FIELD REPORT#4

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May-June 2011, Volume 29 No. 3
29th Year of Publication

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Nuclear Energy & Climate Change
By Richard A. Meserve, Carnegie Institution for Science

Best NPP Operating Experience Worldwide
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Nuclear Turbine Upgrade Technologies
By Eiichiro Watanabe, Mitsubishi Heavy Industries, LTD.

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Fukushima Sequence of Events & Seismic Attributes
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On The Cover
Located on a hilltop northeastern Pennsylvania, the Susquehanna nuclear power plant is a 2,501-megawatt facility with two boiling water reactors and two closed-cycle cooling towers. See page 48 for a profile.

Mailing Identification Statement

Nuclear Plant Journal (ISSN 0892-2035) is published bimonthly: January-February, March-April, May-June, July-August, September-October, and November-December by EQES, Inc., EQES, Inc., 1400 Opus Place, Suite 904, Downers Grove, IL 60515. The printed version of the Journal is available cost-free to qualified readers in the United States and Canada. The digital version is available to qualified readers worldwide. The subscription rate for non-qualified readers is $150.00 per year. The cost for non-qualified, non-U.S. readers is $180.00. Periodicals (permit number 000-739) postage paid at the Downers Grove, IL 60515 and additional mailing offices. POSTMASTER: Send address changes to Nuclear Plant Journal (EQES, Inc.), 1400 Opus Place, Suite 904, Downers Grove, IL 60515.

Nuclear Plant Journal, May-June 2011

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**Nuclear Plant Journal** Rapid Response Fax Form May-June 2011

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New Energy

Bulgaria

AREVA and the Bulgarian Energy Holding Company have signed a memorandum of understanding (MOU) to develop clean energy projects in Bulgaria based on the group’s low-carbon technologies. As a long time partner of the country, AREVA intends to extend its contribution to Bulgaria’s civil nuclear program and assist in developing local renewable energy sources such as biomass and wind.

The MOU provides for potential cooperation in new nuclear projects on the Kozlodui and Belene sites. It also covers the elaboration of fuel management policies and solutions including spent fuel recycling as well as cooperation in the field of nuclear safety and related standards. The parties intend to study cooperation in the development of scientific and technical potential regarding civil nuclear safety, including educational and training activities for improving the qualification of nuclear experts and exchange of experience.

Contact: Pauline Briand, telephone: 33 1 34 96 12 15, email: press@areva.com.

Grant

The Babcock & Wilcox Company (B&W) has received a $5 million grant from the Virginia Tobacco Indemnification and Community Revitalization Commission (TICRC) for its Integrated System Test (IST) facility in Bedford County, Va. The facility is located at the Center for Advanced Engineering and Research (CAER), currently being constructed at the New London Business & Technology Center.

The grant supports further development of the B&W mPower reactor that represents a new generation of smaller, scalable nuclear power plants based on B&W mPower reactor technology.

The test program will collect data to verify the reactor design and safety performance in support of B&W’s licensing activities with the Nuclear Regulatory Commission. B&W anticipates the facility will begin testing activities later in summer 2011.

Contact: Jud Simmons, telephone: (434) 522-6462, email: hjsimmons@babcock.com.

Draft Recommendations

The following are a few of the Blue Ribbon Commission’s Draft Recommendations:

- Reactor & Fuel Cycle Technology Subcommittee: The U.S. government should provide stable, longterm RD&D (research, development, and demonstration) support for advanced reactor and fuel cycle technologies that have the potential to offer substantial benefits relative to currently available technologies in terms of safety, cost, resource utilization and sustainability, the promotion of nuclear nonproliferation and counter-terrorism goals, and waste storage and disposal needs.

- Transportation and Storage Subcommittee: The United States should proceed expeditiously to establish one or more consolidated interim storage facilities as part of an integrated, comprehensive plan for managing the back end of the nuclear fuel cycle.

- Disposal Subcommittee: The United States should proceed expeditiously to develop one or more permanent deep geological facilities for the safe disposal of high-level nuclear waste.

Permanent disposal is needed under all reasonably foreseeable scenarios.

- Geologic disposal in a mined repository is the most promising and technically accepted option available for safely isolating high-level nuclear wastes for very long periods of time.

Following the release of the full commission draft report, the BRC will be seeking further comment through more public meetings and other opportunities.

www.NuclearPlantJournal.com

Plans and dates for this will be released later in June.

Contact: email: brc@nuclear.energy.gov, website: www.brc.gov.

Vietnam

The International Atomic Energy Agency (IAEA) and Vietnam signed the Country Program Framework 2010-2015 (CPF) during the meeting between Vietnam’s Inter-ministerial mission and IAEA on Development of the Integrated Master Plan (IMP).

8 country projects (VIE) will be implemented within the framework of CPF, including some projects relating directly to nuclear electricity such as developing nuclear electricity infrastructure and developing safe nuclear infrastructure for the first nuclear electricity factory.

Together with the formulation of IMP on developing Vietnam’s nuclear electricity infrastructure for the 2011 - 2015, the CPF Signing Ceremony was one of important steps to promote cooperation between IAEA and Vietnam in research, development and use of atomic energy for peaceful purposes in Vietnam, especially in the nuclear electricity field.


Kaiga-4

The fourth units of Kaiga Generating Station (KGS-4), India, which achieved first criticality on November 27, 2010, was synchronized with the Southern grid on January 19, 2011 after completion of mandatory tests and clearance by the Atomic Energy Regulatory Board, India.

With the synchronization of KGS-4 to the grid, India’s nuclear power capacity has increased to 4780 MW with 20 reactors in operation. The installed capacity of the Kaiga site has since increased to 880 MW.

Contact: Vikram Sarabhai Bhavan, Bombay, India, Nuclear Power Corporation of India Limited, telephone: 2599 3000, website: www.npcil.nic.in.

Nuclear Plant Journal, May-June 2011
At Howden, our aftermarket support team gets you the right fix, the first time. We’re armed with more than 150 years of knowledge, along with OEM documentation and expertise to service and supply equipment and parts originally manufactured as JOY Fans, Westinghouse and Buffalo Forge. That means that we’re able to fix your products faster, with less guesswork, to bring them online as quickly as possible. Combine that with our 24-hour emergency support, and you’ve got a team you can depend on for the life of your product.

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Utility, Industry & Corporation

Utility

Merger

The boards of directors of Exelon Corporation and Constellation Energy have signed a definitive agreement to combine the two companies in a stock-for-stock transaction. The agreement brings together Exelon’s large, environmentally-advantaged generation fleet and Constellation’s customer-facing businesses, creating a platform for growth and delivering stakeholder benefits.

The resulting company will retain the Exelon name and be headquartered in Chicago. Exelon’s power marketing business (Power Team) and Constellation’s retail and wholesale business will be consolidated under the Constellation brand and be headquartered in Baltimore. Both companies’ renewable energy businesses will also be headquartered in Baltimore, and the three utilities within the new Exelon – BGE, ComEd and PECO – will remain standalone organizations.

Contact: Lawrence McDonnell, telephone: (410) 470-7433.

Best in Class

The 2011 Top Industry Practice awards were given by the Nuclear Energy Institute in Washington D.C. with Entergy garnering national recognition in two categories: excellence in plant operations by the Indian Point Energy Center in New York for an equipment hatch plug and to Arkansas Nuclear One for materials and services excellence for the creation of the tungsten shielding and vest.

Contact: Margie Jepson, telephone: (601) 368-5460, email: mjepson@entropy.com.

Industry

Lessons Learned

On March 31, 2011, Japanese Prime Minister Naoto Kan met with French President Nicolas Sarkozy, who was making an urgent visit to Japan to discuss developments at the Fukushima Daiichi Nuclear Power Station. The two leaders then spoke to the press.

Prime Minister Kan stated that Japanese people were determined to work together to face and overcome the national crisis. He went on to say that it was Japan’s responsibility to examine the lessons learned and share them with the international community, so as to prevent similar occurrences from happening again. He said that Japan would do its utmost to prevent the disaster from expanding, and that it would thoroughly examine the entire sequence of events once things have settled down.

President Sarkozy said that he was moved by the composed response and the courageous actions of the people of Japan in the face of the major crisis, the worst for the nation since 1945. He also stated that it was necessary to establish international safety standards to make nuclear energy safe—preferably as early as the end of this year – in the wake of the occurrences at Fukushima.

In response to a request from the French president, Prime Minister Kan said that he would make an opening statement at the G8 summit meeting to take place in France on May 26-27, 2011, appear at a G20 meeting that France wants to convene in May to discuss the international nuclear safety standards, and discuss the issues at the International Atomic Energy Agency (IAEA) Ministerial-level Conference in June, 2011.

Contact: Mio Kimuro, Japan Atomic Industrial Forum, website: www.jaif.or.jp/english.

NIRMA

NIRMA celebrates its 35th anniversary with a special 2011 Nuclear Information Management Conference, Forging Excellence in the New Era Across the World, August 14-17 in Summerlin, Las Vegas, NV. The three-track technical program featuring leading industry topics expands into Sunday, and the rich networking program incorporates two new events, as well as vendor exhibit activities. Details and registration at nirma.org.

Contact: Jane Hannum, telephone: (603) 432-6476, email: nirma@nirma.org.

Agency Response

The Nuclear Regulatory Commission has voted to launch a two-pronged review of U.S. nuclear power plant safety in the aftermath of the March 11, 2011 earthquake and tsunami and the resulting crisis at Japanese nuclear power plant.

The Commission supported the establishment of an agency task force, made up of current senior managers and former NRC experts with relevant experience. The task force will conduct both short- and long-term analysis of the lessons that can be learned from the situation in Japan and the results of their work will be made public.

The Commission sets an aggressive schedule for the task force to provide formal updates on the short-term effort in 30, 60, and 90 days.

Contact: telephone: (301) 415-8200, email: opa.resource@nrc.gov.

Corporation

“U” Stamp

The American Tank & Fabricating Company (AT&F) has the longest-running “U” Stamp and many years of experience serving the marketplace with reliable quality tanks, vessels and metal components. ASME “U” Stamp Number 14 was awarded to AT&F the first year the ASME began issuing numbered stamp certifications. Stamp numbers 1 through 13 are no longer active. This is quite a distinction as ASME recently issued stamp number 40,494.

AT&F has added a full complement of nuclear capabilities: ASME “N”, “NA”, “NS”, “NPT”, and “N3” stamps.

Contact: Kevin Cantrell, telephone: (216) 252-1500, email: cantrellk@atfco.com.
Engineering Services
AREVA Canada signed a three-year business development agreement with Cegertec to promote engineering services for maintenance and service work in the Québec nuclear energy market. The agreement capitalizes on shared synergies, staffing resource coordination and their respective expertise in nuclear and electric energy fields, increasing the scope of their nuclear services offers.

The agreement is an extension of the working relationship between AREVA and Cegertec who have already worked on projects in Québec, India and the United States.

Contact: Jarret Adams, telephone: (301) 841-1695, email: jarret.adams@areva.com.

Fukushima Decontamination
Following a request from Tepco, AREVA proposed a solution to treat most of the contaminated water from the damaged Fukushima nuclear power plant, which the Japanese power company has just accepted. The contaminated water must be treated rapidly as it is preventing Tepco from repairing the power plant’s power supply and cooling systems.

For three weeks, AREVA has sent radioactive effluent treatment specialists to Japan to participate in work groups with Tepco. Backed by large teams in France, Germany and the United States, they proposed a method based on a coprecipitation concept. Developed by AREVA and used in the Marcoule and La Hague facilities, the process uses special chemical reagents to separate and recover the radioactive elements. AREVA will then draw on its expertise and solutions for treating and managing these elements.

AREVA also called on the skills of Veolia Water (wastewater treatment). A large-capacity treatment plant equipped with the co-precipitation process will be delivered by AREVA. This installation will sharply reduce the radioactivity levels of the treated water, which could be reused in the power plant’s cooling systems.

