take a closer look into that for you?" Usually the utility's response is yes because it expands their network beyond their site or fleet or even the U.S. industry. It brings global experience and that's the advantage that the resident engineer brings to the customer—relative operating experiences and lessons learned, innovative solutions and expertise, and the ability to tap into vast networks.

2. *Has the regulatory oversight increased due to post Fukushima requirements?*

There are a number of new requirements and striking the right balance between addressing these new regulations and maintaining current safe plant operations is a major task for utilities. Our goal is to help them accomplish this with a cost-effective, efficient, coordinated and planned approach. We plan it, stage it and help the utility implement the requirements on a schedule that makes sense for each individual plant. That way, they are complying with regulations, continuing safe operations and managing the plant fiscally.

We have to be mindful of the economics. The market and grid dynamics right now are such that there is a question as to whether some plants will continue to operate after 2014. For some plants, if the utility tries to do everything at once, it could cause the plant to shut down or threaten the overall health of the utility.

We also pay the utmost attention to the assumptions we make when preforming analyses, say for flooding and seismic. Invalid assumptions may call for unnecessary plant modifications. As a result, it is important that we are critical of our assumptions and use conservative decision making as we address these new regulations. Our job is to help our customers invest their money wisely.

3. *Provide an overview of AREVA's global business?*

Last year, we launched the commercial production of Georges Besse II, an enrichment facility in France. The facility is in operation and we are gradually ramping up production between now and 2016.

We are constructing multiple EPR™ reactors in Europe and Asia. For example, Taishan 1 and 2 are being constructed in China. November 2013, AREVA completed the fuel assembly fabrication and installed the first high-voltage 10 kilovolt switchgear in the electrical building for Taishan 1. We're also in discussions for additional reactors in China.

Under our AREVA Med subsidiary, we opened the Maurice Tubiana Facility located in the Limousin region of France in November 2013. After receiving the administrative authorizations and completing the prerequisite technical testing, the new facility started production to extract and to purify lead-212 (^{212}Pb) for fighting cancer. The story behind that venture is amazing and one of our most successful business incubator projects. We just recently expanded the Phase 1 clinical trial in the United States through collaboration with the University of California, San Diego's Moores Cancer Center.

In January 2014, we installed the reactor pressure vessel at the Flamanville 3 site in France, which is coming along quite well. We are finishing the Olkiluoto 3 instrumentation and controls (I&C) in Finland and look forward to having it online very soon.

Alongside these major construction projects, the EPR™ and ATMEA™ are being competitively bid globally with great traction. AREVA passed a decisive step for the sale of two EPR™ reactors at Hinkley Point in the United Kingdom, in addition to supplying the nuclear steam supply system, digital I&C and fuel over an extended period.

As for recycling, the only operating facilities are currently located in France, but there is one under construction in Japan. There is discussion to build a recycling facility in China, but nothing is final there yet.

4. *Does AREVA have any contracts for technology transfer after the new plants are built?*

As the four EPR™ reactors we are currently building will demonstrate, we developed the optimal Generation III+ pressurized water reactor design, keeping in mind safety, sustainability, performance and competitiveness. We expect to build more EPR™ reactors globally and remain fully committed to completing the U.S. EPR™ license as well.

Through our Safety Alliance Program, we collaborate with utilities worldwide to help them demonstrate or upgrade the safety of their existing plants. The comprehensive range of products, services and solutions we offer help them meet ever-increasing safety requirements and achieve the three main safety imperatives: resistance to major hazards, robustness of cooling capability and prevention of environmental damage. As of 2012, we've launched more than 30 Safety Alliance projects in 11 countries.

5. *Concluding comments?*

We must ensure that nuclear energy is a viable source of electricity well into the future for a number of reasons. The current economics related to nuclear power operations are being challenged in many markets by subsidized forms of energy. We must find a way to place a value on the ancillary benefits of nuclear in order to level the field. Not only is nuclear power a safe, carbon-free, stable and reliable energy source but benefits such as grid stability and on-site fuel storage offer advantages to the grid structure. At AREVA, we are working hard to raise awareness of the expansive benefits of nuclear energy. For instance, last year in the United States, nuclear energy provided 63 percent of carbon-free electricity and 19 percent of the overall electricity supply, and prevented 589 million metric tons of carbon dioxide. To put this into perspective, the amount of carbon dioxide prevented by nuclear power plants is equal to the amount of carbon dioxide emitted by 113 million passenger cars. Without nuclear energy, carbon emissions from the U.S. electric sector would be approximately 25 percent higher.

Our goal is to help our customers' existing fleets become even more reliable, improve their capacity factors while reducing operating costs, and enable them to operate safely and efficiently beyond 60 years. This past winter was particularly severe in many parts of the country, but nuclear energy facilities performed well and continue to be the premier clean, base-load electricity provider.

Our nation's nuclear energy plants are vital national assets that provide reliable, carbon-free electricity to tens of millions of households and businesses around the country. Therefore, we need to make sure that nuclear energy continues to be a major source of electricity well into the future. Nuclear energy matters. It is a safe and stable investment, and it's the right choice for North America as part of a diverse energy mix. At AREVA, our slogan is "forward-looking energy." What that means is it's our mission to educate our stakeholders, to promote nuclear energy's contributions and benefits, and to help our utility customers stay competitive, safe and reliable, so they can continue to provide clean air nuclear energy.

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U.S. Export

By Ron Kirk,Clean and Safe Energy Coalition.

Ron Kirk

Ambassador Ron Kirk is co-chair of the Clean and Safe Energy (CASEnergy) Coalition. He most recently served in the cabinet of President Barack Obama as his U.S. Trade Ambassador, the President's principal trade advisor, negotiator, and spokesperson on trade issues. Ambassador Kirk also served two terms as the mayor of Dallas. A native Texan, Ambassador Kirk graduated from Austin College and earned a law degree at the University of Texas School of Law.

Responses to questions by Newal Agnihotri, Editor of Nuclear Plant Journal.

1. *How does the United States plan to take advantage of the existing global export opportunity for nuclear energy related products and services?*

As other countries recognize the strengths of clean-air nuclear energy for their efforts to curb carbon emissions, the number of nuclear facilities under construction around the world continues to increase, creating a range of export opportunities for the U.S.

The economic benefits of peaceful nuclear trade are substantial – right now, there are 72 new nuclear energy facilities under construction around the world – with another 170 in the licensing or advanced planning stages. The fastest region of growth is in Asia – with 28 facilities currently under construction in China. American technology designs and experience will be indispensable to these efforts. Four Westinghouse AP1000 power plants are currently under construction in China and Westinghouse is in talks with Chinese authorities to sell up to eight additional plants.

The U.S. Department of Commerce estimates the broader international market for equipment and services at $500 billion to $740 billion over the next 10 years, and that every $1 billion of exports by U.S. companies supports 5,000 to 10,000 domestic jobs. But the opportunities it provides to strengthen the nonproliferation regime and enhance international nuclear safety practices are just as compelling.

Unfortunately, there are some unnecessary impediments to exporting nuclear energy technology and materials to other countries. Some nations that are developing new peaceful nuclear programs do not yet have in place a U.S. agreement for nuclear energy cooperation – a prerequisite for trade. Without these so-called "Section 123" agreements in place, markets in these countries are closed to American suppliers.

2. *What are the current efforts in place to simplify the export licensing for nuclear energy related products and services?*

The regulations governing the export of nuclear energy technology have not been substantially updated in almost three decades. The Energy Department is currently updating these regulations but more must be done to ensure that U.S. licensing requirements do not divert international business to non-U.S. competitors. For example, for major markets such as China, the United States should find a way to expedite the government-to-government assurances needed to facilitate export.

3. *Is there a "one stop" licensing procedure to expedite the export licensing for nuclear energy products and services?*

One of the reasons the U.S. licensing regime is so complex is because responsibility is divided between three departments and agencies. The NRC licenses the export of nuclear equipment and material. But typically years before, a nuclear supplier must obtain a license from the Energy Department to export the underlying technology. If the technology is dual-use for nuclear and non-nuclear applications, then they must obtain an additional export license from the Commerce Department.

4. *How does Ex-Im bank help the vendors interested in exporting their products and services overseas?*

The Export-Import Bank of the United States (Ex-Im Bank) is one of the country's most important tools to increase exports and create jobs. The Ex-Im Bank provides direct financing, loan guarantees and other products for billions in U.S. exports, which support thousands of U.S. jobs in the challenging environment of international sales. And, the Ex-Im Bank does not cost taxpayers; it actually returns money to the Treasury.

5. *What is being done to encourage vendors, who are apprehensive of the export regulations, to get interested in export?*

There are those within the industry who would certainly say that U.S. nuclear suppliers bear a disadvantage

(Continued on page 38)

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SNS is located in West Columbia, South Carolina and has access to over 500 professional staff which is dedicated to products and services supporting the nuclear industry to meet the demands of the US based fleet. Siempelkamp's excellent reputation is not only owed to the product range, but also to staff. With their high level of specification, SNS develops solutions of the highest level worldwide which satisfy all technical and economic quality standards. The company places great emphasis on the continuous further qualification of its specialists in order to maintain all performances at the highest level.

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U.S. Export...

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against some international competitors, most of which are state-owned and receive various forms of state subsidies. Although the private-sector U.S. nuclear industry has a different model, industry experts believe that better coordination of federal trade promotion activities would make a significant difference in the competitiveness of U.S. exports.

6. *Is there an effort in place to keep our prices for products and services for the nuclear power industry competitive for the export?*

The best thing the U.S. has going for it is the endorsement that comes with the U.S. brand. Our industry, our education system, and even our thorough oversight and regulation all make U.S. technologies, like nuclear energy technologies, the envy of the world. International customers want to partner with the United States. They want to gain the United States' world-leading advanced reactor technologies and unmatched operational expertise. In order to compete and win on price, U.S. nuclear vendors just need a level playing field.

7. *What type of mentoring is available to assist the vendors interested in export?*

The International Trade Administration of the Department of Commerce has published an Exporter's Guide to the international nuclear energy market, and it leads regular trade missions for suppliers in the energy sector. Additionally, groups like the Nuclear Energy Institute work on issues of concern to nuclear energy suppliers, regularly host international nuclear energy conferences and events, and often sponsor nuclear trade missions.

8. *The French government has an exemplary model for promoting export to other countries. Initiatives include taking delegations with the government visits overseas and holding high-level conferences, where bilateral meetings are facilitated between senior government executives and between vendor representatives. Are there similar efforts in place in the United States?*

Last year, the Department of Commerce took a nuclear energy trade mission to Vietnam and China and a second mission to Saudi Arabia. In addition, the Nuclear Energy Institute and the U.S.-India Business Council recently sponsored a nuclear trade mission to India.

9. *What's the relationship between energy and "national security"?*

There are many aspects to our national security – for instance, energy security and economic security. Domestic resources like nuclear produce a steady, affordable supply of electricity, reducing our dependence on foreign sources. These benefits mean that we can count on nuclear energy when our demand for electricity is high – and long-term price stability for nuclear fuel means consumers and businesses avoid devastating price spikes during peak demand. Additionally, U.S. nuclear energy exports can help to promote U.S. influence on global standards for nuclear safety, security and nonproliferation.

10. *What is the mission of CAS Energy?*

The CASEnergy Coalition helps to advance the national dialogue about our country's energy options, focusing on the value that nuclear energy brings to the table. By driving an informed discussion on the benefits of nuclear energy, we are helping more and more supporters of nuclear energy, including many unlikely supporters like environmentalists, make their voices heard. The Coalition takes pride in the diversity of its membership and membership is open for anyone who supports nuclear energy. I'd encourage anyone interested in more information to visit our website at www.CleanSafeEnergy.org.