Contact: Pauline Briand, telephone: 33 1 34 96 12 15, email: press@areva.com.

New Website
AREVA launched its new website for North America, http://us.areva.com. The site provides an accessible way to learn more about AREVA’s news and activities while giving a closer look at the low-carbon power generation solutions for the U.S. and Canadian energy markets.

With new and interactive features and a plethora of information on nuclear energy and renewable sources, AREVA’s new North America website continues the important dialogue and online conversation about today’s energy needs and the options available to meet them.

As part of the company’s commitments to open dialogue and transparency, the site provides extensive information about AREVA’s operations. It also details the important infrastructure investments the company is making to support new energy development.

Contact: Susan Hess, telephone: (301) 841-1693, email: susan.hess@areva.com.

N-Stamp Certification
The Babcock & Wilcox Company (B&W) announced that its Babcock & Wilcox Nuclear Operations Group, Inc. (B&W NOG) manufacturing facility in Euclid, Ohio, has received N-Stamp accreditation from the American Society of Mechanical Engineers. The certification is considered the industry standard for quality assurance of materials, design, construction, operation, inspection and continuing maintenance of nuclear facilities. B&W’s Mt. Vernon, Indiana; Barberton, Ohio; Lancaster, Ohio; and Cambridge, Ontario, Canada; facilities also hold N-Stamp certifications.

The B&W NOG-Euclid facility is a full-spectrum nuclear supplier with design, manufacturing, inspection, assembly and testing capabilities.

Contact: Carla Parks, telephone: (434) 522-5753, email: cjparks@babcock.com.

Valve Agreement
Curtiss-Wright Flow Control Company announced that it will be expanding its commercial nuclear power teaming agreement with its partner Cameron International Corporation to include support for its WKM® Pow-R-Seal® gate valves. Under the agreement (Continued on page 12)
Curtiss-Wright will manufacture the WKM Pow-R-Seal expanding double disc gate valves under its Quality Assurance (QA) program in accordance with ASME Section III, Division 1 and NQA-1 Quality Standards for Class 1, 2 and 3 requirements for nuclear power plant applications. Work on this contract will be performed by Curtiss-Wright Flow Control Company’s Enertech business unit in Brea, California.

The Pow-R-Seal’s design also provides low pressure drop for compatibility with today’s large turbines used in EPU (Extended Power Uprate) and new construction applications. Enertech will control the Pow-R-Seal with its IEEE qualified (382, 344, 323), ElectroHydraulic Operator (EHO), pneumatic, or electric motor actuator.

Contact: Sharon Dey, telephone: (703) 286-2011, email: sdey@curtisswright.com.

NEI Board

Day & Zimmermann announced that Michael P. McMahon, President of Day & Zimmermann’s Engineering, Construction and Maintenance (ECM) group, has been elected to serve a three-year term on the Nuclear Energy Institute (NEI) Board of Directors.

“Being elected to NEI’s board is a tremendous honor, and it is wonderful recognition for Day & Zimmermann’s contributions to the nuclear industry,” Mr. McMahon said when told of his election. “I look forward to working with my colleagues on the board to help the NEI deliver on its mission to ensure the safety, reliability and regulatory compliance of nuclear energy. The Technical Advisory Board consisting of national experts experienced in the design, operations, safety, and regulatory aspects of nuclear energy. The Technical Advisory Board will help ensure that HI-SMUR 140 embodies the accumulated industry expertise and combined experience to the fullest extent. The mission of the Board is to critique the system from all aspects, specifically concerning safety, reliability, service life, and regulatory compliance. The names of the Board members (in alphabetical order), their affiliation, and professional accomplishments are provided below.

Pierre Oneid, President of SMR, Inc., will serve as the Board’s secretary. The Board will meet as often as the membership deems necessary. The Company will shortly be announcing the designated architect engineer for the HI-SMUR program, whose sponsoring executive will also have a seat on the Advisory Board.

Board members include: John Herron, Entergy Nuclear; Andrew Kadak, Exponent Failure Analysis Associates; William Levis, PSEG Power; Miki Pacilio, Exelon Nuclear; Loren Plisco, NRC retiree.

Contact: Tom Knochenhauer, telephone: (858) 522-8328, email: tom.knochenhauer@ga-esi.com.

Decay Heat Removal

Holtec International has completed the preliminary design of an air cooled heat removal system for spent fuel pools that is deployable at any operating nuclear power station in addition to, or in lieu of, the traditional cooling system currently in use. The spent fuel pool cooling system design currently used in the industry utilizes a pump to circulate the pool’s hot water through a heat exchanger where the pool’s decay heat is rejected to a source of cold water across the walls of the tubes (or thin plates in a plate-type heat exchanger).

The new pool cooling system has the following key design features:

1. An external source of power is not required.
2. It can be installed in any fuel pool at any nuclear plant as a retrofit.
3. The heat removal capacity of the cooling system can be customized to meet the thermal demand of the specific fuel pool.
4. As many cooling systems can be deployed in parallel to cool a pool as deemed necessary by a plant’s owner.

The Company has determined the new cooling system, if structurally designed to withstand Fukushima’s earthquake, would have continued to function in the
wake of the tsunami that struck Japan on March 11, 2011.

Contact: Joy Russell, telephone: (856) 797-0900, email: J.Russell@holtec.com.

Acquisition

Howden has agreed to acquire the entire issued share capital of Thomassen Compression Systems BV ("Thomassen"), Netherlands. The acquisition complements Howden’s existing range of compressors and opens up a much wider market for the company in the oil & gas and petrochemical industries.

This acquisition represents a real boost for the Renfrew, United Kingdom-headquartered multinational as it builds its compressor businesses worldwide and moves into new markets.

Howden and Thomassen have very similar core competencies in the application engineering of custom designed, high technology products for performance critical environments. Howden designs, engineers and supplies air and gas handling equipment including industrial fans, process gas compressors and rotary heat exchangers.

Contact: David Herbertson, telephone: 44 141 885 7918, email: david.herbertson@howden.com.

Marketing Agreement

Merrick & Company (Merrick) and Nuclear Safety Associates (NSA) have announced a joint marketing agreement between the two firms to serve the North American and global nuclear market. Merrick/NSA will provide the nuclear industry with a complete service offering of analysis, engineering design, and fabrication/construction management services to meet the continuing growth of the industry. Both firms are repeatedly called upon to respond to clients needs with effective and safe solutions on highly complex, technical projects. The team will specifically focus on small modular reactors, medical isotopes, fuel manufacturing, existing fleet support, and research reactors as well as other opportunities within the market. The team’s services will include feasibility studies, licensing support, criticality safety, structural analysis, equipment, system, and facility design, and fabrication and construction management.

Contact: Deb Schindler, telephone: (720) 519-3188, email: deborah.schindler@merrick.com.
The equipment and controls in this nuclear plant must function flawlessly.

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New Products

Lighting Fixture

BIRNS introduced enhancements to the popular BIRNS Kelvin™, a fuel pool lighting fixture. This system is seismically qualified per IEEE-344. It has a 3200K tungsten white light that’s easily decontaminated, and relamps in just 60 seconds with a choice of wide, medium or narrow beam lamps. It mounts on a special BIRNS pan-and-tilt yoke, hangs from a suspension assembly or secures (solo or dual) to any of the BIRNS mounting poles. The new model (5813) includes advanced safety features like rugged stainless steel mesh coverings, and a Lexan protector with specially designed Lexan plugs for the finger holes.

This system features a 120v/1,000w lamp with instant ON/OFF and hot-re-strike capability and is designed for underwater use in areas with high levels of radiation and nuclear contamination. It’s ideal for long-term illumination of fuel pools and transfer canals, and is extensively used in reactor cavity illumination during fuel movement or other large-scale activities.

Contact: telephone: (805) 487-5393, email: service@birns.com.

Expansion Joints

Elastomer expansion joints from Garlock Sealing Technologies LLC absorb movement and dampen vibration to reduce detrimental stresses on piping systems for the nuclear power industry’s aging emergency diesel generators (EDGs). Standard pressure and temperature ratings of 250 psi and 400°F respectively exceed requirements for EDG systems, where these devices can reduce vibration levels by as much as 65%.

Contact: telephone: (800) 448-6688.

Rad Camera

The Mirion Technologies Imaging Systems Division announces the release of the IST-Rees™ HD-Rad imaging system for the nuclear inspection market. The HD-Rad camera ensures a superior viewing experience by providing users with crisp, color, high definition images with HD analog component output.

Features of the HD-Rad camera:
- Resolution > 750tv (television lines)
- High definition, color performance
- Radiation tolerance greater than 5 x 104 rads
- Ease of HD module replacement
- 10:1 optical zoom with 4x digital
- Integrated camera/lights/pan & tilt
- Variable speed pan and tilt

This camera is constructed from stainless steel and is capable of providing the higher radiation tolerance necessary for a variety of inspection requirements. The major components are field serviceable in order to enable maximum availability at critical times.

Contact: Kimberly Croxson, telephone: (925) 543-0806, email: kcroxson@mirion.com.

Protective Clothing

OREX’s proprietary, cutting-edge, dissolvable, protective clothing technology has set a new standard for radiation protection within the nuclear industry. Its fabric technology has been proven to significantly reduce personal contamination events. Its dissolvability eliminates radioactive waste and reduces associated disposal costs.

Contact: John Steward, email: jsteward@orex.com.

Reinforced Polyethylene Laminate

Reef Industries, Inc. offers Griffolyn®, an internationally reinforced polyethylene laminate. All Griffolyn® materials are performance engineered for the most difficult applications while providing the ability to withstand extended exposure to weather. Griffolyn® products can protect your investments year round. These high quality plastics can be produced with specialized properties including fire retardancy for safety applications around critical materials or work areas, or antistatic and corrosion protection for sensitive equipment.

Contact: Tom Scarborough, telephone: (713) 507-4251, email: tscarborough@reefindustries.com.

Inspection System

Remote Ocean Systems® new PTZ-1000 HD Inspection System is designed to provide high definition video in refuel outage environmental conditions.

The PTZ-1000 design is streamlined for vertical deployment and it can fit through a 5” diameter hole to reach tight spaces. The modular construction allows for fast and easy servicing when needed and radiation tolerance is increased due to the minimized electronics in the underwater head.

The HD inspection head is operated with a single controller and resides in a 2U 19” rack mount.

Pan and Tilt controls operate via an X-Y analog proportional Joystick and the system allows continuous (360°) on pan. The high definition camera is controlled by a large toggle switch for ease of operation and bi-lateral LED lights provide outstanding illumination for close-up inspection.

Contact: telephone: (858) 565-8500, email: sales@rosys.com.

Lead Bricks

Water Gremlin Company, a Minnesota-based manufacturer of lead components for the nuclear and radiation shielding industries, has developed a line of precision tolerance lead bricks used in radiation shielding applications. This product can be offered in varying lengths eliminating scrap material and features a four-way close tolerance chevron edge for a unique seamless precision fit.

Contact: Jeff Stephens, telephone: (651) 255-9367, email: jeff.stephens@watergrem.com.

(Continued on page 16)
New Products...  
Continued from page 15

Emergency Fuel Pool

Westinghouse Electric Company has developed an emergency fuel pool cooling system (EFPCS) to keep spent nuclear fuel cool in emergency situations, including the loss of all plant power.

The system consists of a permanently installed “primary” cooling loop located inside the reactor building or spent fuel pool (SFP) building, and a mobile “secondary” cooling loop. The secondary cooling loop is stored off-site and then located outside the reactor building for either emergency or pre-planned use. This approach reduces the time required for system assembly and startup, which is especially important during emergency situations, and eliminates the need to enter the reactor building.

Contact: Vaughn Gilbert, telephone: (412) 374-3896, email: gilberv@westinghouse.com.