11. *Concluding remarks.*

The rest of the world wants what we have in the U.S. – a reliable, affordable, and clean source of electricity. All too often we take it for granted that when we flip a switch, the lights will come on – that's what the rest of the world wants in order to grow and power their economies. If we can improve our system for exporting peaceful nuclear energy technologies, we can grow our economy here at home, increase our global competitiveness, and help to make sure more countries have clean-air electric energy. In my time as U.S. Trade Representative, and now as co-chair of the CASEnergy Coalition, I have worked to promote American businesses, products, and people – and I look forward to continuing that good work.

Contact: Clean and Safe Energy Coalition, 607 Fourteenth Street, NW, Suite 300, Washington D.C. 20005; telephone: (202) 338-2273, fax: (202) 337-4320, email: info@casenergy.org. ■

Cutting Edge...

(*Continued from page 29)*

But now the data we've got, we can blend operational data with our design data. So, we're designing something from first principles, and we can bring that into that model and be able to do this predictive type of solutions. So, we can look at pressures and temperatures and operating envelopes and be able to tell where we are relative to our initial designs. And that can certainly be applied to the nuclear industry as well.

8. *Is there an innovation collaboration center at GE?*

Yes. GE is a technology company. So, we continue to do cutting edge technology development. And we have, very close to where Thomas Edison set up the first center in Niskayuna, New York, we have our Global Research Center (GRC).

We have a great research facility that has really cutting edge things in material science, which we use, a lot of in the nuclear team. So, we collaborate with them continuously on all of our technology. And we can take things that we've learned in the aviation business or in the oil and gas business, in materials or performance and bring it right into nuclear or the other way around, what we've learned in nuclear around materials behavior, as an example. When I was in our oil and gas business, the subsea really needed underwater pumps that were not going to fail. So, electromagnetic pumps were a technology they were looking at. We're now taking that, working with our GRC people and applying that to the PRISM technology, which clearly, you want to have nice hermetically sealed pumps. So, there's a lot of collaboration. Having access to Hitachi's construction experience and having access to all that technology is a very unique position for nuclear OEMs, such as GE Hitachi. No other company really has that kind of access to these kinds of capabilities.

Contact: Jon Allen, GE Hitachi Nuclear Energy, telephone: (910) 819-2581, email: jonathan.allen1@ge.com. ■

A Fourth-Generation Technology

By Eric Loewen, GE Hitachi Nuclear Energy.

Eric Loewen

Since 2006, Dr. Loewen has guided GEH's technical efforts for deployment of the PRISM integral fast reactor. His US Navy service included Instructor at Nuclear Power School, and Quality Control Officer and Senior Reactor Operator in USS Long Beach (CGN-9). As Science and Technology Advisor to the Congress and aide to then-Senator Chuck Hagel, he integrated nuclear power into the U.S. Energy Policy Act 2005. From June 2011-June 2012 Eric served as President of the American Nuclear Society (ANS).

Responses to questions by Newal Agnihotri, Editor of Nuclear Plant Journal.

1. *What is the evaluation status of PRISM by NDA?*

PRISM (Power Reactor Inherently Safe Module) is a high energy, sodium-cooled reactor that uses proven, safe and advanced technologies to create an innovative solution to harness the remaining energy potential of used nuclear fuel and surplus plutonium.

In January 2014, following a two-year review process, the UK Nuclear Decommissioning Authority (NDA) declared that PRISM's fourth generation nuclear power technology is a "credible option" for managing the UK's plutonium stockpile.

We continue to work with the NDA to further develop their understanding of the technology as a credible option.

2. *What are the past and current applications of PRISM?*

PRISM is based on the successful EBR II reactor that began operating in 1964. GE started to work on PRISM technology in 1981 and in 1984 the U.S. government, through the U.S. Department of Energy funded the Advanced Liquid Metal Reactor program at the Argonne National Laboratory. The goal of the physicists and engineers who worked on this program was to mitigate concerns associated with nuclear power including waste, economics, proliferation and fuel supply. The 10-year program was unique in that it involved U.S.-owned companies, including GE, all working with the national laboratories to come up with an advanced nuclear reactor design that would lead to a new, safer and more secure approach to nuclear energy. After 30 years of development, the technology utilized by PRISM is ready to be commercialized and can be made operational within a time period that is competitive with other potential plutonium reuse options.

Recycling used nuclear fuel with PRISM is calculated to make approximately 95 percent more energy available from uranium than current conventional reactors. At the same time, extracting this energy makes used nuclear fuel easier to dispose of and safer over the longer term. Finally, PRISM is uniquely suited to the disposition of plutonium stockpiles thereby making the world more secure from nuclear proliferation concerns. A single nuclear power plant technology, PRISM, can concurrently increase the world's supply of low-carbon electricity, address the nuclear waste issue and improve nuclear security.

3. *What are its abilities to be used for (e.g. power generation, hydrogen generation, desalination plant, district heating, any other applications)?*

PRISM is designed to have many applications including plutonium disposition and electricity generation. PRISM has a rated thermal power of 840 MW and an electrical output of 311 MW. Two PRISM reactors make up a power block that combined produce 622 MW of electrical output. Of course low cost electricity opens the door to many other possible applications.

4. *Is there any collaboration with international Gen IV effort?*

GE Hitachi encourages industry involvement of US companies in government-led international programs that promote advanced nuclear technology such as the Gen IV effort.

5. *Has PRISM been proposed for any applications at Fukushima Daiichi nuclear power plant?*

Our joint venture partner Hitachi continues to assist TEPCO. We believe the fuel technologies associated with the PRISM reactor design would be ideal to treat damaged oxide cores initially cooled with seawater by stabilizing the radioactivity in a robust ceramic and metallic waste form.

6. *Who are the vendors collaborating for engineering, construction and manufacturing in the United Kingdom? Who is supplying the digital equipment, including the control room?*

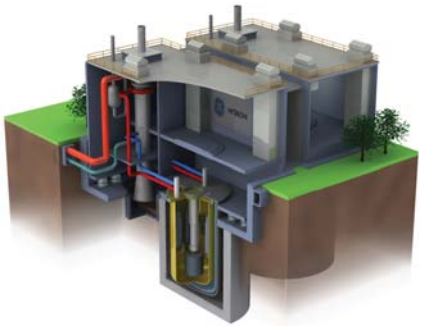
In April 2012 we conducted a supplier conference and met face-to-face with a number of talented and

experienced employees from nuclear sector suppliers at ENERGUS Convention Center in West Cumbria, U. K. We were supported in planning and conducting the conference by Britain's Energy Coast Business Cluster. And we have a Memorandum of Understanding in place with engineering firms Costain, Arup and Pöyry. In addition, we met with several supply chain representatives during an event in November 2011 at the Church House Conference Center in Westminster, London and we have a memorandum of understanding with National Nuclear Laboratory Ltd. (NNL) and the University of Manchester for expert technical input to the deployment of PRISM. We continue to work with potential UK suppliers for the project and are committed to the greatest extent possible to utilizing UK companies and workers for this effort.

7. *What is the planned timeline for design, construction and operation of PRISM in the United Kingdom after receiving the go-ahead?*

While no formal commercial contract arrangements have been developed, we estimate the schedule for the first irradiation of plutonium in a PRISM reactor to be comparable to other options. Licensing is always significant for new nuclear plants because safety is of the utmost importance, but multiple reviews including one performed by the U.S. NRC have concluded that there are no fundamental impediments to PRISM licensing. The technology is proven and PRISM's simplified reactor design should speed construction.

PRISM represents a multi-billion pound investment in the UK, regional and local economy. This will be a much needed boost to the UK business community, particularly as the economy continues to emerge out of recession. Based upon preliminary investment plans and current thinking, it is estimated that the construction of a PRISM reactor could create a peak of several thousand jobs in the local economy, with 900 of these being permanent operational jobs at Sellafield. In addition to jobs directly associated with the project and plant, further jobs would be created in the local economy, for example from suppliers to the plant and in the local retail sector. The engineering and research work to support PRISM will undoubtedly have a direct and significant impact on jobs and skills in West Cumbria, bolstering the UK's nuclear research capability in many areas pre and post-construction phase.



PRISM Cutaway Illustration.

8. *When was the prototype for PRISM tested to ensure its operation after deployment?*

The basis of PRISM technology comes from the 30-year operation of EBR II from 1964-1994. In addition, PRISM leveraged the testing and demonstration done during the Clinch River breeder reactor program from 1972-1983 as well as large component testing during the Advanced Liquid Metal Reactor program from 1984-1994. Many of these tests were done at the U.S. Department of Energy's Energy Technology Engineering Center in California.

9. *How does PRISM coolant temperature compare with ESBWR and an ABWR under normal conditions and under accident conditions?*

The normal operating temperature for sodium cooled reactors is about 500° Celsius whereas the normal operating temperature for water cooled reactors like the ESBWR and ABWR is about 300° Celsius. In addition, PRISM is designed to operate at much lower pressure than either boiling or pressurized water reactors.

10. *Describe the safety aspects of PRISM reactor under a Beyond Design Basis Event.*

Various safety features of the PRISM design are specifically intended to prevent a loss of coolant accident. These safety features make PRISM robust for coping with beyond design basis events. For example, PRISM is the only nuclear facility designed to sit on seismic isolation bearings. The seismic isolation system reduces horizontal seismic accelerations that are transmitted to the reactor module by a factor of three. Another example is that the control room, reactor plant and steam plant are separated and don't impact each other. Yet another example is that PRISM has the ability to remove decay heat passively without any operator action.

In the event of a worst-case-scenario accident, the metallic core is designed to expand as the temperature rises so that its density decreases, thereby slowing the fission reaction. The reactor simply shuts itself down. PRISM's very conductive metal fuel and metal coolant then readily dissipates excess heat without damaging any of its components. Passive safety is a design feature that relies upon the laws of physics, instead of human, electronic or mechanical intervention, to mitigate the risk of an accident.

11. *Describe any other important features.*

The manufacture of PRISM metallic fuel will incorporate more forgiving dimensional tolerances than plutonium oxide fuel. Because PRISM's fuel can accommodate a larger relative proportion of plutonium than other reactor options being considered by the UK, this is highly likely to mean lower fuel manufacturing cost, less fuel handling and less used fuel to dispose. Plant electrical output is designed to permit tailoring to operator needs through the modular addition of power blocks. This modularity is expected to allow expansion from one power block to as many as desired on one side. Factory fabrication of the modules is aimed at providing improved quality, reduced cost and shortened construction times.

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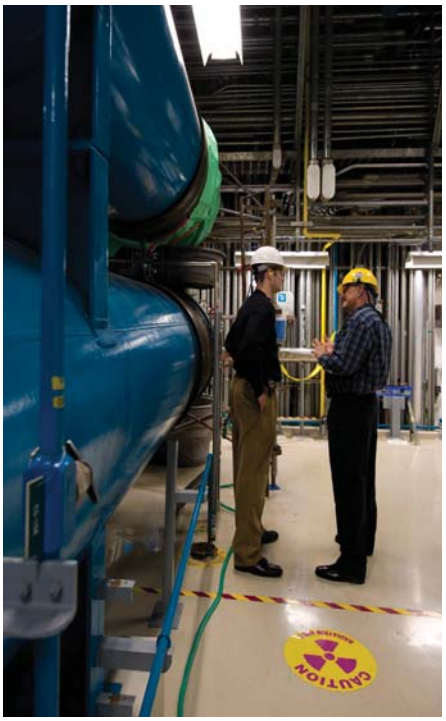
Pathway to Success: How Project Management Can Help Nuclear Power Facilities Succeed



Across the United States nuclear utilities face fierce competition from low cost natural gas and subsidized renewable energy resources. In addition, flat demand growth and marginal electricity prices finds many nuclear utilities with limited capital to address increasing regulatory hurdles and growing project backlogs. The challenges facing the nuclear sector are further compounded by the loss of utility project management expertise due to aging workforces and retirements.