Services

Consulting
Exponent offers many services for its nuclear power generation clients. Exponent’s engineering services address the utility industry’s needs for design, construction, repair, and retrofit.

Nuclear utility work has required stringent quality assurance requirements. Exponent is ISO 9001 certified and conducts work in strict accordance with a quality control program that meets 10 CFR 50, Appendix B.

Contact: Andrew Kadak, telephone: (508) 652-8509, email: akadak@exponent.com.

Oil Degradation
Herguth Laboratories, Inc. has worked nuclear power plants in the US to develop operating profiles and recommendations for extended use cycles for Reactor Coolant Pump (RCP) oils.

Herguth Laboratories, Inc. provides a rapid turnaround time on analysis reports, so plants may use the results to make decisions about extending their drain cycle. A detailed report containing the plant’s analytical results, interpretation of the plant’s data compared to other similar equipment and oil configurations, and specific recommendations for replacing or extending the oil is sent within days after receipt of samples.

Contact: telephone: (707) 554-4611, email: info@herguth.com.

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Nuclear Plant Journal issues for the last 28 year are now available online through the journal website www.NuclearPlantJournal.com for a nominal fee of $25 per issue. This will enable marketing professionals and engineers to search on any specific term of their interest.

Type your word or phrase in the search box in the top right-hand corner. The search results will be displayed. You may review the text and select a specific issue. Follow the guidelines given in the top of the box to purchase your selected issue.

Contact: Kruti Patel, telephone: (630)858-6161 x 105, email: kruti@goinfo.com.

Engineering Services

Structural Integrity Associates, Inc. (SI) has provided support and engineering services to both domestic and international nuclear utilities for more than 25 years. Engineering assessments, repairs, and consulting services for nuclear plants were SI’s first business offering in 1983. Since then, nearly every nuclear utility in the United States — and many internationally — has relied on SI’s support.

SI’s professional staff is active in ASME Code committees, and they develop technology and software that have become nuclear industry mainstays.

Contact: Vicki Douglass, telephone: (704) 977-2332, email: v Douglass@structint.com.

Contracts

Digital Control Computer

L-3 MAPS has been awarded a contract from Nucleoelectrica Argentina S.A. (NA-SA) to replace the Embalse nuclear power plant’s Digital Control Computer (DCC) systems hardware. Four DCC systems will be delivered to NA-SA under the contract. The first system will be used as a testing and training platform and is due to be installed in early 2013. Three other redundant DCC systems for plant operations are expected to enter service in mid-2014.

DCC systems are used to monitor and control the major reactor and power plant functions at CANDU nuclear power plants. The new DCC systems will feature the latest SSCI-890 CPUs and modern VME-based replacements for the existing Ramtek display system, and will replace the Varian 73 computer systems and related equipment.

Contact: Andre Rochon, telephone: (514)787-4953, email: media.mapps@L
dcom.com.

Valve Actuators

Rotork, United Kingdom, has been awarded a major contract for the supply of electric valve actuators for the Hong Yan River and Ningde Nuclear Power Station project in China.

More than 1200 Rotork IQPro intelligent electric valve actuators have been ordered for Phase 1 of the new power station complex, which will deliver a designed generating capacity of 16000MW when all phases are completed. The Rotork actuators will operate butterfly, gate and check valves on ancillary plant including high pressure systems serving the station’s pressurized water reactors.

Contact: telephone: 44 1225 733200, email: mail@rotork.co.uk.
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New Documents

ANS Standards

1. ANSI/ANS-15.11-2009: Radiation Protection at Research Reactor Facilities. This standard establishes the elements of a radiation protection program and the criteria necessary to provide an acceptable level of radiation protection for personnel at research reactor facilities and the public consistent with keeping exposures and releases as low as is reasonably achievable. Price: $98.
2. ANSI/ANS-40.37-2009: Mobile Low-Level Radioactive Waste Processing Systems. This standard sets forth design, fabrication, and performance recommendations and requirements for mobile low-level radioactive waste processing (MRWP) systems (including components) for nuclear facilities that generate low-level radioactive wastes as defined by the Atomic Energy Act as amended. The purpose of this standard is to provide guidance to ensure that the MRWP systems are designed, fabricated, installed, and operated in a manner commensurate with the need to protect the health and safety of the public and plant personnel. Price: $5.

To receive a complimentary copy of the above standards, contact Jeanette Gabrys, American Nuclear Society, 555 N. Kensington Avenue, La Grange Park, IL 60526; telephone: (708) 352-6611, email: jgabrys@ans.org.

Handbook

Gilson and Voss Handbook of Radiation Data - A pocket-sized “field manual” of data, charts, formulae and facts useful to professionals in the fields of radiation monitoring and protection. The Gilson and Voss Handbook of Radiation Data has an international circulation (30 countries at last count) and more than 60,000 copies have been distributed. Price: $5.

Contact: Tom Voss, telephone: (505) 920-1470, email: tjvoss@newmexico.com.

EPRI

1. Nuclear Plants Optimize Used Fuel Dry Cask Storage with EPRI Software Cask Loader program enables nuclear plants to standardize and streamline interim on-site storage of used fuel assemblies. Product ID: 1023167. Published April, 2011.

Entergy, Exelon and other nuclear utilities are applying EPRI’s Cask Loader software to plan and execute the loading of used fuel assemblies into dry cask storage. The software, along with collaboration and information sharing among members of the Cask Loader User Group, is helping utilities:

- Optimize cask loading cost and scheduling
- Ease crowding in spent fuel pools
- Analyze cask loading scenarios to plan future used fuel management strategies
- Standardize dry cask storage procedures across multiple sites.


The report provides technical guidance for addressing cyber security requirements during the system development life cycle (SDLC) phases of a plant digital system, device, or component (digital asset) within the scope of 10 CFR 73.54 under the station cyber security program.


This report updates Electric Power Research Institute (EPRI) report 1021508, Losses of Offsite Power at U.S. Nuclear Power Plants — 2009, which provides a database and overview analysis of losses of offsite power at U.S. nuclear generating units for the 10-year period 2000 through 2009. This update provides loss of offsite power data for the year 2010 and limited overview data and analysis for the 10-year period 2001 through 2010.

Report

ICRP Publication 111

In this report, the Commission provides guidance for the protection of people living in long-term contaminated areas resulting from either a nuclear accident or a radiation emergency. The report considers the effects of such events on the affected population. This includes the pathways of human exposure, the types of exposed populations, and the characteristics of exposures. Although the focus is on radiation protection considerations, the report also recognizes the complexity of post-accident situations, which cannot be managed without addressing all the affected domains of daily life, i.e. environmental, health, economic, social, psychological, cultural, ethical, political, etc.

For a free download of this report, go to: http://www.icrp.org/publication.asp?id=ICRP%20Publication%20111.

Launderable Products

Exponent, a renowned environmental sciences firm, recently studied the consequences of using launderable and single-use (PVA) nuclear protective clothing. The full life cycle inventory considered all aspects of manufacture, transportation, laundering, and disposal of each garment type. Their report concludes that using UniTech’s ProTech launderable produces just 6% of the greenhouse gas equivalents generated by PVA disposable – achieving savings of 475 metric tons/year/reactor unit. The independent report is available to download at www.unitechus.com (ISO 14001).

Contact: Steve Hofstatter, email: shofstatter@unitechus.com.
Meeting & Training Calendar


6. **52nd Annual Meeting of the Institute of Nuclear Materials Management** INMM, July 17-21, 2011, Palm Desert, California. Contact: telephone: (847) 480-9573, fax: (847) 480-9282, email: inmm@inmm.org.


11. **Nuclear Information and Records Management Association** Conference NIRMA 2011, August 14-17, 2011, Summerlin, Nevada. Contact: Jane Hannum, telephone: (603) 432-6476, email: nirma@nirma.org.


15. Spent Nuclear Fuel Dry Storage and Transportation Seminar, September 7-9, 2011, Atlanta, Georgia. Contact: Chris Delance, **NAC International**, email: cdelance@nacintl.com.


Committed to Doing Nuclear Right

By William McCollum Jr., Tennessee Valley Authority.

1. What are TVA's current “New Build” plans?

We pursue our nuclear projects in three phases, development, engineering, and construction. We strive to have only one project in any given phase at any one time. In the construction phase right now, we have Watts Bar Unit 2, that’s well under construction and should complete within a year or so. In engineering phase, we have Bellefonte Unit 1, and we’ll get to a point within the next year where we are ready to make a recommendation relative to proceeding on Bellefonte Unit 1. In the development stage, we have small modular reactors. We signed a memorandum of understanding with Babcock & Wilcox and Bechtel regarding their mPower reactor. We have had some discussions about developing a small modular reactor project and whether that’s a feasible option for us.

Watts Bar Unit 2 is being constructed under a Part-50 license process, and we have filed an application for operating license. Bellefonte Unit 1 is also under the Part-50 process, and we have a construction permit which is in “deferred plant status” right now. If we were to pursue completion of Bellefonte Unit 1, we would use the Part-50 process and activate the construction permit and then apply for an operating license. With the small modular reactors, we are looking at the options for licensing, and we believe there might be some benefit to doing some initial work under Part-50, but making a combined operating license application under Part-52 with the NRC for two AP1000 units at Bellefonte which would be Bellefonte Units 3 and 4.

2. How will the “New Build” be financed?

TVA receives no appropriations or subsidies from the government. Our operations are totally self-funded from power revenues. We have the ability to sell bonds and that, combined with the money we get from our power sales, funds all our activities. Any projects we pursue would use a combination of borrowing and revenues for funding.

TVA is a unique institution in that our board of directors is appointed by the President of the United States and has the ability to set wholesale rates within our service territory. The TVA board has the flexibility to adjust rates and authorize borrowings, within prescribed limits, to fund our operations and construction activities.

Separately at Bellefonte, the units that were under construction previously are designated as Bellefonte’s Units 1 and 2. We also have a combined operating license application under Part-52 with the NRC for two AP1000 units at Bellefonte which would be Bellefonte Units 3 and 4.

3. How has TVA responded to NRC Information Notice 2011-05 dated March 18, 2011, related to review of its plants due to Fukushima natural disaster?

We have six nuclear units in operation right now; three at Browns Ferry, two at Sequoyah, one at Watts Bar and a second unit under construction at Watts Bar. Immediately following the natural disaster in Japan, we put together a team within TVA to assess the information coming out of the events in Japan and to look at things we needed to do to make our defenses against these occurrences more robust. The team came together and began to look at all the information available. Information is still emerging, so we continue to evaluate it and incorporate everything we can in our reviews. We began looking not only at Browns Ferry, but our other nuclear units as well. We needed to know whether our defenses for natural disasters, multiple occurrences and things that may beyond our plants’ design basis are robust enough.

We looked at events that go beyond the NRC’s B-5.l and SAMG (Severe Accident Management Guidelines).

An Interview by Newal Agnihotri, Editor; Nuclear Plant Journal at the Nuclear Energy Assembly in Washington, D.C. on May 11, 2011.

Bill McCollum was appointed Chief Operating Officer of the Tennessee Valley Authority in April 2007. He is responsible for the management of TVA’s power production, transmission, power trading, and resource management programs.

McCollum came to TVA from Duke Energy, where he served as Group Executive and Chief Regulated Generation Officer.

A native of Rossville, Georgia, McCollum graduated from the Georgia Institute of Technology with a bachelor of science degree in electrical engineering in 1973 and a master’s degree in nuclear engineering in 1974.

He received a master’s in business administration from the University of North Carolina at Charlotte in 1983.

McCollum is a registered professional engineer in North Carolina and South Carolina. He has held a Nuclear Regulatory Commission-issued senior reactor operator license for Catawba Nuclear Station.

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(Continued on page 22)
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Continued from page 20

events, assessed our capabilities and determined where we could make those defenses more robust. For instance, we plan on using small gasoline-powered electric generators to help us charge batteries, maintain communications and last longer in the event of some beyond-design basis event. Satellite phones are available so that in the event of a natural disaster--where you may not have land line phones or cell phone towers may be destroyed--you’d have the opportunity to still maintain good communications with the site. We’re also considering longer term actions, such as installing hard pipe runs to the spent fuel pools with connections outside of the buildings where you’d be able to bring in fire pumps, hook them up and put water in the spent fuel pool. INPO issued their IER, and it had a list of four or five areas to review. We incorporated them; in fact most of them were areas, we were already looking at as part of our review, and we provided our responses back to INPO. The NRC has also issued their temporary instructions, and we have incorporated those as well. So this is all about taking stock of all of the information available from Japan and looking at our capabilities for multiple natural disasters--what we refer to as stacked events--where you might have floods, tornadoes or other natural disasters occurring simultaneously. That work is ongoing and some of these actions will take years to complete.

4. How did TVA and its nuclear power plants cope with the current series of tornadoes and thunderstorms in its territory?

We had an unprecedented outbreak of severe thunderstorms and tornadoes in late April 2011. The hardest hit area for us was northern Alabama. Because of the loss of all of our 500,000-volt transmission lines in the area around Browns Ferry Nuclear Plant, all three units automatically shut down. The plant shut down safely, and all safety equipment worked to keep the units stable. Seven of the plant’s eight emergency diesel generators were available and operated as designed as the operators brought all three units to cold shutdown. We have since restored off-site power, and the units are being returned to service. It was a devastating storm, the biggest tornado outbreak in history. There were over 153 tornadoes in just a limited area across Mississippi and Alabama, and our transmission system suffered the worst damage it has ever experienced.

5. Do TVA’s Mark 1 reactors need any further upgrade due to US NRC Information Notice 2011-05?

Brown Ferry’s physical layout is a little different than Fukushima. Browns Ferry sits on the Tennessee River so we obviously are not going to have a tsunami as they did at Fukushima. You can certainly have some flooding along the river, and the plant was designed with that in mind. Some of the fuel supplies for the diesels at Fukushima may have been exposed to the tsunami, but we have taken steps to prevent that at Brown Ferry. The eight emergency diesels that we have on site are in fully enclosed, water-tight buildings and have fuel supplies that are encased in the buildings or buried underneath. Switchgear that connects to the diesels and feeds the essential loads is inside the secondary containment and is at a higher elevation than the maximum probable flood level. With our design and layout, I think we are in a better position to withstand major flooding than was apparently the case at Fukushima.

6. How has TVA improved the capacity factor of its plants in the last decade?

Over the last decade, capacity factors in the U.S. nuclear industry have improved because we are constantly improving our plants. At TVA, we’ve replaced steam generators on a couple of our pressurized water reactor units and have made many equipment upgrades. We are constantly upgrading equipment and replacing it with newer better equipment. So improvements are ongoing and not a one-time event in the life of the nuclear plant in response to a crisis.

7. How does TVA’s nuclear generation economics compare with the economics of non-nuclear generation?

TVA has more than 1,300 megawatts of wind power under contract. The wind power is from the Midwest which gets shipped into our territory via transmission lines. We have gas-fired generation. We are expanding our gas-fired generation portfolio. We have a large coal-fired fleet as well as a significant amount of hydroelectric generation. If you look at the different forms of electric generation, wind can be competitive under some circumstances; but it’s intermittent, so we can’t rely on it for our baseload power needs. Hydro is very good, and we have a substantial hydroelectric generation portfolio, but there are limited opportunities to expand that. We are doing some upgrades on the hydro units to improve their efficiencies and get a few more megawatts, but there aren’t a lot of opportunities to build new dams and reservoirs. The coal-fired fleet has been a workhorse over the years--we get approximately 60 percent of our electrical energy from our coal plants. But coal is challenged, so building a unit today that would meet all the newest clean air regulations and potentially more regulations that are coming would be a real challenge. And, while coal prices were stable for several decades, more recently they have essentially doubled. They actually spiked up higher than that and came back down a bit to a level that’s about twice where we started. So, to summarize coal, the price of the fuel has increased, and there are a lot of challenges to building and permitting new coal fired units. Consequently, a lot of people right now are looking at gas-fired generation. The capital cost to build a gas-fired generating unit is comparatively lower and then you pay for the cost of the natural gas that you burn over the life of the plant, which is a substantial fuel cost. Comparing gas to nuclear, the capital cost to build a nuclear plant is higher, but the fuel cost is much lower. Once you invest the money up front to build a nuclear plant, you’ve locked in most of your cost and have hedged that against future inflation, and you have a lower fuel cost going forward. Nuclear can be very competitive against gas, but you have to be able to scope and engineer and execute your project well so that you bring it online in time and on budget.

I should also note that TVA has developed a new vision for how we intend to fulfill our mission to serve our region over the next decade. We intend to keep our rates as low as we can, have a highly reliable electric supply and
were very clear to say we didn’t have the information as we understood it coming out of Japan. We explained the differences between our plants and those in Japan. We talked to reporters about the steps we were taking. We explained the differences so we conducted a lot of media outreach.

Due to Fukushima situation?

We wanted to be extremely transparent about what we were doing, including having a media day at Browns Ferry where we had almost 100 media representatives participate. We gave presentations to help them understand Browns Ferry, the design differences and our approach to operations. Then we took as many journalists as we could on a tour of the plant. We had one unit down for refueling, so we were actually able to go inside the primary containment and show them many of the safety features, which I strongly feel promotes a better appreciation of nuclear safety in general. Transparency is extremely important at TVA. We are making greater efforts to reach out, communicate and put things like nuclear plant design, construction and operation in perspective to improve understanding with our stakeholders.

8. How does TVA deal with the challenges of retiring experienced staff members?

With the baby boom generation moving toward retirement, knowledge management, knowledge transfer and the workforce transition are challenges for everybody in every industry. Nuclear is no exception. We have to work hard to incorporate the knowledge that our more senior employees have in our procedures and our programs and record that knowledge so it doesn’t go away when people retire. We have a strong program to bring newer employees into the workforce who can learn, develop and gain some of this knowledge while folks are still here.

9. How has TVA dealt with the general public and the media to alleviate concerns due to Fukushima situation?

We wanted to be extremely transparent about what we were doing, so we conducted a lot of media outreach. We talked to reporters about the steps we were taking. We explained the differences between our plants and those in Japan. We explained the information as we understood it coming out of Japan. We were very clear to say we didn’t have the full picture, and some of the things we think we know now will change as more information becomes available. But, based on what we did know, we wanted to get out and talk to people and address their concerns. We also talked about the safety reviews we were doing and the actions that we’re going to take. We did things to help overall public understanding, including having a media day at Browns Ferry where we had almost 100 media representatives participate. We gave presentations to help them understand Browns Ferry, the design differences and our approach to operations. Then we took as many journalists as we could on a tour of the plant. We had one unit down for refueling, so we were actually able to go inside the primary containment and show them many of the safety features, which I strongly feel promotes a better appreciation of nuclear safety in general. Transparency is extremely important at TVA. We are making greater efforts to reach out, communicate and put things like nuclear plant design, construction and operation in perspective to improve understanding with our stakeholders.


All of us, as we look at the events in Japan, have a serious responsibility to ensure that we perform reviews and incorporate the lessons learned in our operations. We must ensure that we’re well prepared for natural disasters, even those beyond the design basis of the plant.

I said earlier that we are committed to doing nuclear right at TVA. It’s an important part of our vision for the next decade, and we’re going to ensure that we operate and maintain our plants well. Although we’re doing a lot of work that we’re proud of and we’re moving forward with new plants, we’re not at all complacent or self-satisfied. We’re continuing to look every day for the things we need to do to improve our plants, our operations and the overall safety margins of our nuclear power program.

Contact: Ray Golden, Tennessee Valley Authority, telephone: (423) 751-8400, fax: (423) 751-8541, email: rrgolden@tva.gov.

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Nuclear Energy & Climate Change

By Richard A. Meserve, Carnegie Institution for Science.

1. Are costs considered by the NRC in regulating utilities, such as in connection with fire regulations?

It is important for the NRC to evaluate the cost of its regulatory requirements. But as problems are exposed, we do learn things and we need to adapt to them. Our fire regulations needed to be updated and improved. My impression with regard to the fire regulations, based on what I have read, is that there are a number of utilities actually interested in proceeding with the new approach. So, this may be a situation in which an appropriate balance of safety and cost has been reached.

2. Can the U.S. waste classification system be improved?

There is a guide covering all types of waste that has been promulgated by the International Atomic Energy Agency. It covers everything: long-lived and short-lived waste, high level waste, low level waste, very low level waste and exempt waste. Exempt waste is below a threshold such that it can be disposed of outside the regulatory system. In short, there is a systematic structure that the IAEA has defined that covers the whole landscape and has a consistent way to deal with waste presenting similar risks. We do not have a similar approach in the United States and it would be desirable in my view to have a comprehensive and logically consistent system.

In the US we don’t have that sort of logic. We have waste categorized by how it was produced and not by risk. The system is based on the origins of material and has no necessary connection to risk or science or anything else. If it’s uranium milling waste it’s handled one way, but if it’s naturally occurring radionuclides it may be handled another.

3. What about the proliferation risk from the fuel cycle?

There is interest in establishing some sort of a system for both the front end and back end of the fuel cycle to eliminate the proliferation risk associated with enrichment technology and waste reprocessing technology. It would be very desirable to have such a system in place because we have a large number of countries that are now planning to construct reactors that do not currently have them. There is no proliferation risk from the reactors. Proliferation risks can arise from enrichment facilities because the technology could be used for weapons purposes. From a proliferation point of view, it would be desirable to enable countries to use reactors for power production, but not to place them in a position where they feel the need to pursue the other parts of the fuel cycle. From an economic point of view you don’t want to have an enrichment facility producing fuel for just one or two reactors in any event. There is a proposal at IAEA and other organizations as well to try to deal with that problem through establishment on an international level. Similarly, it would be desirable to have international enterprises to handle the spent fuel so that reprocessing is discouraged.

4) How can United States address the challenge of Climate change?

In order to deal with climate change, we need to develop diversity of technologies, and thereby enable reduction of our dependence on fossil fuels. Those technologies must include nuclear power. We will regret that we have not made more progress on nuclear, as well as on solar and wind. We should be doing all of these things to address climate change. I think that for nuclear, the big problem right now is financial.

Contact: Carnegie Institution for Science, 1530 P Street NW, Washington, D.C.; telephone: (202) 387-6404, email: president@carnegiescience.edu.

Responses to questions by Newal Agnihotri, Editor of Nuclear Plant Journal.
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By James A. Glasgow, John H. O’Neill Jr., and Jay E. Silberg, Pillsbury Law.

1. Can U.S. export control regulations be simplified?

James A. Glasgow:

A complex maze of export laws and regulations must be successfully navigated by American companies that seek to win and perform contracts for the design, construction and operation of nuclear power stations outside the United States. They must confront the export controls of the U.S. Department of Energy (DOE) with respect to technology transfer, as well as the U.S. Nuclear Regulatory Commission’s (NRC) rules regarding export of nuclear material and components of power reactors. The Commerce Department’s Export Administration Rules (EAR) are also applicable to exports of some nuclear power plant items (generally for the so-called “balance of plant”).

Some observers claim the U.S. export control system is far more complex and has more barriers to exports than any other country exporting nuclear power-related goods and materials. However, this common perception should be tested. Other supplier nations have specific export controls that are at least as restrictive as those of the United States. For example, Japan recently required the U.S. State Department to provide peaceful use and retransfer assurances, in the form of a “note verbale,” in connection with proposed exports, to the U.S., of nuclear fuel-related technical data. Such assurances go beyond the assurance that the U.S. Government requires for similar exports from the U.S. to Japan.