Viewed holistically, the negative impacts caused by the inability to properly manage capital project execution are now challenging the economic viability of some nuclear plants. A robust and rigorous project management process can significantly mitigate these negative impacts, freeing up resources to focus on operations and power generation.

Black & Veatch possesses the experience and required balance of economic and technical understanding to successfully manage large capital projects. With nearly 100 years of managing projects on-schedule and on-budget, our teams of seasoned professionals serve as strategic advisors to utilities while providing a full range of EPC capabilities.

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> **— DEAN OSKVIG, PRESIDENT, BLACK & VEATCH'S ENERGY BUSINESS**

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- Planning projects with the end user in mind
- Use of innovative tools, processes and team work create a culture of project success
- Seamless integration of project controls, project management, engineering management and construction management from project initiation through final acceptance

For nuclear power plant owners, Black & Veatch emphasizes the importance of managing the risks inherent to any project. Developing a fully defined project scope is critical to identifying risks that can ultimately derail a budget and timeline. Based on decades of global experience, Black & Veatch has developed a planning contingency model that considers project specific and systemic risk factors to quantify the uncertainties that remain.

"Calibrated with information gathered across our global footprint, final observed risk factors are often within 2 percent of the projections the model generates for contingency," states Jon Gribble, Nuclear Director. "These same tools can also be applied for utilities that want us to manage projects, thereby creating opportunity for knowledge transfer to their personnel."

In addition to its experienced project professionals, Black & Veatch deploys a robust and rigorous project management approach necessary for success, including:

- Budgets tracked by individual procurements, as well as by category of work activities and labor type
- Skilled project cost controls professionals that accumulate cost updates on a weekly or hourly basis and provide feedback to track progress against the plan
- Advanced project software programs to develop intricate, resource loaded schedules
- Sophisticated reports and tools to anticipate adverse trends and analyze emerging events associated with a variety of solutions

"Black & Veatch prides itself on the skills and focus that our professionals bring to each and every clients' project," said Dean Oskvig, President of Black & Veatch's energy business. "Whether as a consultant, an owner's representative or contractor, we will help better position utilities with nuclear assets to succeed in this challenging market by reducing or eliminating their project risk."

Leveraging Technology to Improve Refueling Outage Coordination and Performance

By Shawn St. Germain, Idaho National Laboratory and Carlos Williams, Palo Verde Nuclear Generating Station.

Shawn St. Germain

Shawn St. Germain holds a master's degree in nuclear engineering from the University of Idaho, an MBA from City University of Seattle and a BS in mechanical engineering from Michigan Technological University. He has worked at the Idaho National Laboratory for 7 years as principal investigator in the Risk Assessment and Management Services department. He is currently the principal investigator for an NRC project titled "Operating Experience Data for Risk Applications" and a Department of Energy Light Water Reactor Sustainability project titled "Advanced Outage Control Center Pilot Project". He was a nuclear trained surface warfare officer in the United States Navy for 7 years where he was qualified as a Navy Nuclear Engineer by the Department of Naval Reactors and qualified Propulsion Plant Watch Officer on the USS Nimitz.

Managing nuclear power plant refueling outages is a complex and difficult task due to the large number of maintenance and repair activities that are accomplished in a relatively short period of time. During a refueling outage, the Outage Control Center (OCC) is the temporary command center for outage managers and provides several critical functions for successful execution of the outage schedule. Essentially, the OCC functions to facilitate information inflow, assist outage management with processing information, and facilitate the dissemination of information to stakeholders. Currently, outage management activities primarily rely on telephone communications, face-to-face reports, and periodic briefings in the OCC. It is a difficult task to maintain current information related to outage progress and any discovered conditions. One of few remaining areas where significant improvement in plant capacity factors can be made is in minimizing the duration of refueling outages (St. Germain et al. 2013).

Effectively managing refueling outages is essential to the long-term commercial viability of nuclear power plants. Outage delays incur significant expenses due to the costs of replacement power and additional labor. The pilot projects have shown that advanced instrumentation, information, and control technologies can improve refueling outage performance. A new Advanced Instrumentation, Information, and Control System Technologies Pathway pilot project is focused on developing methods to implement an Advanced OCC (AOCC).

The AOCC is intended to maximize the use of communication and collaboration technologies for outage coordination, problem resolution, and outage risk management. Light Water Reactor Sustainability (LWRS)Program researchers are working with the Palo Verde Nuclear Generating Station (i.e., the pilot project industrial partner) to evaluate the current outage function allocation, identify areas where new technology can improve safety and efficiency, and effectively implement the new technology.

The conceptualized AOCC will provide tools for outage managers to monitor work status, coordinate resources, and communicate with the rest of the station. Some of the AOCC technology-enabled functions include real-time collaboration to resolve emergent issues, real-time work status, automatic support notifications, and improved information flow from and to the OCC. Implementation of an AOCC will require a technology infrastructure that includes mobile worker technologies, electronic work packages, plant-wide Wi-Fi coverage, and electronic component identification. Most nuclear power plants currently do not have the technology infrastructure to fully implement all of the AOCC capabilities; therefore, an important part of the current approach involves planning for incremental technology implementation. An incremental introduction of new technology and the resultant modification of processes will allow workers to gain proficiency with the new technology and methods while developing the infrastructure that supports future capabilities.

LWRS Program researchers are developing a first-of-a-kind AOCC to investigate some of the advanced functions in a real outage setting. Using systems procured by Arizona Public Services, candidate advanced technologies and process improvements were implemented for evaluation during refueling outages by Palo Verde Nuclear Generating Station, supported by LWRS Program researchers.

LWRS Program researchers observed outage activities at the Palo Verde Nuclear Generating Station during spring 2013. Through observations, data were collected that supported a function and task analysis of outage activities and an assessment of the human factor aspects of the physical OCC layout. Based on observations of outage activities and interviews with Palo Verde Nuclear Generating Station

(Continued on page 46)

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Leveraging Technology...

(*Continued from page 44)*

staff, several areas were identified where the use of communication and collaboration technologies may benefit outage coordination activities. One of the first areas identified for application of technology was for the Issues Response Team (IRT), which is a team of individuals assembled to understand and facilitate the needed recovery actions for resolving issues discovered during a refueling outage. The IRT is assigned emergent issues by the OCC that require the coordination of several groups. These emergent issues may challenge the critical path of a refueling outage. The IRT primarily is tasked with the development, communication, and implementation of a recovery plan until a clear path to success is apparent.

LWRS Program researchers observed the IRT during the spring 2013 refueling outage. Based on previous research of emergent issues resolution, LWRS Program researchers identified areas where technology could improve IRT function. Some of the areas identified include the following:

- **Information Management**. A standardized method for storage and retrieval of information was needed. Information was stored in an individual's e-mail and shared network folders; printed material was only available in the team room. A simple text turnover log was the extent of the formal documentation.
- **Collaboration**. A standardized method of sharing information was needed. Team meetings were held to share information and formulate plans. For example, the team used dry erase boards to collect ideas presented during the meetings. Action items were assigned, but follow up was difficult without an effective tracking tool. Likewise, it was difficult to share information with subject matter experts and others working on the issue who were geographically dispersed.
- **Status Updates**. A standardized method for communicating updated information was needed. The IRT leader took notes on a paper pad and then walked to the OCC to give management (i.e., the Shift Outage Director) a verbal update on the status of the issue. In addition, the IRT leader provided updated information to other department managers via telephone conversation without the use of any visual support.

To address these needs, LWRS Program researchers developed a study scenario that uses collaboration technology based on an actual issue worked by the IRT during a previous outage. This scenario highlighted the advantages of the standard issues package using collaboration technology to manage information for emergent issues. The standard issues package is a template using collaboration software to consistently collect, organize, and share information. The standard issues package includes tabs for photos, drawings, schedule impacts, actions items, etc. The technology was shared with Palo Verde Nuclear Generating Station staff during the LWRS Program Utility Working Group meeting held in Idaho Falls, Idaho on August 20 to 22, 2013.

Prior to Palo Verde Nuclear Generating Station's fall 2013 refueling outage, several communication and collaboration tools were chosen to support performance of the IRT. Microsoft OneNote and WebEx™ were used as collaboration software tools. OneNote is a computer program for free-form information gathering and is a multi-user collaboration software tool that allows multiple users to simultaneously add and modify content to the standard issues package, allowing for nearly real time information sharing. WebEx provides on-demand collaboration, online meeting, web conferencing, and video conferencing applications. In addition, Palo Verde Nuclear Generating Station purchased a 70-inch touch screen monitor for use in the IRT room. Video cameras for remote collaboration also were added to the IRT room and the OCC.

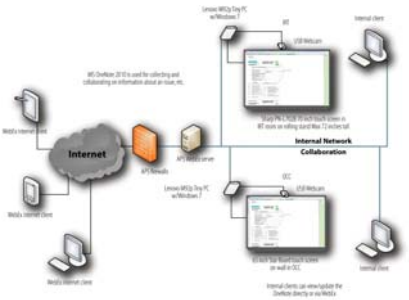

Diagram of Issues Response Team Collaboration Tools.

IRT templates that included the necessary procedural forms were built to support IRT issue tracking and resolution. A standardized file structure and instructions were developed for issue documentation. Training was held with IRT managers and staff prior to the start of the refueling outage to familiarize personnel with the new collaboration tools.

Palo Verde Nuclear Generating Station implemented the technology upgrades and modified the IRT process to take advantage of the new collaboration tools during the fall 2013 refueling outage. LWRS Program researchers observed the IRT's use of the technology to evaluate both its effectiveness and to identify any issues and shortcomings in its expected use. The IRT professionally managed several issues during the fall 2013 refueling outage, including an identified leak located on one of the nozzles on the bottom of the reactor vessel for reactor instrumentation known as bottom-mounted instrumentation (BMI).

The IRT used the standard issues package created using OneNote from the initial assignment by the OCC. Because of the complex nature of the BMI issue, the entire Palo Verde Nuclear Generating Station organization was mobilized to develop a thorough response and repair plan. The value of the collaboration tool was quickly recognized by Palo Verde Nuclear Generating Station management due to the standard issues package being network accessible and updateable by numerous users simultaneously. The standard issues package was used to coordinate and document every aspect of the inspections, recovery planning, and repair, including industry operating experience, materials, engineering, schedule impacts, and task assignments. The standard issues package was accessible from any workstation on site; therefore, the OCC received fewer ad hoc status queries. A similar BMI

issue had been experienced at South Texas Project. The time from issue identification to repair at South Texas Project was approximately 72 days. Use of operating experience, vendor support, and technology improvements, including OneNote, allowed Palo Verde Nuclear Generating Station to complete similar repairs in approximately 32 days. Several Palo Verde Nuclear Generating Station managers involved in resolution of the BMI issue said that the improved collaboration tools helped them achieve success in issue resolution. Some of the specific benefits cited by using the network-based collaboration tools included the following:

Information Management

- Enhanced organization and collection of information by including predefined tabs in the new IRT template.
- Improved storage and retrieval of information related to an issue by using standardized file structure.
- Improved knowledge management by using a new search feature, combined with organized information, allowing complex searches across issues.

Collaboration

- Enhanced sharing of information by using large touch screens during team meetings.
- Enhanced organization and collection of information by using the new template during the meetings.
- Improved collaboration because the standard issues package is available and updatable from any machine on the network, allowing collaborators to add content and update status remotely.
- Improved and seamless transition of transferring an issue to another responsible organization for implementation.
- Superior remote real-time collaboration due to the use of WebEx and video cameras. This option was used on a limited basis due to the close proximity of the IRT team room to the OCC.

Enhanced Status Updates

- Enhanced briefing capability. The IRT leader can display the entire standard issues package in the OCC and use it for briefing the Shift Outage Director.
- Enhanced status updates. The Shift Outage Director started reviewing the standard issues package from the OCC between updates, improving his understanding of the status and reduced his need to call the IRT for updates.
- Enhanced access to information. The standard issues package can be brought up on any network computer, allowing subject matter experts and managers the opportunity to view, from their office, all the collected information and contribute content.

Implementation of a new technology may fail due to a lack of training, poor selection of tools, or a perceived increased workload by staff. Additionally, too many changes at once can have a compounding effect during implementation. For these reasons, the technology application (i.e., collaboration and communication tools) was initially limited to the IRT process. The reactions of the staff using the new tools were documented. In general, the feedback from the IRT staff was positive. The following additional observations were generated from Palo Verde Nuclear Generating Station staff's use of the new collaboration tools:

Updated Unit 2 Outage Control Center Video Wall.

- Use of the standard issues package simplified shift turnover.
- The technology enhanced the ability to quickly review information in one location and allow others to quickly understand complex issues.
- After his first exposure to the new collaboration tools, the Work Management Director said he wanted touch panels installed prior to the next refueling outage, replacing all the dry erase boards used for status tracking in the OCC.
- The Nuclear Engineering Director indicated that he was going to start using the collaboration tool for his weekly update meetings.
- After a brief introduction to the collaboration tool, the Maintenance OCC team converted their logs to OneNote and started using it to collaborate with the individual shops. The Maintenance group was not part of the initial technology deployment, but adopted the tools on their own to help save time and printing costs.

In summary, the initial study of AOCC technology at the Palo Verde

(Continued on page 64)

Carlos Williams

Carlos Williams has worked at Palo Verde Nuclear Generating Station for more than 28 years. He has held staff positions in various groups including Nuclear Production, Human Resources and Quality Assurance. In these positions he has learned a great deal about nuclear power plant operations and outage management. Since 2002 he has been an IT Client Manager in the Palo Verde Information Technology group as well as serving as Outage IT manager for numerous refueling outages. In this role, he works with the Palo Verde organization to provide technology solutions for the business needs. Carlos has been collaborating with Idaho National Laboratory and other industry groups to provide sustainable information technology improvements for Palo Verde and the nuclear industry.

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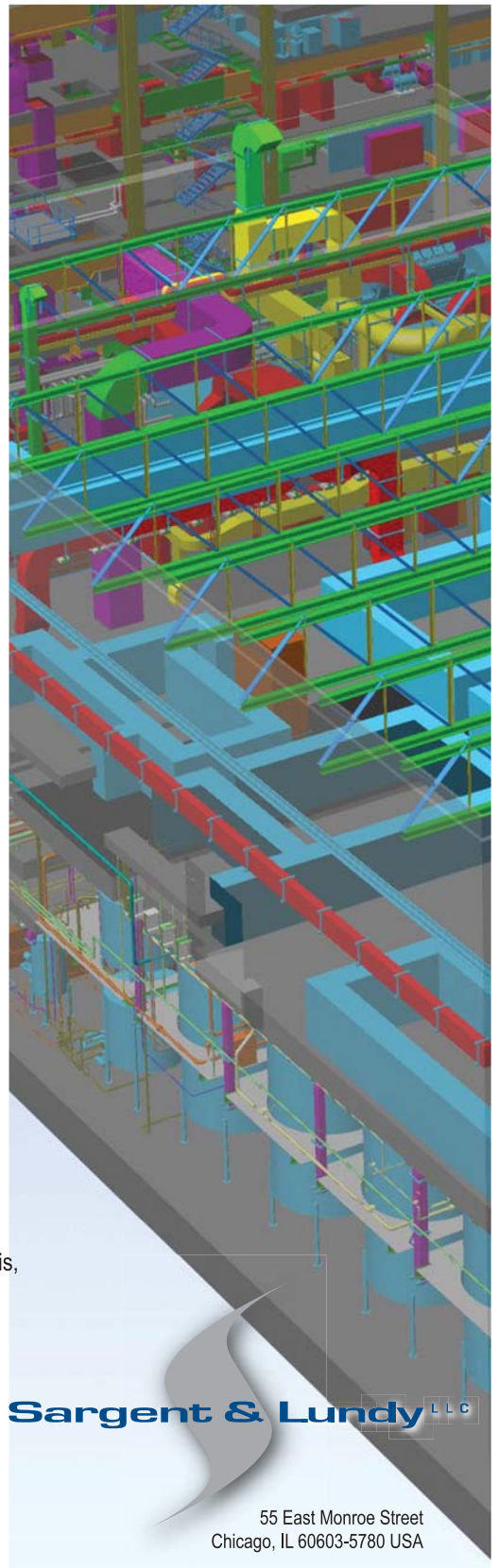

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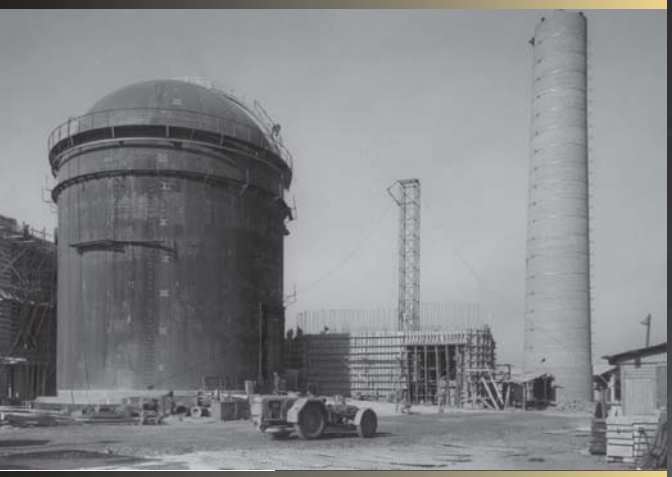

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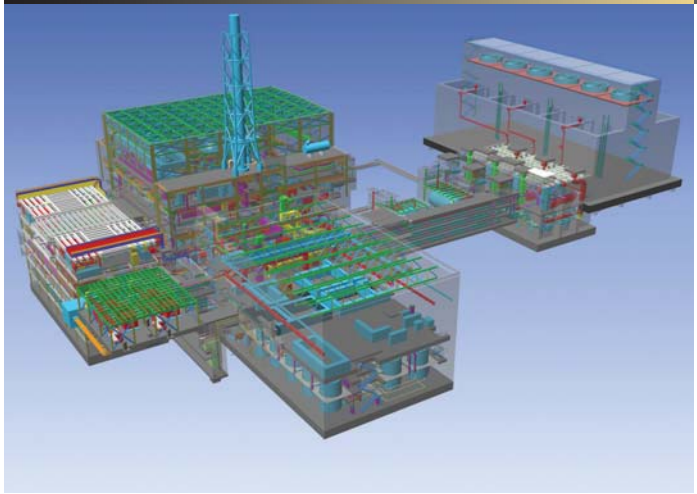

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Ensuring Nuclear Plant Safety During Power Loss

By Ken Price, AREVA Inc.

Ken Price

Ken Price serves as Product Development Manager in the Reactors & Services Business of AREVA Inc. Ken moved into this position in 2012 after working 24 years as Technical Support for AREVA and previous iterations of the company.

Ken began his career in 1975 in procurement engineering at Babcock & Wilcox (B&W) while completing an engineering administration program at George Washington University. He was transferred to AREVA's Old Forest Road Nuclear Parts Center in 1984 and held the role of business manager through 1988. He has been working with Jeumont reactor coolant pump (RCP) products since 1999.

A graduate of North Carolina State, Ken holds a bachelor's degree in Engineering Operations.

In the relentless quest to make plants continually safer and more reliable, one issue in particular has garnered a lot of attention – from the industry, the U.S. Nuclear Regulatory Commission (NRC), the public and the media: what happens when a plant loses power during a natural disaster or another extreme event? The nuclear industry is working tirelessly to address this question by developing new tools and products to ensure the safety of nuclear plants during natural disasters and other extreme conditions.

AREVA Inc. is working to help utilities ensure the safety of their plants during both normal operating conditions and extreme events. In fact, through its subsidiary AREVA JEUMONT, AREVA completed an extensive development and qualification program for its new Passive Shut Down Seal (PSDS), which limits reactor coolant system leakage through the reactor coolant pumps (RCP) during post-accident event conditions with loss of all sources of seal cooling. Under these conditions, a typical current RCP hydrostatic seal design could allow leakage through the seal of approximately 21 gallons per minute. With AREVA's PSDS installed, the leakage through the RCP seal is limited to less than one gallon per minute for up to seven days after the loss of cooling. As a result, this robust mechanism improves plant safety because the controlled low leakage gives the plant operator time to focus on reducing the pressures and temperatures, and mitigating any other post-accident impacts.

The PSDS is simple, with only four operating parts and a single triggering mechanism, which adds reliability. This triggering mechanism, known as the fuse spacer, is made from a high-temperature polymer that keeps the energizing component, known as the wave spring, compressed. This keeps the PSDS components under compression in normal plant operation.

Passive Shut Down Seal.

The RCP shaft with the driver motor on one end and the impeller on the other must pass through the reactor coolant system (RCS) boundary to immerse the impeller in the RCS water. The RCPs utilize a three-stage hydrostatic seal that is designed to control the leakage through the seal and break down the RCS pressures from full system pressure to ambient pressure. This pressure breakdown is accomplished via the RCS water passing through the three stages with each stage designed to break down a portion of the pressure. The first stage seal breaks down roughly 96% of the pressure while

controlling the leakage through the seal between 1.0 and 5.0 gallons per minute (gpm). Normal operational leakage is about of 2.5 gpm. Without the hydrostatic seal, the RCS water would leak through this area at a very high rate.

The hydrostatic seal operates with two separate sources of cooling water that cools the RCS water going through the seal. These cooling sources cool the RCS water from 572° F to 140°F. If both of these sources of cooling are lost, the 572° F RCS water would enter the seal cavity and cause the hydrostatic seal to fail.

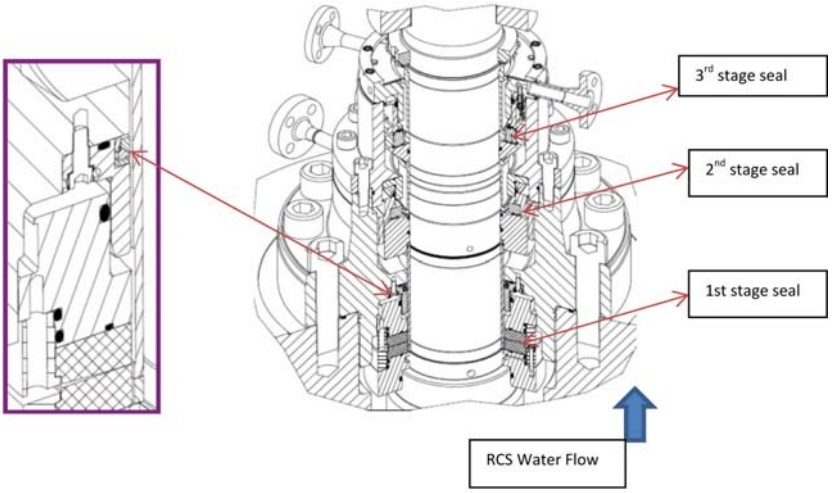
During an event with a loss of all cooling, the hot reactor coolant seal water enters the RCP seal cavity and subjects it to these higher temperatures. Under these higher temperatures, the fuse spacer transforms from a hardened state to a softer state and is no longer able to keep the wave spring compressed. When the wave spring is decompressed, it pushes a piston ring upward, which causes a sealing ring to begin to constrict around the pump shaft/sleeve to eventually seal off the leakage path. Multiple tests have proven the reliability of the triggering mechanism to actuate the PSDS when it is needed. Limiting the leakage through the seal lessens the need for additional makeup capacity by helping to maintain the existing reactor coolant system inventory, reduces the load to existing makeup systems, and reduces cleanup and associated radiation dose, all of which contribute to improved safety at the plant.