Furthermore, some Asian countries that are emerging suppliers of nuclear reactors and related goods and services have export control regimes that are largely untested with respect to exports of nuclear power plant components, materials and technical data. Major questions about the effect and scope of their laws are unresolved, including their implementation of the Nuclear Supplier’s Group (NSG) Guidelines for Nuclear Transfers. So, the assumption that buying nuclear components, materials or technology from U.S. suppliers means accepting a more complex export control regime is not necessarily true in every instance.

It is true, however, that, with respect to U.S. agreements for cooperation concerning peaceful uses of nuclear energy (the so-called 123 agreements, which are governed by section 123 of the Atomic Energy Act), the United States has recently sought to impose a tougher standard than has been required by most other countries. For example, in the U.S.-United Arab Emirates (UAE) 123 Agreement, the United States obtained a commitment from the UAE not to acquire enrichment or reprocessing technology or facilities. In that Agreement, the United States also imposed restrictions on U.S.

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An Interview by Newal Agnihotri, Editor, Nuclear Plant Journal at the Regulatory Information conference on March 9, 2011 in Bethesda, MD.
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For nuclear damage resulting from accidents. Suppliers generally want to see whether the nuclear liability regime in the customer’s country is substantially in accordance with “modern” nuclear liability regimes in countries that are parties to one of the two nuclear liability conventions (Paris Convention and Vienna Convention) or laws based on those Conventions and require the operator to maintain a substantial amount of financial security to compensate persons who suffer nuclear damage. Whether a country’s nuclear liability regime is in accordance with the requirements of the Annex to the Convention on the Supplementary Compensation for Nuclear Damage (CSC) is increasingly used as a “litmus test” in assessing the adequacy of that regime.

In the United States, recent developments concerning nuclear liability have included DOE’s actions in moving toward issuance of a proposed rule regarding U.S. implementation of the CSC, which the U.S. ratified on May 21, 2008. Specifically, on July 27, 2010 (75 Fed. Reg. 43, 945), DOE issued its Notice of Inquiry (NOI), concerning DOE’s development of regulations as required by Section 934 of the Energy Independence and Security Act of 2007 (EISA), which provides for implementation of the CSC. DOE’s NOI seeks comments on DOE’s establishment of a retrospective risk pooling program to provide reimbursement to the U.S. Government for any contribution that it is required to make pursuant to the CSC’s contingent cost allocation.

In essence, EISA transfers the U.S. Government’s financial obligation under the CSC to U.S. nuclear suppliers, in accordance with provisions that will be specified in DOE’s rule. Other nations may evaluate whether to adopt the U.S. approach that allocates this governmental responsibility to U.S. suppliers.

The CSC was opened for signature more than a decade ago but it still has not gained the necessary minimum, for entry into force, of five countries collectively having a minimum of 400,000 Mw (thermal) of installed nuclear generating capacity. Currently, only four countries have joined the CSC, the U.S. being the latest to join.

John H. O’Neill Jr.:

I think there are multiple areas where the U.S. gets involved regarding the UAE. First, there may be requirements for re-transfer approval because technology from Westinghouse, for example, that is delivered to the Korea Electric Power Corporation (KEPCO) needs to then be transferred to the UAE to support KEPCO’s contracts there. So that raises the question of whether or not there is still re-transfer approval required for certain technologies. It is possible, Westinghouse has assurances from regulators that this is permissible.

Second, part of the UAE arrangement was for Westinghouse to supply fuel. If the fuel comes from the U.S. or if it is destined to fuel a U.S. reactor design, you are going to need approvals for that fuel to be exported to UAE. This is where the U.S. government will get involved. It will recognize a direct transfer of technology or fuel. Authorities could also require...
Westinghouse to obtain U.S. approval for the re-transfer of their technology from the Koreans to the UAE.

Jay E. Silberg:

There are a number of issues vendors are concerned with. One concern is intellectual property (IP), or protecting patented designs and other inventions. How do they protect their IP assets? In some countries they insist on technology transfer. How do you evaluate the trade off between protecting your intellectual property versus the demand by some countries that you transfer that technology?

Another concern is liability protection, in the event of accidents. In some countries, the nuclear liability regimes are much more robust than in others. A number of vendors are reluctant to sell their products into some countries, because the levels of protection are felt to be too small or the liability protection regimes not sufficiently formalized or tested. You have the problem of neighboring countries which may not be a party to any of the nuclear liability treaties. Some vendors have been aggressive in seeking foreign markets because the rewards are great, while others have been standing back because of the uncertainties. Some would be more willing to sell to countries that are not signatories to some of the international conventions if the vendors had confidence in the existing (though non-treaty based) nuclear liability regimes.

2. How can the United States utilize innovative financing for its new nuclear power plant construction?
Jay E. Silberg:

Financing construction in the U.S. is obviously key. The DOE loan guarantees have been a significant issue because the authorized amounts would only be sufficient for a few reactors. Another issue is the size of the credit subsidy imposed by the Office of Management and Budget. In some cases, these costs have made the loan guarantee process uneconomic. On the other hand, foreign countries such as France and Japan have financing that is available if you are using their technology. I’m not sure the U.S. government has kept pace.

The President’s announcement that he will seek to increase the amount of loan guarantees is a positive sign, though Congressional action is far from certain. Some of the U.S. policymakers normally thought supportive have budget issues on their mind more than nuclear power construction. There is going to be a trade-off in terms of getting the budgetary authority for more loan guarantees and concerns with the budget deficit.

John H. O’Neill Jr.:

There are parties in Asia and the Middle East who are interested in investing in the U.S. nuclear market. There have been investments by Japanese companies in U.S. plants that are in the planning and licensing stages. Mitsubishi Heavy Industries (MHI) has acquired a 12% interest in Comanche Peak 3 and 4. But there are other foreign companies that are interested in investing for a number of reasons in the U.S. nuclear market. Sovereign wealth funds, for example, are looking for projects that will be a good return on investment for a long period of time.

Once nuclear power plants are built, they are “cash cows.” The question is whether they can be built at a cost that will get the return on investment over a reasonable period of time. I think we will see investments from other countries who will view U.S. nuclear as a good investment for multiple reasons. The Chinese, for example, might invest not only for the return on investment, but also to understand how to structure commercial nuclear projects in the capitalistic country that invented civilian nuclear power; and to understand and export back to China the best operating practices of U.S. nuclear utilities.

America’s experience in running nuclear plants, across utilities and the broader industry here is the best in the world, even though we have arguably lagged behind Japan and Korea when it comes to designing and building state-of-the-art plants. Experience is still invaluable, however. The U.S. has the know-how to operate plants safely at the highest capacity levels. In the last 20 years, for example, we’ve gone from U.S. plants running at 65% of their energy output capacity to 95%.

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Best Operating...
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We have improved these plants’ overall output, such that over those decades - even as more non-nuclear power plants have come online - nuclear output has maintained its share – about 19% - of U.S. energy production. This achievement is, again, due to updates, improved efficiencies and that invaluable know-how and expertise our country has to export.

In the UAE tender for example, one of the bidders included a major U.S. utility that committed to provide the operations training, assist in start-up, initially operate the plant and eventually turn it over to the local company. Simulator training, for example, is just one of the areas where the U.S. is very well-positioned to export tools and skills in demand.

3. Do the U.S. innovations in the nuclear power industry have an encouraging environment in the current U.S. export regime?

James A. Glasgow:

I want to add to what John was saying. With respect to new reactor designs, some of the U.S. companies that were in the power reactor business years ago have reentered that business. Babcock & Wilcox is a good example of that, with their mPower reactor. U.S. companies have some exciting and innovative reactor designs that have a good chance, in my view, of gaining acceptance domestically and overseas.

You asked what can be done to give U.S. power reactor vendors and other U.S. suppliers to nuclear power facilities a level playing field and increase their chances of getting overseas orders. First and foremost is the pressing need for better coordination among Federal departments and agencies that have jurisdiction in this area. This is a subject on which I testified before a U.S. House of Representatives subcommittee hearing in May 2010 on behalf of the Nuclear Energy Institute. In my testimony, I outlined a number of areas for improvement.

One basic step that could be taken is to require U.S. agencies to improve their coordination with respect to matters substantially affecting U.S. companies’ ability to compete for contracts supplying foreign nuclear power stations. For example, with respect to the CSC implementing rule that the Department of Energy plans to publish later this year, DOE has had only limited consultation and coordination with the Department of Commerce about the way that this rule should evolve.

It is widely accepted that the rule could be a major impediment to U.S. vendors, by making the U.S. vendors responsible for paying for the U.S. government’s share of any supplemental compensation that is owed to other countries pursuant to the CSC. Such a rule obviously will add a contingent cost to sales of nuclear goods and services that must be borne by U.S. companies, in a manner that will be specified in the rule. Vendors in nations that join the CSC, but do not require their nuclear suppliers to bear the cost of paying the nation’s share of supplemental compensation under the CSC will have a cost advantage compared to U.S. suppliers, as will suppliers in countries that do not join the CSC.

Returning to my comment regarding the need for improved coordination among U.S. departments and agencies, the Commerce Department is thinking about ways that the U.S. industry can be more competitive in international requests for proposals for the design and construction of nuclear power stations, in accordance with one of the DOC’s key missions. On the other hand, the Department of Energy has said that it will soon publish proposed amendments to its long-standing rule concerning assistance to foreign atomic energy activities (10 CFR Part 810). The likelihood of an unsatisfactory outcome will be reduced if DOE closely evaluates the DOC’s comments on the impact of such revisions to Part 810 on the ability of U.S. companies to compete in the international marketplace for the design, construction and operation of nuclear power stations. It is my understanding that, to date, DOE and DOC have interacted little, if at all, on the implications of this rulemaking for the ability of U.S. vendors to compete on a level playing field.

I should also point out that new impediments can be created as a result of enactment of legislation. A bill pending in the House of Representatives (HR 1280) would require Congress’s affirmative approval, through a joint resolution, of new 123 agreements that do not contain the cooperating nation’s pledge not to acquire reprocessing and enrichment facilities and technology. Since obtaining a Joint Resolution to approve such an agreement that lacks such requirements would be very difficult, the pending legislation, if enacted, would essentially create a de facto requirement for new agreements that many countries may be unwilling to accept. The resulting impasse could block or severely limit U.S. suppliers’ access to some new markets.

Another area for reform is DOE’s revision of its rules regarding “assistance to foreign atomic energy activities (10 CFR part 810). Senior DOE officials have indicated that a proposed rule to make revisions to Part 810 is nearing completion within DOE and should be sent to the Office of Management and Budget (OMB) in the near future. The rule could be published for public comment by this summer and conceivably could be promulgated as a final rule by the end of this year. The current Part 810 rules, dating from the height of the Cold War, create substantial impediments to U.S. companies’ ability to assist foreign nuclear power programs. The key question is the extent to which DOE’s proposed amendments to the rule are responsive to concerns that have been expressed by the nuclear industry and whether the final rule is fair and workable.

4. Are the needed import regulations of India in place for U.S. organizations to start the export of equipment and services?

James A. Glasgow:

I have followed this issue closely, including participating in a trade mission, sponsored by the NEI and the U.S.-India Business Council, to New Delhi and Mumbai in December of 2009, to present a paper about this subject. This past summer, the Indian Parliament finally passed nuclear liability legislation, which was widely heralded as a solution to the nuclear liability concerns vendors expressed about doing business in India. Enactment of that legislation was followed closely by Indian Government statements that India would sign the CSC
and ratify it. To my knowledge, although India has signed the CSC, they have not yet ratified it.

On its face, in section 46, the Indian nuclear liability law preserves existing remedies of plaintiffs under other aspects of Indian law. Moreover, section 17 gives a power plant operator the right to seek recourse against the vendors in the event the operator is out of pocket by having to pay persons injured as a result of a nuclear incident at the operator’s nuclear power station. Presumably, the basis for the operator’s recourse under section 17 would be a claim that the vendors’ products were not in conformity with applicable standards. Pillsbury is not an Indian law firm. Therefore, while I am able to provide the foregoing general thoughts, I cannot offer a definitive response to questions about Indian law and must defer to lawyers in India who have followed these issues.