AREVA specifically developed the PSDS for use in U.S. pressurized water reactors using the Westinghouse Model 93A, 93A1 and 100 reactor coolant pumps with hydrostatic seal designs. International utilities using similar hydrostatic RCP seal designs can also use the PSDS. Currently, the AREVA PSDS is installed and in operation in a model 100 RCP at a U.S. utility site and is scheduled to be installed in a French nuclear plant in the first quarter of 2015. After a full cycle of operation, AREVA will remove the PSDS from the current U.S. reactor pump and perform an actuation test to confirm that the seal is operating properly after being actively used during an operating cycle.

In addition, AREVA is working with the NRC to review the design and qualification program in order to gain the agency's certification of the PSDS as a low leakage seal. AREVA will then work with a utility on the low leakage assurance in the probabilistic risk assessment and core damage frequency calculations under Extended Loss of All Power, NFP 805, Mitigating Systems Performance Index and other programs.

AREVA's PSDS is one of many examples of how the industry is innovating to improve the safety and reliability of the existing fleet, especially in relation to emergency event preparedness. Through experience feedback and a thorough understanding of the needs of nuclear plant operators, AREVA is working to secure the future of nuclear electricity generation in the United States.

Contact: Mary Beth Ginder, AREVA Inc., 1 International Plaza, Suite 210, Philadelphia, Pennsylvania 19113; telephone: (301) 841-1703, email: Marybeth.ginder@areva.com.



Three stage hydrostatic seal arrangement and location of PSDS.

Company Profile: Zachry Nuclear, Inc.

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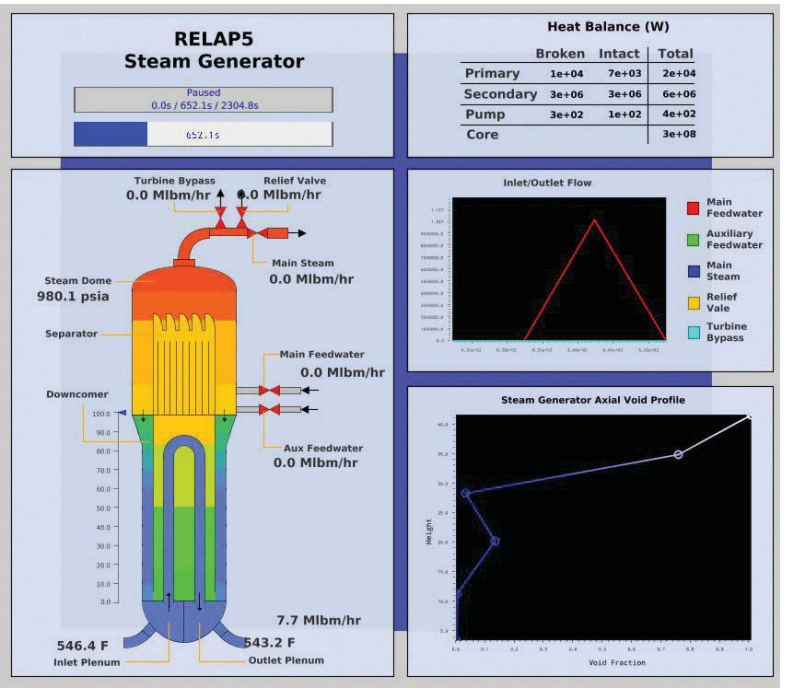
Headquartered in San Antonio, Texas, Zachry Nuclear has offices located throughout the United States in Stonington, CT; Charlotte and Cary, NC; Richland, WA; and Chicago, IL. They offer mechanical, electrical, controls and civil/structural engineering professionals and designers who are knowledgeable and experienced in power plant systems; engineering analysis and modification package development; and startup of power plant systems and components. Zachry Nuclear is a qualified nuclear QA supplier; all services are performed in accordance with their Nuclear Quality Program, which complies with 10CFR50 Appendix B and ASME NQA-1 (1994), and has been successfully audited by NUPIC.

Zachry Nuclear's full range of engineering and design services are backed by years of nuclear power plant system experience and practical application of time-tested solutions. Their engineers, designers, project managers and system analysts have an impressive combination of training and experience. When you have a design need, Zachry assembles a fit-for-purpose team for the job, taking into account employees' specialties, education,



skills and expertise. Zachry utilizes industry-recognized design tools and processes, including an in-house Failure Modes and Effects Analysis (FMEA) procedure that fully evaluates proposed system modifications to ensure they will operate effectively and without error. The Numerical Applications Division (formally NAI) has consistently provided the industry with state-of-the-art modeling techniques and approaches for containment response and area heat-up during both design and beyond design basis events. This division of Zachry Nuclear provides a wide spectrum of engineering analysis services including thermal hydraulic, radiological, chemical, core physics and safety analysis, and is the leading developer of nuclear software including Proto-FLO™, Proto-HX™, Proto-HVAC™, Proto- Sprinkler™, CentralStor™, RADTRAD-NAI™ and GOTHIC™* computer code and applications. GOTHIC™, as applied by Numerical Applications, has become the industry standard for containment modeling and analysis, and has been extensively utilized in operating and new plant licensing activities. Their team also has considerable experience using industry-standard software tools such as RELAP and RETRAN.

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Zachry Nuclear Engineering provides engineering analysis services including thermal hydraulic, radiological, chemical, reactor physics/core design and safety evaluations. We are a leading developer of software used in more than 90% of the U.S. nuclear fleet, including GOTHIC™*, Proto-FLO™, Proto-HX™, Proto-HVAC™, Proto- Sprinkler™, CentralStor™ and RADTRAD-NAI™.

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William Murphy, Duke Energy.

Summary

In May 2013, Catawba Nuclear Station successfully loaded 37 pressurized water reactor (PWR) used fuel assemblies into the NAC International MAGNASTOR® dry storage system. This was the first-ever loading of more than 32 PWR fuel assemblies in a welded canister dry storage system. Duke Energy operates Catawba Nuclear Station's two Westinghouse PWRs at a site near York, South Carolina. Unit 1 has been in operation since January 1985 and Unit 2 since May 1986. Each unit has a standalone spent fuel pool (SFP) with a licensed capacity of about 1,400 fuel assemblies. The pools reached capacity in the mid- 2000s, requiring implementation of dry used fuel storage technology. In 2007, Catawba deployed the NAC-UMS® dry fuel storage technology. Catawba loaded 24 NAC-UMS® systems between 2007 and 2011, each with a capacity of 24 PWR used fuel assemblies. This system had been used extensively in industry prior to Catawba. Though a proven and reliable technology, the relatively low capacity of the NAC-UMS® system presents challenges with long-term storage of used fuel at Catawba. Off-site disposition of the site's used fuel inventory will likely not occur for many decades. Additional renewal of the site operating license is plausible. The Independent Spent Fuel Storage Installation (ISFSI) land area was designed to support used fuel storage for a single renewal period and cannot be expanded due to facility and geographic limitations. As the inventory of older, decayed used fuel is loaded into dry cask systems, newer and hotter fuel, beyond the capabilities of the NAC-UMS® system to store, will need to be loaded. In 2010, Catawba elected to transition to the MAGNASTOR® dry fuel storage technology. The new system incorporates multiple evolutionary improvements from its predecessors. In the same concrete cask outer diameter as NAC-UMS®, the MAGNASTOR® system stores thirty-seven PWR used fuel assemblies – an increase of 54%. Transition to the MAGNASTOR® system was controlled as a station major project. A multidisciplinary team, consisting of personnel from various functional areas, ensured that required station modifications, calculation changes, regulatory requirements and field testing were completed prior to loading. Changes in canister processing from NAC-UMS® to MAGNASTOR® system warranted new technologies to maximize efficiency and minimize personnel exposure. EMS Solutions, Inc. supplied the E1000LT Vacuum Drying Skid (VDS), which performs all ancillary activities from weld hydrostatic testing to helium backfill from a single location. Major station modifications include:

- A Vertical Concrete Cask (VCC) construction yard exterior to the site protected area.
- Design, fabrication and installation of MAGNASTOR Transfer Cask (MTC) annulus flush and cooling system, including modifications in the spent fuel buildings to connect the MTC to the plant spent fuel pool cooling system.
- Electrical, air and gas supply to the E1000LT VDS, in addition to installed piping to connect the VDS to the canister.

After three field testing exercises from 2012 to 2013, Catawba completed loading of industry's first ultra-high capacity storage system in May 2013. Operating experience from Catawba was applied to subsequent MAGNASTOR® loadings at McGuire Nuclear Station and Zion Nuclear Station.

Safety

The increased storage capacity of MAGNASTOR® systems results in fewer overall loading evolutions required to maintain adequate SFP operating margins. As a result of this transition, 11 fewer loading evolutions are projected to be required between 2013 and 2020 – a reduction of more than 30 percent. Dry cask loading evolutions present challenges in nuclear safety (fuel handling), radiological safety (personnel exposure during cask

(Continued on page 56)

William Murphy

William Murphy is a Reactor Systems Engineer at Duke Energy-operated Catawba Nuclear Station. He has 10 years of experience in used nuclear fuel storage and was the lead engineer responsible for transitioning Catawba to the NAC-MAGNASTOR ultra-high capacity storage system. Prior to dry fuel storage work, he served as a criticality safety analyst and special nuclear material controls and accountability engineer. William holds a degree in Nuclear and Radiological Engineering from the Georgia Institute of Technology and a Professional Engineering license in South Carolina.

Nuclear Energy Institute's Top Industry Practice (TIP) Awards highlight the nuclear industry's most innovative techniques and ideas.

This innovation won the 2014 Nuclear Fuel Process Award.

The team members who participated included: William Murphy, Program Manager Catawba ISFSI; Scott Friend, System Engineer Catawba ISFSI; Jochen Krist, Catawaba ISFSI Technical Support/Job Sponsor; Craig Bigham, Catawba Reactor Engineering Manager; Bud Peeler, Project Manager.

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1967	Fuel Manufacturing—Wilmington, NC
1969	Nine Mile Point, NY; Oyster Creek, NJ
1974	25th BWR—Peach Bottom 3, PA
1986	50th BWR—River Bend, LA
1996	1st ABWR—Kashiwazaki-Kariwa, Japan

Enhancing

Helping utility customers achieve safe and reliable operation, improve plant efficiency and reduce dose levels

- 1996 — First-Generation III: ABWR
- 2000 — Global Nuclear Fuel
- 2013 — Parts Asset Management Solutions (PAMS)
- ESTIMATED 2014 — ESBWR

Innovating

Developing technology that has played a key role in optimizing plant performance, safety and profitability

- 2012 — **Global Laser Enrichment**—NRC issues first-ever site license for a laser-based uranium enrichment facility
- 2012 — **Spent Fuel Pool Monitor** is introduced
- 2013 — **Stinger Remote Inspection Tool** begins service
- 2014 — **PRISM** declared credible option for plutonium stockpile management

HITACHI

Dry Used...

(*Continued from page 54)*

processing, including neutron radiation), and industrial safety (heavy lifts of the empty and loaded system, placement of lids, working on elevated surfaces, and operation of heavy equipment such as the vertical cask transporter and automated welding system). Reduction in the overall number of loading evolutions for the same population of fuel decreases the risk of safety events.

MAGNASTOR® VCC Docked with Vertical Cask Transporter.

Safety benefits are also realized in long-term storage of MAGNASTOR® systems at the ISFSI. Increasing the density of used fuel stored results in improved off-site dose characteristics as the fuel is shielded by its neighboring assemblies. Use of the high-density MAGNASTOR® system will minimize the used fuel storage footprint at the Catawba site. This will be particularly beneficial after the cessation of power operations, if no used fuel is shipped off site, as the smaller footprint reduces the security profile and maximizes the amount of land that can be reclaimed for general use. Presuming no fuel is shipped off site over the lifetime of the station, the ultimate size of the stand-alone ISFSI will be minimized, allowing for the greatest amount of land to be reclaimed for general use and reducing the security profile of the site. The MAGNASTOR® system uses a single composite shielding/structural closure lid for confinement, along with a light (approximately fifty pounds) closure ring for confinement redundancy. Most dry storage systems require two lids to be installed. Lid placement is a critical lift evolution (weighing in excess of five thousand pounds), with accompanying safety challenges. The single lid design constitutes a design enhancement with major positive safety implications. The E1000LT VDS requires only a single set of connections to the canister for all of its processing functions (i.e., one set of boom lines to the vent and drain ports, as well as thermocouple connections to the MTC). Compared to multiple separate pieces of equipment for each function (e.g., hydrostatic testing, vacuum drying, etc.), this configuration minimizes occupancy time on top of the loaded system, reducing personnel exposure. Elimination of multiple equipment manipulations also reduces the probability of human performance induced component events.

Cost Savings

The cost to load a MAGNASTOR® system (hardware, personnel, and consumables) is essentially the same as the lower-capacity NAC-UMS®. Overall, an estimated cost reduction of $4,500 per fuel assembly stored can be realized from this transition, or savings of $3.3 million between 2013 and 2020 for the required inventory of fuel. Cost savings will continue to grow past this timeframe as more systems are loaded. Additional cost savings will be realized by reducing the total number of ISFSI storage pads required, as well as the ultimate size of the ISFSI at station end-of-life.

Innovation

The MAGNASTOR® system was licensed by the Nuclear Regulatory Commission in 2009. Duke Energy supported NAC International in obtaining initial regulatory approval. It is the first ultra-high capacity (37 PWR or 87 Boiling Water Reactor assemblies) storage system available in the industry. Deployment of the MAGNASTOR® system at Catawba is a first-of-a-kind activity, requiring contributions from multiple station and corporate organizations. Industry and regulatory efforts to characterize dry fuel storage systems for extended storage periods have identified the desire to obtain system data during loading Evolutions. The E1000LT VDS has onboard data logging capabilities, allowing for automated detailed record of canister conditions, including: MTC cooling system performance, drain down flow rates, water temperature, vacuum drying and backfill conditions, and evolution durations. The E1000LT VDS gathers much more key parameter data than typical dry storage data logging systems. These data can be made available for use in detailed best-estimate computer simulations of fuel conditions during vacuum drying, thereby demonstrating margin to safety and regulatory thermal limits and establishing initial conditions for analyses of fuel mechanical performance during extended storage.

Productivity/Efficiency

Loading one canister is a two-week evolution from preparing an empty system to placing the loaded system in the ISFSI. A loading evolution is significant for an operating nuclear facility, requiring resources and priority from multiple station organizations (Fuel Handling, Welding, Radiation Protection, Chemistry, Engineering, Operations and Security). In addition, vital plant equipment (notably spent fuel pool cooling) must be formally protected during loading to preclude equipment issues. Obviating the need for 11 loading evolutions over seven years constitutes 22 weeks of regained productivity, not including the time required to mobilize and demobilize equipment from the spent fuel buildings. Additional efficiency gains will be realized beyond 2020 as additional ultra-high capacity systems are loaded. The previously-mentioned single closure lid design decreases post-backfill cask processing time by several hours because the secondary confinement boundary (a 50-pound closure ring) is far easier to install and orient for welding than a second complete lid. The E1000LT VDS performs all of the following functions:

- MTC annulus cooling system temperature monitoring.

- Canister closure lid weld hydrostatic pressure testing.
- Water drain down and totalizing.
- Vacuum drying and dryness testing.
- Helium backfill and totalizing.

The E1000 VDS requires only a single set of connections to the canister for all of its processing functions (i.e., one set of boom lines to the vent and drain ports, as well as thermocouple connections to the MTC). Compared to multiple separate pieces of equipment for each function (e.g., hydrostatic testing, vacuum drying, etc.), this configuration greatly increases efficiency in system processing.

E1000LT VDS Installed in the Spent Fuel Pool Building.

Transferability

The MAGNASTOR® system was licensed by the Nuclear Regulatory Commission in 2009. It is available for use by any commercial nuclear power facility licensed under 10 CFR 50. The lessons learned from field testing and subsequent loading evolutions at Catawba have already been incorporated into NAC International's generic operating procedures for the MAGNASTOR® system. This data was used to successfully load MAGNASTOR® systems at McGuire Nuclear station in the summer 2013, followed by the decommissioned Zion Nuclear Station in fall 2013. Any subsequent user of the MAGNASTOR® system will directly benefit from the lessons learned acquired during the first-of-a-kind loading at Catawba. These lessons learned have also been shared beyond MAGNASTOR® users via the NAC International Users Group (NUTUG) and Electric Power Research Institute (EPRI) committees. Beyond MAGNASTOR® applications, the trend of the industry is toward high capacity storage systems that minimize the number of individual loadings. Experience gained by Duke Energy in this first loading of a dry storage system with 37 pressurized water reactor fuel assemblies is applicable to other high capacity systems currently in development and deployment. Duke Energy routinely shares lessons learned with other utilities through various fora including the Nuclear Energy Institute (NEI) Dry Storage Task Force, the annual NEI Used Fuel Management Conference and utility benchmarking activities. System loading data from the E1000LT VDS can be used for extended storage studies and license renewal activities. Such work should benefit all plants engaged in used fuel dry storage.

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ECCS Water Management Initiative

By Eric Henshaw, Duke Energy.

Eric Henshaw

Eric Henshaw is a Principal Engineer in the Duke Energy Nuclear Fuels Engineering Safety Analysis Section, located in Charlotte NC.

Mr. Henshaw received a Master of Science in Nuclear Engineering from the Georgia Institute of Technology and is a registered professional engineer in North Carolina and South Carolina.

Since joining Duke Power in 1984, he has helped develop Duke Energy's in-house licensing basis methodologies for performing Updated Final Safety Analysis Report (UFSAR) Chapter 15 non-LOCA analyses and UFSAR Chapter 6 containment response methods for both large dry and ice condenser containments.

Nuclear Energy Institute's Top Industry Practice (TIP) Awards highlight the nuclear industry's most innovative techniques and ideas.

This innovation won the 2014 Vision, Leadership and Ingenuity Award.

The team members who participated included: Eric Henshaw, Principal Engineer; Mike Weiner, Principal Engineer; Bryan Meyer, Principal Engineer; Ari Tuckman, Lead Engineer; Tom Baumgardner, Senior Technical Specialist, Duke Energy.

Summary

Duke Energy developed, licensed and implemented significant changes in the post-accident operation of containment spray at the McGuire and Catawba Nuclear Stations. The changes, known as the Emergency Core Cooling System (ECCS) Water Management Project, produced a marked increase in safety (reduction in calculated core damage frequency or CDF) and reduced operator burden during a postulated accident. This project is consistent with the Nuclear Energy Institute (NEI) and the Pressurized Water Reactor Owners Group (PWROG) Water Management initiative.

Duke Energy recognized that improvements in containment analysis (coupled with other analytical improvements and minor plant hardware changes) could, during certain postulated events, significantly delay sump recirc and provide other benefits by postponing or eliminating the need for containment spray. Accordingly, Duke Energy initiated the ECCS Water Management Project to use in-house methods to modify the plant design basis for high energy line breaks inside containment. The project hinged on the ability to obtain an acceptable containment pressure response and acceptable dose consequences following a large break LOCA with delayed credit for containment spray.

The project was successful and resulted in the following plant changes which have been fully implemented in the Catawba and McGuire Nuclear Stations.

- The containment spray system was changed from automatic actuation on high-high containment pressure to manual initiation following the transfer to sump recirc.
- Only one spray pump is operated rather than two.
- The requirement to take manual action to align Residual Heat Removal (RHR) spray was removed.
- A narrow range refueling water storage tank (RWST) level instrument was installed to reduce RWST level measurement uncertainty.
- The RWST low and low-low level alarm setpoints were reduced to maximize injected volume from the RWST.
- The emergency procedures were revised to transfer the intermediate head and high-head injection pumps to high pressure recirc at the RWST low-low level alarm setpoint (rather than the low level alarm setpoint).
- The technical specification requirement for minimum initial RWST volume was increased.

Safety

Background Information

The McGuire and Catawba Nuclear Stations are dual unit four-loop Westinghouse pressurized water reactors (PWRs) with ice condenser containments. Ice condenser containments contain large quantities of ice through which hot steam and liquid would flow following a high energy line break inside the reactor building. High energy line breaks include large and small break loss of coolant accidents (LOCAs), steam line breaks and main feedwater line breaks. The steam released from the high energy line break would condense on the ice, thereby minimizing the increase in containment pressure. As a result, it was possible to construct ice condenser containments smaller and with a much lower design pressure (15 psig for McGuire and Catawba) than conventional PWR containments.

Ice condenser containments are equipped with containment spray systems which were designed to actuate at the initiation of a high energy line break, taking suction from the refueling water storage tank (RWST) and pumping cold water into the top of containment to provide additional steam condensation (pressure reduction) and radioactive fission product removal. The RWST is also the source of ECCS injection water – high head, intermediate head and low head injection flow into the reactor coolant system. The ECCS flow keeps peak cladding temperatures below regulatory limits and ensures adequate soluble boron in the reactor coolant in the event of postulated accidents.

Once the large inventory of the RWST depletes to the low level alarm setpoint following an accident (known as injection phase), the suction source for the low head injection pumps transfers to the containment sump (known as the sump

recirc phase of the event). Following transfer of the low head injection pumps to the sump, the intermediate head and high head injection pumps must be aligned to take suction from the discharge of the low head injection pumps. This operating mode for the intermediate and high pressure pumps is known as high pressure recirc, and it is necessary because the intermediate and high head pumps cannot take suction directly from the sump due to net positive suction head (NPSH) limitations.

Transferring to high pressure recirc successfully following a small break is a risk-significant scenario for McGuire and Catawba. In the original plant design, with all pumps taking suction from the RWST, it takes place approximately 30 minutes following the initiation of the postulated accident to reach high pressure recirc. Following the high pressure recirc alignment, the containment spray pumps would continue to deplete the RWST to the low-low level alarm setpoint, where the spray pumps would be stopped, the suction source transferred to the containment sump, and the pumps restarted. Another nuance of the original plant design basis was a requirement to direct one train of low head injection flow to auxiliary containment spray headers 50 minutes after accident initiation in order to ensure that containment design pressure is not exceeded following the melting of all of the ice. This alignment, known as residual heat removal (RHR) spray, essentially redirects a significant portion of the injection to the upper containment instead of core injection for core cooling.

Over the years since initial plant licensing, Duke Energy developed a comprehensive in-house capability for ice condenser containment analysis using the GOTHIC and RELAP5 computer codes. RELAP5 is used for the system mass and energy release calculations and GOTHIC is used for the containment response analysis. The GOTHIC methods were validated against ice condenser performance data developed by Pacific Northwest Laboratories under the sponsorship of Duke Energy, TVA and American Electric Power, the United States utilities that operate plants with ice condenser containments. The Duke Energy RELAP5/GOTHIC methodology is mechanistic and represents a significant improvement over the vendor methods that were part of the original plant design basis.