Some knowledgeable lawyers in India have suggested that the Indian Government will be able to promulgate interpretative rules to limit the apparent clash between India’s nuclear liability laws and the fundamental principle stated in the CSC and the Vienna and Paris Conventions that liability is channeled exclusively to the operator. Some other people have said that once the Indian government becomes a party to the CSC that “fixes the problem.” Any government that signs the CSC is essentially saying that its own domestic laws meet the requirements of the CSC. The principal requirement is channeling the liability to the operator on the basis of a strict or absolute liability. I will defer to lawyers in India as to whether or not sections 17B and 46 of the Indian nuclear liability law are at odds with that principle of channeling liability exclusively to the operator.

From an international perspective, it seems that India’s law, purely on its face, is inconsistent with the fundamental principal of channeling liability exclusively to the operator. Joining the CSC would not change those Indian laws unless there is a doctrine in India law that any conflict between India’s domestic law and the international obligation of India pursuant to international agreements and conventions, such as the CSC, are resolved by having the international obligation “trump” or override the inconsistent domestic laws.

The bottom line, in my view, is that many vendors are still concerned that the nuclear liability issue in India is not yet resolved and want a full and transparent resolution of the current concerns before they design and construct nuclear power plants in India. The options for providing a resolution that may be acceptable to vendors surely should be explored.

However the resolution is achieved, prospective suppliers of nuclear goods and services to India’s nuclear power program need to know whether nuclear liability in India is indeed channeled exclusively to operator or whether there may be some sort of “back door,” path by which such vendors may be sued and found liable in Indian courts.

John H. O’Neill Jr.:

The nuclear liability issue is a very complex one for many countries. India has great promise, a lot of companies want to participate in India but they are still not ready to do so at present.

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Nuclear Turbine Upgrade Technologies

By Eiichiro Watanabe, Mitsubishi Heavy Industries, LTD.

1. How does Mitsubishi Nuclear Energy Systems’ retrofitting of nuclear steam turbines improve its performance and mechanical features?

Mitsubishi Heavy Industries (MHI) has continuously developed new products by state of the art technologies to improve thermal efficiency and mechanical reliability of nuclear steam turbines. These technologies are applied to newly constructed units and also to existing units by retrofitting turbine components.

Thermal efficiency and electrical output of existing turbines are increased by replacing Low Pressure (LP) turbine last stage blades with newly developed longer blades to reduce turbine exhaust loss. Exhaust kinetic energy from the last stage would be energy loss of plant thermal cycle, therefore, the reduction of exhaust kinetic energy, which is exhaust velocity, will increase electrical output of the plant. MHI has continually developed longer last blades which have a larger steam path annulus area and has applied them to existing turbines to reduce exhaust steam velocity and consequently increased electrical output.

Another efficiency improvement technology is to replace High Pressure (HP) turbine and LP turbine blades with the latest higher efficiency fully 3 dimensional flow design blades.

Along with Computational Fluid Dynamics (CFD) advances, aerodynamic design technologies have been greatly improved in the past twenty years and a high efficiency twisted and bowed blade design became available for retrofitting existing units.

Mechanical reliability of nuclear turbines is improved by retrofitting existing LP rotors with full integral rotors (FIR) and Integral Shroud Blades (ISB).

The majority of the original nuclear steam LP turbine designs in the industry have been the shrink-fit disc rotor with grouped blade design blading and long term operating experiences exposed susceptibility of these design to Stress Corrosion Cracking (SCC) and blade high cycle fatigue failures, respectively. MHI developed FIR and Integrated Shroud Blades (ISB) to improve mechanical integrity of LP turbine and had it applied to existing units and thus completely solved field failure problems.

The MHI standard retrofitting scope of existing unit upgrade are replacing rotors, rotating and stationary blades, and inner casing of HP and LP turbines with the above-mentioned new design. The outer casing of HP and LP turbines are usually reused. The efficiency improvement depend on the existing turbine design or operating conditions and typically 4 to 5% improvement can be expected.

2. What material degradation has been observed by Mitsubishi Nuclear Energy Systems in its turbines for pressurized water reactor, boiling water reactor, and pressurized heavy water reactor nuclear power plant turbines in the last 30 years?

MHI supplied their first nuclear turbine in 1970 and has manufacturing and operating experiences of nuclear turbines for 24 PWR units and 2 BWR units.

Major material degradation experiences in the nuclear turbine industry including MHI are LP rotor disc stress corrosion cracking (SCC) and LP long blade high cycle fatigue cracks.

The transition temperature from dry to wet steam in a nuclear turbine is relatively higher than fossil fuel plant and the LP discs operated at this transition zone had high potential for SCC.

Disc SCC became a common problem in the industry in the 80’s and was mostly related to the shrink-fit disc rotor design. SCC mechanism studies were conducted by laboratory material tests and also by field monitoring tests and the results were applied to design and maintenance to prevent SCC. Principles to prevent SCC in nuclear turbine operating environments are 1) to use clean rotor materials with less inclusions or impurities, 2) to use lower yield strength materials, 3) to reduce stresses, and these requirements are all satisfied and achieved by FIR design.

LP end long blades mechanical design and verification are a most important reliability issue in nuclear steam turbines and are a major concern for plant safety operation. LP end long blades failure incidents have continually occurred in the past. Longer last stage blade height contributes to efficiency improvement but on the contrary, they increase centrifugal and vibratory stresses and reduce mechanical strength. Past experiences show 3 typical damage mechanisms for blade failures, which are the blade natural frequency resonance with harmonic excitation, aero-elastic vibration and the blade vibration by torsional excitation. MHI has the world’s largest LP turbine test facility in Takasago Machinery Works and

Eiichiro Watanabe
Eiichiro Watanabe is Chief Engineer of Nuclear Energy System and Power System, Mitsubishi Heavy Industries, LTD. He graduated from Tokyo Institute of Technology with a master’s degree and joined MHI in 1975. He worked on steam turbine design and development and was especially involved in turbine blade developments. He was General Manager of Turbine Engineering Department and Nuclear Power Department. He is now Chief Engineer and responsible for steam turbine technologies.

Responses to questions by Newal Agnihotri, Editor of Nuclear Plant Journal.
has investigated blade vibration behavior for various excitations at actual operating conditions and developed ISB to solve vibration problems of LP end blades.

3. What measures have been taken to improve these material degradation mechanisms in the last thirty years?

Past experiences show that most critical part of nuclear turbine reliability is the LP turbine and especially last blades failures had great impact on safety operation of nuclear units. MHI tried to solve blade problems by the original grouped blade design but could not find complete solutions and decided to make an innovative design change in the late 80’s to solve field problems of LP end blades and at the same time established a process to verify new technologies before field application.

The newly developed blade is Integral Shroud Blade (ISB) which is a one piece design with an integral shroud and mid-span stub having small gaps between adjacent blades at non-rotating conditions. At rated rotating speed, the gaps of the blades will be closed and interlocked by blade untwist due to centrifugal force and all blades will form a single continuously coupled structure. This shroud and stub surface contact will generate damping during blade vibration and greatly reduce blade vibratory stresses. The most severe condition for long last blades would be low load with high back pressure operations where the flow is reverse in a lower diameter region. In this condition the entire flow is highly disturbed and susceptible to aero-elastic blade vibration such as flutter vibration. ISB significantly improved operational flexibility in this low load and high back pressure range and reliability has been verified by the comprehensive tests at actual operating conditions in test turbines.

MHI started ISB and FIR turbine retrofits about 20 years ago and have excellent operating experiences with completely solving nuclear turbine field problems.

MHI built LP test facility in Takasago Machinery Works about 25 years ago and established a verification process for newly developed LP end blades. This facility has about 450t/h (one million pounds per hour) maximum steam flow capacity and is the world’s largest class test facility for steam turbine tests.

After the new blade design is completed, new blades are operated in this test facility and reliability and performance are verified before field application. The completely scaled LP turbine rotor, blades, and casing model are manufactured and installed in the test facility. The test facility has a condenser simulating actual power plant and the turbine output is absorbed by water dynamometer. Similarity law between a full scale actual turbine and 1/2 scale model tests are validated by past tests and for nuclear turbine model scale is selected larger than 1/2 to insure the satisfaction of similarity law. The test turbine is operated at the same conditions as an actual plant and also operated at more severe conditions such as higher loading or higher back pressure than an actual plant. Blade stresses are continuously measured by strain gage and transmitted by a telemetry system during the whole operation. Flow is measured by condensed flow and pressure and temperature at various locations are measured to evaluate overall efficiency. Pitot tube traverse tests are conducted to measure the flow path pressure distribution for internal flow pattern confirmation.

These tests will completely simulate the blade stresses and performance of new blades at actual operating conditions and put all the data on the table to verify before field application.

Advanced technologies and products verified by these tests are applied to retrofit existing nuclear turbine to improve reliability and performance of nuclear plants.

4. What latest innovative tools and technologies have been applied for routine maintenance and retrofitting of steam turbines in the last five years?

MHI retrofitted the 1200MW class HP and LP turbine with 54 IN last blades and other advanced technologies to improve efficiency and to increase electrical output in 2009.

The last blade was 44 IN blade in the existing unit and replaced with 54 IN ISB to reduce exhaust loss. The 54 IN blade is a newly developed ISB and completely verified by 0.55 scale test turbine tests and are also applied to 900MW class new unit which started commercial operation in December 2009. HP blading and LP upstream blading are replaced with twisted and bowed fully 3 dimensional flow design blades to improved efficiencies.

LP rotors were replaced with FIR to improve reliability against environmentally assisted degradations in long term operation.

Following 54 IN blades excellent operation experiences, MHI recently completed 74 IN last blades development and verification tests. 74 IN blades will be applied for next generation 1700MW class units.

5. What is the life expectancy of the current generation steam turbines manufactured by Mitsubishi Nuclear Energy Systems?

MHI current generation steam turbines are designed for a 60 year lifetime. Actually, the lifetime can be expected to be longer than 60 years from our experiences and new technologies verification results.

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International Opportunities for U.S. Vendors

By James Gallagher.

This interview was modified after the release of the Draft Recommendations by the Blue Ribbon Commission on May 13, 2011.

1. What should be the U.S. nuclear power industries’ approach for long term disposal of spent nuclear fuel and high level waste?

The long term solution for high level waste is the Yucca Mountain repository which is safe. There was a lot of research put into Yucca Mountain and it was terminated for political reasons. I think that now it’s been terminated, we should at least try to maintain it in a ready to go condition. But for now I agree with the Blue Ribbon Commission’s call for interim storage. I would advocate for a spent fuel storage retrieval system on a DOE site in the east, maybe Oak Ridge or Savannah River and one in the west at the Idaho or Hanford sites, and then we can continue to study ultimate disposal. I believe recently the NRC has indicated that onsite storage of spent fuel could continue for 60 years. The issue is long term such that there is no apparent crisis at the moment with regard to spent fuel. In reality we do have time to continue studying the issues.

2. Do you believe fuel reprocessing is the preferred option for the U.S. nuclear power industry?

On global scale, what you mention is a good idea, that developing countries utilize nuclear energy to meet their growing needs. The model of taking the fuel back, reprocessing in Europe and sending the fuel back is a good model. But I think in this country, reprocessing probably won’t occur for quite some time. We have developed a deep once through fuel cycle culture.

3. Does the United States have the needed infrastructure to build new nuclear power plants?

One of the issues is that we have lost our infrastructure to build reactor vessels and large components. The reactor vessels for the new plants are being manufactured overseas. We don’t have an infrastructure anymore for large components. It’s going to be very difficult for the United States nuclear industry without large component manufacturing capability. Our specialization will be predominantly technology, engineering and buying components from manufactures in United States such as pumps, valves etc.