Primary Benefits

1. **Significant improvement in plant safety as measured by core damage frequency (CDF).** The changes result in approximately a 16 percent CDF reduction for Catawba and an 18 percent CDF reduction for McGuire. The main source of this reduction is the small break LOCA "high pressure recirc" failure described below.

   ECCS Water Management changes reduced the probability of needing to transfer to high pressure Recirc for Small Break Loss of Coolant Accidents (SBLOCAs), thereby reducing the possibility of the operators or plant failing to successfully make the transition. The plant response to a small break LOCA is a function of break size and location. For some break sizes, the plant will depressurize enough before RWST depletion that core cooling can then be provided directly from low head injection. ECCS Water Management extends the time of the injection phase, so more break sizes depressurize fast enough to avoid the need for high pressure recirc. The additional time is available primarily because the containment spray pumps would not automatically actuate, and because the minimum RWST inventory increased and the low RWST level alarm setpoint was reduced.

   The significantly increased amount of time available before transfer to sump recirc for all LOCAs reduces operator burden during an accident. The benefit varies with the accident scenario, but the amount of time available is at least double the amount before the ECCS Water Management changes. As a result, the operators have additional time to diagnose the event and prepare for time-critical evolutions such as transition to sump recirc and, if necessary, high pressure recirc.

2. **Reduction in the debris loading on the containment sump strainers.** The ECCS Water Management Project reduces the total sump flow rate (as recommended in NRC Bulletin 2003-01, *Potential Impact of Debris Blockage on Emergency Sump Recirculation at Pressurized-Water Reactors*) and thereby decreases the transport of debris to the containment sump screen. Also, later initiation of sump recirc provides increased settling time. The net effect is additional margin relative to Generic Safety Issue (GSI)-191, "Assessment of Debris Accumulation on PWR Sump Performance."

3. **Increased RWST inventory for core cooling injection.** As noted in #1 above, this is due to increased initial RWST inventory and lower RWST low level setpoints. The lower RWST level setpoints were justified by taking credit for the lower injection flow rates and refined vortex formation correlations.

4. **Reduction in diesel generator loading during the initial portion of the accident.** Prior to ECCS Water Management there was relatively little margin in the emergency diesel generator loading sequence. Removing the electrical load of the containment spray pumps from the initial sequence provides considerable margin.

5. **Eliminated the transfer to sump recirc for secondary system breaks (main steam line breaks and main feedwater line breaks) inside containment.** Without the ECCS Water Management changes, high energy line breaks in containment would actuate containment spray and deplete the RWST to the point at which transfer to sump recirc would be required. The actuation of containment spray complicates the operator response to the transient and adds time pressure. The operator response is simplified with the ECCS Water Management changes.

(Continued on page 64)

Emergency Response Is What We Do.
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Critical Pump Seizes

A low head safety injection pump rotor seized in its casing, bringing a nuclear power plant to critical operation status and requiring emergency repairs. Hydro's Chicago nuclear qualified repair service center was engaged to work on the pump 24/7. From decontamination all the way through testing, Hydro's engineering and operations team responded quickly, providing a lasting solution at a critical time. Flexibility, qualified and thorough engineering analysis, and essential resources led to fast and reliable uptime – and a very satisfied customer.

Rotor was damaged due to pump running dry for approximately 30 minutes.

Pump Decontamination and DCI

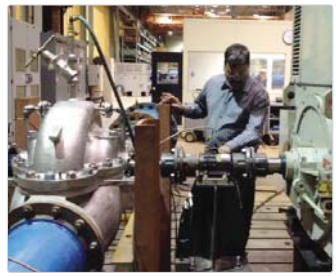
While the damaged pump was being decontaminated at a dedicated facility, numerous spare parts from the plant's inventory were reviewed by Hydro's engineering team. Equivalencies such as dimensional and functional conformity were studied.

Spare Parts Analyzed

A spare OEM impeller supplied by the customer ostensibly manufactured to the same pattern and drawing numbers initially appeared to be a drop-in replacement. However, upon close inspection, Hydro's engineering team discovered the OD and vane underfiling geometry deviated from the OEM's specs. Expected loss of hydraulic performance due to this deviation was calculated and brought to the customer's attention, with suggested additional improvements.

Diminished Axial Float Diagnosed/Adjusted

While analyzing the pump assembly, engineers noted that the impeller's overall exit width was larger than spec, obstructing lowering of the casing's upper half. To meet the drawing requirements, machining the shroud was recommended. Evaluations and justifications confirmed that the original design's mechanical strength, axial thrust, and hydraulic performance would not be negatively impacted.



Final Testing and Turnaround

Hydro's performance test lab had been on standby throughout the repair process, with the preliminary test layout. When repairs were completed, the pump was immediately tested and approved by the customer. The pump was shipped to the customer only eight days after its arrival, and was up and running immediately after successful results of pre-service tests.

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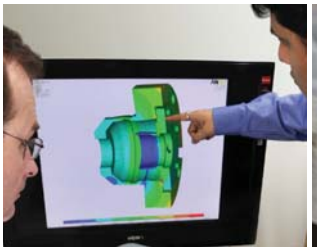


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Our Comprehensive Services

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Field Service Support for Installation & Start-up I Certified Performance Testing
Pump System Reliability I Engineering Services I Customer Training

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ECCS Water...

(*Continued from page 61*)

6. **Simplified emergency procedures for small break LOCAs.** The original emergency procedures used two different procedures to transfer to sump recirculation depending on sump level. This has been simplified to a single procedure.

Additional Benefits

In addition to the aforementioned benefits that have been realized, the changes from the ECCS Water Management Project have the potential to provide additional operational advantages. Such additional benefits would require further analyses and justification to implement. The potential additional benefits to boron precipitation, post-LOCA subcriticality, sump debris transport, and LOCA peak cladding temperature are summarized below.

- **Initiation of hot leg recirc at an earlier point in time following a LOCA**. Hot leg recirc is the realignment of one train of intermediate head safety injection to two hot legs instead of the cold legs. The realignment is required to prevent the core boron concentration from reaching the level at which precipitation will occur, and to preclude the buildup of regions of demineralized water that pose a recriticality concern. Hot leg recirc is aligned following the transition to sump recirc, and may lead to an increase in containment pressure and temperature when it is done. As a result, current analyses require a significant delay from the initiation of the event before starting hot leg recirc. Revised analyses should enable earlier transition to hot leg recirc, producing associated benefits: 1) increased margin to post-LOCA recriticality, and 2) increased margin to boron precipitation.
- **Termination of high head safety injection flow following transfer to sump recirc**. The current Westinghouse ECCs design and procedures maintain high head injection flow after a LOCA. With low head and intermediate head safety injection pumps providing ample flow for core cooling, it should be possible to terminate high head pump operation without an indicated subcooling margin as is done for B&W designed reactors. Implementing this benefit would be a first for Westinghouse designed reactors. This would limit the exposure of the high head injection pumps (which have the tightest clearances) and the associated throttle valves from the post-LOCA debris that may be expected during extended sump recirc operation.
- **Additional margin when demonstrating compliance with LOCA peak cladding temperature requirements.** The margin may be obtained through analysis by increasing minimum containment backpressure and extending the duration of relatively cold RWST injection. The increased containment backpressure is estimated to result in a 100°F benefit for peak cladding temperatures.

Transferability

The ECCS Water Management Initiative Project should be directly applicable to any ice condenser containment plant. There are five other nuclear power reactors in the United States with ice condenser units (DC Cook 1&2, Sequoyah 1&2, and Watts Bar 1), and one unit under construction (Watts Bar Unit 2). In addition, the methodologies used in this work are also applicable to PWR dry containment plants. The potential benefits at any plant will depend on plant-specific factors such as the extent those plants rely upon containment spray to mitigate the range of design basis events.

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Leveraging Technology...

(*Continued from page 47*)

Nuclear Generating Station to support the IRT was well received. Palo Verde Nuclear Generating Station plans to permanently adopt the IRT process and technologies used during the fall 2013 refueling outage. Based on the advantages observed using the network accessible collaboration software, Palo Verde Nuclear Generating Station updated their Unit 2 OCC with this technology to improve outage communication and collaboration. Use of the new OCC technology during the spring 2014 refueling outage was well received and Palo Verde Nuclear Generating Station achieved a new station record for outage duration.

LWRS Program researchers will continue to monitor and assess the process of technology implementation, develop new AOCC capabilities, and look for industry best practices related to outage management for incorporation into the AOCC. The results of this research will be published in a technical report for industry-wide implementation of the AOCC in 2014.

References: St. Germain, Shawn, Ronald Farris, and Heather Medema, 2013, Development of Methodologies for Technology Deployment for Advanced Outage Control Centers that Improve Outage Coordination, Problem Resolution, and Outage Risk Management, INL/EXT-13-29934, Revision 0, September 2013.

Contact: Shawn St. Germain, Idaho National Laboratory, telephone: (208) 526-9575, email: shawn.stgermain@inl.gov. ■

Drywell Replica

By Brian O'Grady, Entergy Nuclear.

Cooper Nuclear Station's construction of a replica of a quarter of the plant's drywell area helped to save an estimated 600 man hours of outage work and reduce radiation dose from a predicted 44 REM to 31 REM during work to replace four fan coil units.

"The fan coil replacement – an infrequently conducted evolution – was a tremendous success for Cooper," said Entergy Nuclear's Brian O'Grady, former Vice President and CNO of Cooper.

"We came in under our dose goal and on schedule, both of which are directly related to the use of our drywell mockup."

Construction of the drywell replica

Cooper, an 810-megawatt boiling water reactor, is owned by the Nebraska Public Power District and managed by Entergy Nuclear. The plant came online in July 1974. In 2010 the station received a license renewal from the US Nuclear Regulatory Commission to operate for another 20 years. Cooper is located 80 miles from Omaha, Nebraska in the central United States.

Chris Pelchat, Cooper project manager, said the work included contracting local metal fabricators, carpenters and other specialists to build the $250,000 replica, which was housed inside a closed school at a nearby town. The replica took three months to build.

The replica supported a project to replace the plant's four belt-driven fan coil units with direct-drive units, an enhancement related to Cooper's change from a 12-month fuel cycle to an 18-month cycle.

The drywell replica was built and an adjoining training facility with classrooms and a workstation for the radiation simulation tracking was constructed.

A wireless system was set up to analyze movements in the radiation area, with location tags worn with the dose rate metres. The location tags gave workers information on the best path while performing work in the replica to lower the dose. Real-time video added to the practice work and the video of the actual drywell work was available to anyone with access to the plant's internal website.

A radiation survey of the actual drywell in the station, taken during the last refuelling outage, supplied the data for the mockup radiation simulation. Imagery also was taken during the last outage by a 360-degree laser measuring of all the elevations of the drywell.

Training and teamwork

Groups of plant employees, supplemental workers and vendors spent three weeks at the replica, practicing ways to limit dose. The coursework was broken into two-hour rotations of three teams, who would then evaluate their training through video playback and discussion.

"We went through the training with the workers and went from basic to more complex work," said Pelchat. "For example, the drywell mockup is pretty well lit for the initial training. But then as training progresses, they have to hang the temporary lighting, be dressed out and perform all the tasks that they would have to do in the actual evolution."

The plan sheet of Cooper's Drywell used to build the mockup.

"The team members have come up with some incredible ideas – how can we get around this, how can we make this better – it's a questioning attitude that makes this whole project even better," said Pelchat.

Pelchat said ideas solicited from the workers resulted in an easier way to move equipment and tools to and from the drywell mockup, without the hazards and raised dose from rigging.

A metal box was constructed to roll on rails of ball bearings to and from the entrance of the drywell mockup, reducing dose and saving time.

"That gave us a lot more flexibility to move something, to get it out of the way," said Pelchat.

The mockup was painstakingly designed from the original plant blueprints, with details down to small upward kinks in the metal-grating floor that workers would step on while performing the evolution.

The replica fan motor assemblies and coil assemblies are the precise weights of the actual plant machinery. The training also included disassembling pipes in order for welders to reassemble them.

"Just sharing an identical replica is beneficial," said Pelchat. "When the workers come down here they can see the challenges other teams or personnel face. It really makes the teams think about how to work well together."

Public engagement

Pelchat said while building the mockup, nearby residents would come by the closed school to see what was going on. He said the interest prompted a community outreach day sponsored by Cooper. More than 200 people attended.

"This gave us a chance to tell the people how we are working to assure their safety and be transparent about the changes we're making to the plant," said Pelchat. "There was a lot of community interest and a great chance for us to tell our story."

"I am definitely happy with the results," said Pelchat. "The vendors on the project were all new to nuclear prior to this. The drywell mockup gave them the opportunity to develop proper radiation worker behaviours better than any classroom training. The project's aggregate dose, duration and overall success can be attributed to their practice and lessons learned while rehearsing the mockup." ■

Brian O'Grady is the former Vice President and Cheif Nuclear Officer of Cooper Nuclear Station, Entergy Nuclear.

Credit: *World Association of Nuclear Operators "Inside WANO" newsletter, Volume 21, Number 1, 2013.*

Nuclear Plant Journal

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A Digital & Hard Copy Publication

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Major Modernization

OKG, Sweden has decided to extend the safety modernization of Oskarshamn-2. The modernization work in the turbine hall has been successfully completed, as have all the major mechanical installations. The full focus is on the installation of electric power and control equipment. This is the most comprehensive part of the work and includes the rebuilding of the control room:

"As the project has been evaluated, schedules have constantly been made and the focus on safety and quality of implementation always been the highest priority. Since we can see there will be delays in the work connected with the electrical and control equipment, we have decided to extend the safety modernization. We are now looking at the schedules together with the main suppliers, to see when the restart of the plant can occur," says Johan Svenningsson, Managing Director of OKG.

The delays have been partly caused by the unique and advanced nature of the challenge of laying an enormous volume of cables in an existing facility, with the limitations and the requirements for separation. This delay also delays other work and affects the possible restart date.

"The initial schedule and input data that we received from the main suppliers to the safety modernization contain some uncertainties and indicate a restart in spring 2015. Our own initial assessment indicates a restart during summer 2015. Until these uncertainties have been clarified, OKG will be unable to give any exact information about the planned restart date. It is clear however that the plant will be shut down over the coming winter, which we naturally regret," says Johan Svenningsson.

The current modernization of Oskarshamn-2 is in total a very large and complex industrial project, which involves an investment of approximately SEK 8 billion ($1.17 billion). The project has therefore been divided into stages; safety modernization is the second last and most significant stage. Because of delays during the safety modernization, OKG has already advised that the coming power increase stage will not be performed during 2015. The aim is now to implement the power increase during 2017.

Oskarshamn-1 has completed its annual maintenance shutdown and is once more in operation. The annual maintenance shutdown at Oskarshamn-3 is now ongoing – the planned restart is June 30, 2014.

Facts

The safety modernization began on June 1, 2013 and is the second to last stage in the modernization of Oskarshamn-2. The modernization of Oskarshamn-2 covers a safety upgrade, plant life extension and a power increase.

It has been calculated that after the project is completed, the plant will be able to deliver competitive electricity for at least another 20 years.

The modernization creates added value for the electricity consumer and also the environment, by replacing fossil-based electricity production in the European energy system equivalent to 1 million tons of carbon dioxide a year.

800 tons of new components will be installed in the plant and 850 kilometers of cable will be laid. 5,800 different items in the plant are affected and the heaviest lift is 158 tons. 80,000 connections and 20,000 welds will be made. More than 2,000 people from several European countries are involved in the project.

The modernization project will be concluded with a power increase from 660 MW to 840 MW.

OKG was founded in 1965 and today owns and operates three nuclear reactor units – Oskarshamn-1, 2 and 3 – which together account for ten percent of the total electricity generation in Sweden. OKG presently has approximately 850 employees.

The plant is located on the Swedish east coast, 30 km north of Oskarshamn. Oskarshamn-1, also Sweden's first commercial nuclear power unit, was commissioned in 1972. Oskarshamn-2 has been in operation since 1974 and Oskarshamn-3 was put into commercial operation in 1985.

Contact: website: www.okg.se/en ■

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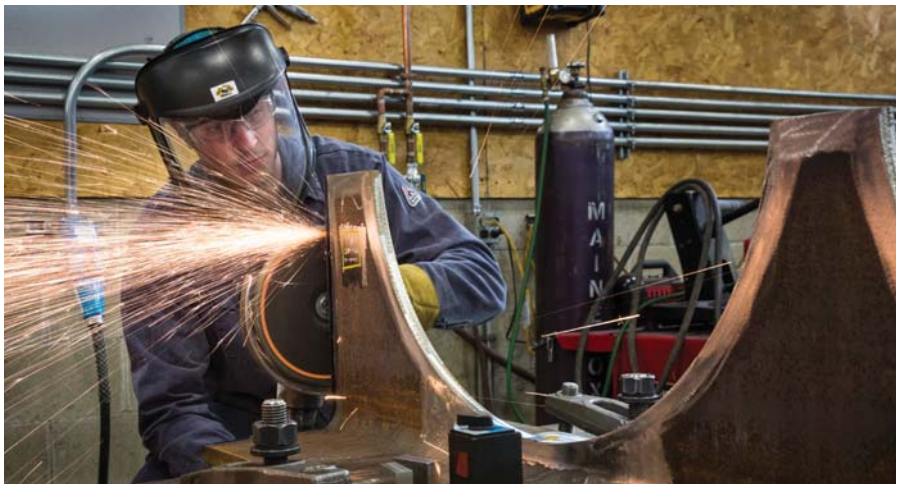
Westinghouse Manufacturing: Meeting Customer Needs Around the Clock

For nuclear utilities, response time for emergent issues is critical, especially during an outage. In the midst of a recent outage, a utility discovered that some reactor coolant pump (RCP) bolts needed to be replaced. The bolts were not standard replacement parts and had to be custom manufactured on deadline in order to meet the outage schedule.

Knowing that Westinghouse has the capabilities to manufacture major components, the utility contacted Westinghouse to provide the RCP bolts. Westinghouse's manufacturing facilities are staffed around the clock, and the company's skilled welders, machinists and manufacturing technicians were able to safely manufacture high-quality parts to meet the customer's outage schedule and deadline.

Westinghouse's world-class, global manufacturing capabilities include: precision machining with heavy and light Computer Numerical Control System (CNC) mills and lathes; large horizontal and vertical CNC boring mills; heavy crane capacity (up to 200 tons); fuel-handling equipment manufacturing, nuclear fuel and components manufacturing; instrumentation and control, and electro-mechanical products. Westinghouse welders, machinists and technicians are experienced in working with numerous metals, including stainless steel, carbon and alloy steels, Inconel®, Monel®, Stellite™ and zirconium alloys. A variety of precision manufacturing, welding and machining processes are used in our state-of-the-art global manufacturing facilities.



An air tank mid-frame is prepared for fabrication by a Westinghouse fabrication mechanic.

At Westinghouse, safety, quality and customer support are our top priorities. Westinghouse's manufacturing quality assurance programs are top notch, employing a number of non-destructive examination (NDE) methods, including magnetic particle, liquid penetrant, visual, radiographic (RT) and ultrasonic testing to ensure optimal quality.

Westinghouse employs the best welders, machinists and manufacturing technicians in the industry, and they are on hand to support critical needs around the clock. Whether a replacement part is needed, a damaged component is found during an outage, or you're placing your next routine order, you can be sure that Westinghouse has the facilities and the experience to deliver what you need.

A machine-arch, gas tungsten welding process called hard surfacing is performed on a Stellite™ product at a Westinghouse manufacturing facility.

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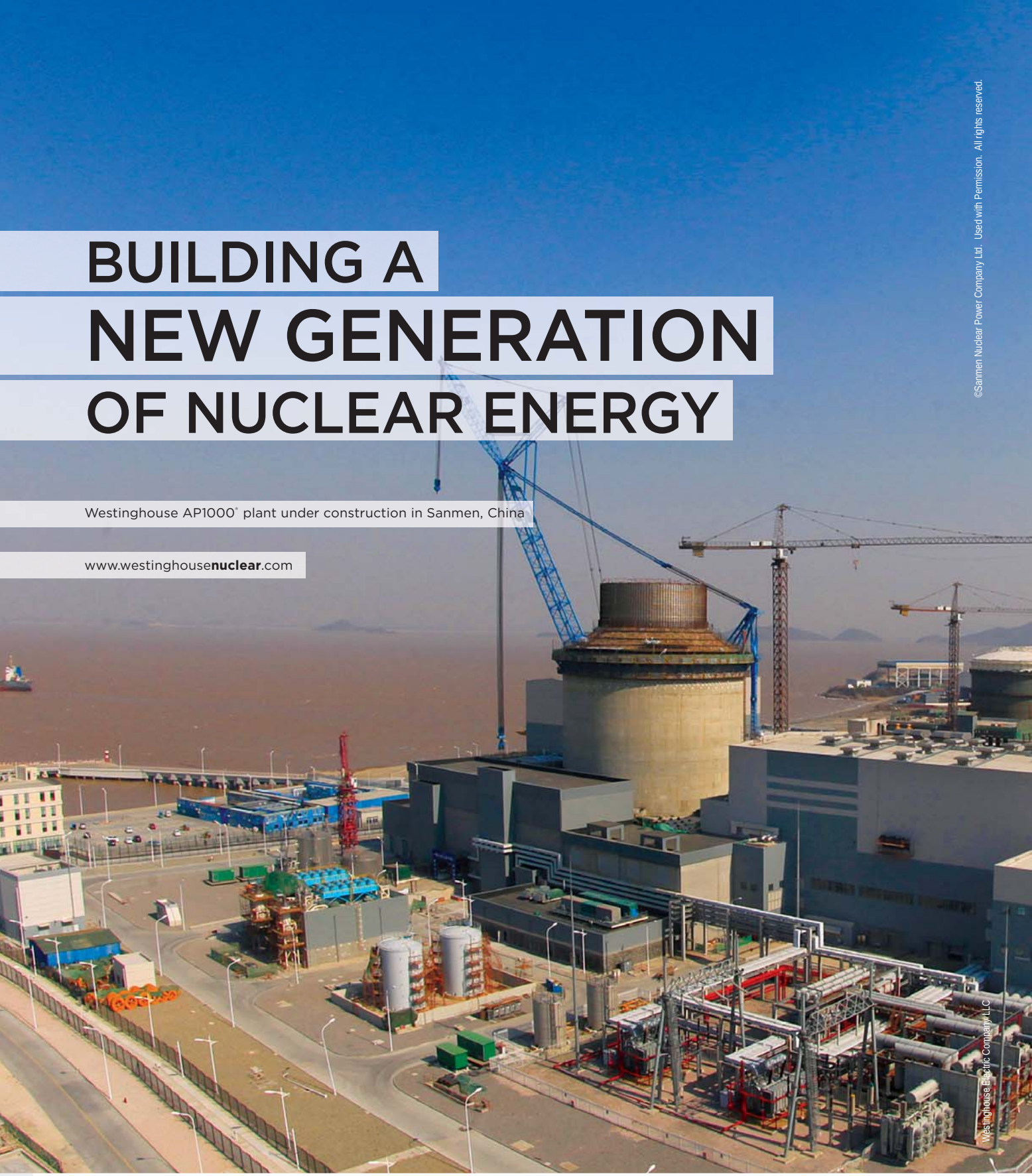

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