Increase in natural gas reserves in this country in last few years has resulted in cheaper prices and the recession has also reduced the demand of electricity. The cost of nuclear power plants has increased in the last few years. So these factors could delay the nuclear energy renaissance in this country.

4. How do you rate American Nuclear Technology?

After TMI and with the fact that there were no new orders in this country and with the expansion particularly in France, a lot of people thought that American nuclear energy technology innovation was dead. However, America has certain characteristics the world views very positively in terms of technology. We were out of the nuclear energy game for a number of years but recently the Chinese bought four plants using American technology and the Koreans are using American companies to help in the UAE. The world continues to have a favorable view of the United States in regard to American Nuclear Technology.

5. Concluding Remarks.

I think the opportunities for the U.S. nuclear industry are international. The general perception of America is positive so, that can be used to U.S. companies’ advantage to export their nuclear reactor technology.

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Fukushima Sequence of Events & Seismic Attributes

Accident Sequence
By John Thorp, Chief of the Operating Experience Branch in the Office of Nuclear Reactor Regulation, U.S. NRC.

Four nuclear power stations were actually affected by this earthquake. At Onagawa, the northernmost affected site, all three units scrambled and are currently in cold shutdown. The single unit at Tokai, the southernmost affected site, also scrambled, and it is in cold shutdown.

The operating Fukushima Daiichi and Fukushima Daini plants successfully scrambled after the earthquake. However, the subsequent tsunami resulted in a loss of heat sink at the Fukushima Daini, ichi being one, ni being two, so this is the number two station that I’m referring to now.

This was categorized as an INES Level 3 or serious incident. The Fukushima Daini operator was eventually able to restore operation of seawater pumps, but not before suppression pool temperatures reached saturation conditions, necessitating the declaration of an emergency action level and Japanese officials ordering an evacuation of residents within 10 kilometers of the site. The Fukushima Daini reactors are currently in cold shutdown and stable.

Extended station blackout at Fukushima Daiichi immediately following the earthquake, the reactors at Fukushima Daiichi, Units 1, 2, and 3, scrambled. The earthquake also caused a loss of offsite power, resulting in the plants having to use their emergency diesel generators.

About an hour after the earthquake, the tsunami hit and inundated the underground emergency diesel generator rooms, rendering the diesel generators non-functional and initiating the extended station blackout condition. It is not clear to what extent the station’s batteries contributed to mitigating the station blackout with DC power.

After the tsunami and station blackout, core cooling was provided by an isolation condenser system for Unit 1, and reactor core isolation cooling, or RCIC, systems for Units 2 and 3. Continued operation of an isolation condenser is dependent on the ability to refill the condenser shell side with makeup water to serve as a heat sink.

During a station blackout, RCIC operation is dependent on batteries to provide DC power to energize valve control circuits. The Japanese utility reported that they lost all cooling, presumably after the isolation condenser boiled dry for Unit 1, and the batteries providing power to RCIC were exhausted for Units 2 and 3.

Moving along, the loss of flow, and presumably the inventory, some inventory in Units 1, 2, and 3, resulted in at least partial core uncoverly. Primary containment pressure increased, potentially threatening the integrity of these structures, as evidenced by the utility taking measures to reduce pressure through venting.

The regulator reported that on March 12, 2011 as water level in Unit 1 reactor pressure vessel lowered, fuel cladding interacted with the water and generated hydrogen. This hydrogen accumulated outside of the primary containment vessel and caused an explosion in the reactor building.

A similar explosion was reported by the regulator as having occurred in Unit 3 on March 14, 2011. Two more explosions were reported in Unit 2 and Unit 4 on March 15, 2011. However, the exact cause of these explosions is as of yet unconfirmed. Open source imaging shows significant damage to the Units 1, 3, and 4 reactor buildings. News videos recorded the explosion in one or more of the units.

The utility reports that the Unit 2 explosion may have occurred within the suppression chamber or torus, potentially damaging that unit’s primary containment.

The regulator had reported that the Units 1, 2, and 3 reactor cores are likely damaged, as evidenced by the presence of iodine and cesium in the environmental monitoring samples they have taken. Additionally, TEPCO, Tokyo Electric Power Company, has announced publicly that they estimate the core damage in Unit 1 as 70 percent; Unit 2, 30 percent; and Unit 3, 25 percent. These figures were based in their statement on radiation levels that they measured in the units on March 14th and 15th, 2011.

The use of seawater for core cooling was taken for several days, and resulted in some degree, we believe, of salt buildup within the reactor pressure vessels for these units. They have switched to fresh water cooling.

Nitrogen inerting of Unit 1 primary containment, those operations were conducted on Wednesday, April 6, 2011. Their containments are supposed to be inerted anyway. So, their concern is to inert the containment, so that if they have to vent they will minimize the possibility of hydrogen explosion.

I think we have been working to obtain materials that -- from our staff that is stationed in Japan. We call them the site team or the Japan detachment.

All the units are using cooling pumps that are powered by offsite power sources as of April 3rd.
Freshwater is being injected through various means, including the feedwater and low pressure coolant injection systems. There are reports of high radiation levels, in the thousands of r, inside the primary containments, as I had noted above.

While the radiation levels are high, they have trended downward. As a result of the significant dose rates onsite, several workers have received higher than normal doses. However, there have been no reports of workers exceeding regulatory dose limits for response to emergencies. I have seen a 25 rem limit for a response to emergencies, and there are lower limits, their normal regulatory limits, for exposure, occupational exposure.

The Unit 4 reactor core was offloaded into the spent fuel pool about three months prior to the earthquake. The Unit 4 explosion that occurred on March 15, 2011 caused significant damage to the reactor building. Since the spent fuel pool cooling system is not functional, cooling and makeup water is being provided by injection of fresh water from a concrete pumper truck.

Units 5 and 6 did not experience an extended station blackout condition following the earthquake and tsunami, although Unit 5 may have experienced loss of all AC power for a period of time. These two units are in cold shutdown, and shutdown cooling systems are operating normally for Units 5 and 6.

Seismic Attributes
By Syed Ali, Section Leader, Office of Research SL, Structural Issues, U.S. NRC.

This earthquake was magnitude 9 on the Richter scale. The epicenter was about 109 miles from the Fukushima site. The peak ground acceleration at about 80 miles from the epicenter was in the range of 1 to 2.75 g.

We don’t have probabilistic data, but we do have some comparisons of the design versus the observed.

The tsunami data -- we say peak amplitude reports vary, because looking at different reports we get different numbers. Now, that could be because they were observed at different locations or interpreted differently, but we have numbers anywhere varying from 14 meters to 23 meters (45.93 to 75.45 feet) from the wave height.

The design basis number -- again, we don’t have the exact numbers right now, but that also varies anywhere from five to 10 meters. And we have seen some reports stating that the reactors and the backup power sources were located 10 to 13 meters (16.4 to 32.8 feet) above the sea level. But, you know, this is something that we will be getting more details on and firm up the numbers as we move along.

From the records that we have seen, or from the reports we have seen, for Daiichi, three of the six units had observed accelerations greater than the design. And the other three were either close to the design or a little bit less than the design.

Units 2, 3, and 5 observed more than the design. And the other three units were less than the design.

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Fukushima Area Airborne Monitoring


The results of the Airborne Monitoring by the Ministry of Education, Culture, Sports, Science and Technology and the U.S. Department of Energy (announced April 5, 2011) were summarized on May 6, 2011 and are provided here.

Goals
In order to understand the effects over a wide area due to radioactive substances, and for the assessment of doses and of the deposition of radioactive substances for future evacuation zones, the Ministry of Education, Culture, Sports, Science and Technology, Japan and the U.S. Department of Energy (hereinafter, “U.S. DOE”) are jointly performing airborne monitoring, and checking the air dose rate 1 meter above the ground surface within 80km from Fukushima Dai-ichi NPP, and the deposition of radioactive substances in the ground surface. Airborne monitoring is a technique in which highly sensitive, large radiation detectors are installed in aircraft, and gamma rays from radioactive substances accumulated in the ground are quickly measured over a large area, in order to check the surface deposition.

Details
- Measurement dates: April 6 to 29
- Aircraft:
  1. Ministry of Education, Culture, Sports, Science and Technology (Nuclear Safety Technology Center)
     • Private helicopter (BELL 412)
  2. U.S. DOE
     • Small aircraft (C-12)
     • Helicopter (UH-1)
- Items covered: Air dose rate 1m above the ground surface within an 80km range of Fukushima Dai-ichi NPP, and deposition of radioactive substances in the ground surface (cesium 134, cesium 137).
- Aircraft monitoring performed by U.S. DOE within 60km from the Fukushima Dai-ichi NPP, and by Ministry of Education, Culture, Sports, Science and Technology, Japan from 60km to 80km away.

Results
Given below is the “Dose Measurement Map” which shows the air dose rate 1m from the ground surface, and the “Soil Concentration Map” which shows the deposition of radioactive substances.
substances in the soil surface, both prepared through this monitoring.

The maps were prepared based on the following conditions.

- Created based on results of airborne monitoring by the Ministry of Education, Culture, Sports, Science and Technology, Japan and the U.S. DOE.
- This published data was prepared based on results obtained from April 6 to 29, 2011 by a small airplane and two helicopters, in a total of 42 flights. Their flight altitudes were from 150 to 700m above ground.
- The air dose rate at the ground surface is the averaged value of air dose rates in a roughly 300m to 1500m (984.25 to 4,921.25 feet) diameter circle (varies by flight altitude) below the aircraft.
- The eastern part of Inawashiro Town is a mountainous area, making low altitude flights difficult, so there are no measurement results there. (In this area, as a result of measurements by the Monitoring Car of the Nuclear Safety Technology Center, Japan, it was confirmed to be one microsievert or less per hour.)
- Airborne monitoring just above the Fukushima Dai-ichi NPP has to be done directly from the power plant, so such monitoring has not been done.
- For the air dose rate and deposition of radioactive substances in the ground surface, decay of radioactive substances was considered and actual readings were converted into values as of April 29, 2011 when this monitoring was last done.
- For the air dose rate and deposition of radioactive substances in the ground surface, decay of radioactive substances was considered and actual readings were converted into values as of April 29, 2011 when this monitoring was last done.

Airborne monitoring just above the Fukushima Dai-ichi NPP has to be done directly from the power plant, so such monitoring has not been done.

- The deposition of cesium 134 in the ground was calculated based on the results of airborne monitoring and of measurements which the U.S. DOE took on the ground using a gamma ray energy analysis device.
- Based on the results of U.S. DOE measurements of cesium 134 on the ground using a gamma ray energy analysis device, and analysis values of cesium 137, the deposition of cesium 137 in the ground was calculated from results of accumulated cesium 134.
- The measured area range is 80km, to check the spread status of radioactive substances.

**Future Plans**

Based on study on these results, future flight areas will be decided, and continued aircraft monitoring performed.
Members Need to Live up to their Commitments

By Laurent Stricker, World Association of Nuclear Operators (WANO).

1. What has been WANO’s role to ensure that each and every nuclear power plant, including those in Japan are safeguarded against an event similar to Fukushima Daiichi nuclear power plant in Japan?

Six days after Fukushima, WANO provided to its members, a SOER (Significant Operating Experience Report), asking them to check their plant’s capability to face a “beyond design basis event”, including blackout which may result in equipment failure. WANO member organisations are required to provide a response to WANO by the middle of May 2011. The answers will be analysed by WANO’s Operating Experience Team in order to share the knowledge.

All NPPs (nuclear power plants) are located near a body of water (e.g. sea or a river); therefore, it is very important for NPPs to check the design and the siting of each plant; especially, the elevation of the plant as compared to the sea level. Our understanding at this stage of analysis is that Fukushima Daiichi plant – units 1 to 4 – has a plant elevation of 10 m (32.8 feet); whereas the Fukushima Daiichi plant – units 5 and 6 – which was built later, has been built a few meters higher above sea level. The analysis of the accident will take months but, based on the available information, the plant systems operated as designed to safety shut down the three operating units following the earthquake. However the equipment could not sustain the flood due to the tsunami which immediately followed the earthquake.

Because of its higher plant elevation compared to sea level, the Fukushima Daiini plant kept functioning as designed.

2. How did WANO assist with the operation of Fukushima Daiichi nuclear power plant in managing its accident?

WANO surveyed member utilities for supplies and expertise that were immediately available and sent additional resources to Tokyo Centre. So far, it has not been in WANO’s scope to assist with the operation of a nuclear power plant in an accident condition. WANO’s current mission is “To maximise the safety and reliability of nuclear power plants worldwide by working together to assess, benchmark, and improve performance through mutual support, exchange of information, and emulation of best practices.” WANO has set up an international commission to analyse the accident and to propose improvements to the members including possibly additional responsibilities to provide assistance during accident conditions.

3. What short-term and long-term measures are being taken by WANO to ensure safe operation of nuclear power plants worldwide?

The SOER that we issued within six days of the Fukushima accident asked the members to respond to WANO within two months with information on their ability to mitigate a beyond design basis event; and to manage a station black-out, an internal or external flooding and a fire.

The members were asked to submit their response within two months and WANO is analysing the replies and interacting with its members.

During our biennial meeting in Shenzhen, China in October 2011, based on the commission recommendations, I plan to propose to our members to grant the WANO Board a mandate to be a stronger organisation with, for example, a wider scope for the peer reviews including emergency preparedness, beyond design basis events and onsite fuel storage.

An Interview by Newal Agnihotri, Editor; Nuclear Plant Journal at the Nuclear Energy Assembly in Washington, D.C. on May 9, 2011.

Laurent Stricker was elected chairman of the WANO Governing Board in January 2009. Before his election, he was Deputy General Manager of Electricité de France – Generation Division and Special Nuclear Advisor to the President and CEO of Electricité de France.

Laurent Stricker has been Head of Nuclear Operations (CNO) for six years from 1999 to 2005. He was responsible for the operation of the French nuclear fleet – 58 nuclear units, representing a generating capacity of approximately 63,000 MW – with a staff of about 20,000 people.

He is board member of Andra (French Nuclear Waste Agency) and has been board member of numerous companies, in particular, CEA (Atomic Energy Agency), World Nuclear Association, Socodei (Nuclear waste) and Energie Badenwurttemberg, AG.
Another possibility should be to ask the members to increase the frequency of “peer review” of each nuclear power plant unit to less than six years. Currently the peer review is done every six years and every nuclear site in the world has gone through, at least, one peer review.

My job as the chairman of WANO is to facilitate decision-making amongst our members to ensure safe operation of nuclear power plants worldwide.

4. What could Daiichi nuclear power plant have done differently to prevent this accident?

It is too early to answer this question. It may take some hours between shutdown of the reactor and core damage if the cooling function is unavailable. An accident could be because of, for example, a natural event or a technical event. Daiichi nuclear power plant operators safely shut the reactor down; however, the cooling could not be continued because of unavailability of backup power equipment which was damaged due to the tsunami. The plant operators attempted to restore power from the diesel generators; however, without any success as the tsunami had damaged the diesel generators as well as the grid and the electrical equipment.

5. What do you believe can be done to mitigate an accident such as Fukushima Daiichi?

I believe, for example, readily available portable diesel generators and portable pumping equipment could have assisted the operator during this situation. These diesel generators and the portable pumps may be strategically located to be made available quickly to nuclear power plants, in case of an emergency.

As far as I know, I believe TEPCO took care of the workers and of the public while managing the accident. The plant operation has to be confirmed later through the event analysis.

6. What are the organizational changes you would recommend to WANO following the accident?

My proposal to WANO members will be to make improvements in the plants’ emergency preparedness and to check these improvements periodically. An international commission with representatives from different utility members worldwide will provide recommendations for WANO to be stronger and more efficient in preventing and mitigating nuclear accidents and increasing nuclear safety worldwide for WANO utility members. The chairman of this commission is Tom Mitchell, CEO of Ontario Power Generation, Canada.

7. Provide your thoughts on President Sarkozy’s recommendation to have an international regulatory organization.

Several meetings are planned in the coming weeks including among G8 and G20 countries that President Sarkozy is actually chairing. Nuclear safety will probably be discussed on these occasions. I believe that WANO must play an important role in addition to IAEA to ensure safe operation of nuclear power plants worldwide.

IAEA may be required to harmonise the regulatory requirements among different regulators worldwide.

8. Concluding remarks.

WANO needs the cooperation and the support of its members. WANO also needs to have the trust of its members, which means having continued, accurate, and confidential reporting from plants indicating what is going well and what is not going well.

Each member must honour their membership commitment to act upon WANO recommendations in a timely and transparent manner.

All these issues will be discussed and decided in October 2011 during the WANO Biennial General Meeting (BGM) in Shenzhen, China.

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Equipment Hatch Closure Plug

By Joseph C. Goebel, Entergy Nuclear.

Institute of Nuclear Power Operations (INPO) issued SOER (Significant Operating Experience Report) 09-01 on August 31, 2009 that focuses on five key outage shutdown safety functions: decay heat removal, inventory control, electric power availability, reactivity control and containment closure.

SOER 09-1, Shutdown Safety Recommendation 11

“Prior to reducing inventory below the reactor vessel flange with fuel in the vessel, either establish containment closure or validate equipment, procedures, and capable personnel necessary to establish closure prior to core boiling are in place.”

SOER 09-1, Shutdown Safety Recommendation 11, Indian Point Actions

• Design and fabricate Equipment Hatch Closure Plug prior to Unit 2 R19.
• Installation training for closure team.
• Timed installation drills.
• If Closure Plug cannot be installed prior to time to boil, establish containment closure prior to draining.

SOER 09-1 recommended implementation by fall 2010 outages. However, the existing Indian Point Energy Center (IPEC) Equipment Hatch design would not facilitate implementation of the containment closure requirements. IPEC took action and designed, manufactured, tested, trained and executed the use of an Equipment Hatch Closure Plug (EHCP) in the March 2010 outage, experiencing many benefits.

IPEC improved outage performance via an innovative use of a simple application of a pipe plug that solved a nuclear safety issue while netting 106 hours of critical path time. The project team designed, manufactured, tested and installed the EHCP within the requirements of SOER 09-01.

The 13,000 pound equipment hatch closure plug manufactured by the day and night shift personnel paid off in saved dose, improvement in human performance and gains in occupational safety. Designed by the IPEC team, the EHCP was installed with precision handling aided by the use of remote cameras under intense time pressure of INPO requirement SOER 09-01.

Achievements

SOER 09-01 describes recent shutdown safety events that involved industry weakness in outage scheduling, risk management, procedure quality and human performance behaviors. There were nine losses of shutdown cooling in 2008, and eight in 2009 – six were preventable. In these examples, inadequate measures were taken to prevent the loss of protected equipment.

Entergy employees at IPEC implemented practices to comply with SOER 09-01 that included identifying and addressing any weaknesses in protecting important equipment, inconsistencies in the practices used to identify protected equipment, or a lack of understanding by station personnel, including supplemental employees, of how their actions can affect important-to-safety equipment.

Additionally, in the case of an actual event, the EHCP is installed from the outside of containment alleviating the need for personnel to work in a potentially harsh environment during installation.

The EHCP was successfully implemented with the highlight achievements listed below:

Critical path time
• 106 critical path hours saved during the outage.

Person hours
• 112 person hours saved in the installations and removal of equipment hatch two additional times.

Dose savings
• 35 mRem savings from the installation and removing of the equipment hatch two additional times.

(Continued on page 44)
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Equipment Hatch...
Continued from page 42

- 1 Rem savings from not extending outage to 106 hours.

Dollars saved
- 106 hours of critical path time saved equates to approximately $5,000,000.
- 112 person hours saved equates to approximately $6,000.

“When compared to the existing Equipment Hatch this hatch plug is significantly easier to install and seal the equipment hatch penetration. It reduced and in some cases, eliminated human performance traps – with time pressure, distractions and other activities in the physical environment, it worked great,” said Joe Goebel, assistant outage manager.

Outage Lap Safety
IPEC’s use of the EHCP was identified as an “improvement to key safety function defense” in the INPO spring outage summary. Approximately 33 percent of a station’s overall risk is associated with outage periods. We know that plant configurations during an outage are significantly different than 100% power when many systems/components are out of service. With many more activities taking place than normal, we also experience many personnel, unfamiliar with the plant working during outages.

Therefore, during the intense period of this refueling outage, the EHCP innovative solution played an important role in helping IPEC to achieve safety, and operational outage goals in 2010.

Unique features that delivered results
- The EHCP does not attach to plant. The original idea was to bolt it onto containment. This would have required over 30 bolts. The EHCP is held in place by self-contained, adjustable strong-backs that are supported by the existing structure.
- The EHCP has “back stops” so it can not be inserted too far.
- The EHCP has self-contained jacks to level the plug most effectively and efficiently.
- The EHCP has self-contained ladders facilitating installation.
- The EHCP has two 100% seals tested for security and safety.

• The EHCP has a self-contained control panel improving operation and installation.
• The weight of the EHCP is 13,800 pounds. It is mounted on the plug so there are no questions about stability or installation issues.
• The EHCP is moved into place with dedicated fork lift.
• Faced with the large size and tight production schedule Mechanical Research reached out to a local yacht-building company as a constructor who could accommodate the size, meet the schedule, and comply with our nuclear safety requirements and specifications.

Indian Point Innovation
The equipment hatch closure plug was a solution that was created, designed, manufactured, tested and installed by the IPEC team. Using a simple application of a pipe plug, the IPEC team solved a nuclear safety issue.

This innovation also provided many other benefits including keeping the costs down as compared to other options; delivered substantial dose savings and eliminated critical path time.

The challenge of this innovation was being able to meet the INPO requirements and overcome containment concerns stated in SOER 09-01:
- The time-to-boil is less than the validated time it takes to close the containment hatch.
- Containment closure requirements are not met prior to fuel movement and inventory reduction.

The customizations for the fork truck, the installation apparatus, the wheelbase on the plug and structural delivery method for the plug are of original design to meet this unique challenge with in the time limits (time-to-boil) for containment. The installation team also applied rigor to the training, testing, installation drills and all aspects of this important safety hatch to insure that closure requirements are met.

Even as the SOER 09-01 recommendations were not expected to be implemented until fall 2010 outages, IPEC pressed forward with the development of the EHCP innovation for the spring 2010 outage.
“We had the idea for a new solution. Working through implementing the concept, it was very satisfying to see it completed, successful and adding true value to our plant and our company. The team effort was the success story,” said Tom Odell, Senior Outage Scheduler.

SOER 09-1 recommendation 12 requires stations to use their systematic approach to training processes to determine if additional training, enhanced training or alternate methods are appropriate to close performance gaps identified in the SOER. Station line and training personnel are expected to use an assessment of their station’s shutdown safety performance and industry operating experience as an input to determining the design, development and implementation of the training, or the suitability of other methods that may be used to bridge identified knowledge gaps within the station population.

Specifically for containment hatch closure, issues of concern in SOER 09-01 are:

- Opening the equipment hatch when demonstrated closure time is greater than the time to boil.
- Several Abnormal Operating Procedures don’t direct immediate closure early in the procedure.
- Some stations don’t know closure time, or have not drilled or validated closure time in many years.

At Indian Point, the project team took a new approach to a process, while saving time and dose. Also contributing to productivity were the change management practices and intensive training in regard to the equipment hatch closure plug which included:

- Classroom training of the installation crew.
- Scheduled drills for both the day shift and the night shifts prior to the outage.
- Single point of contact established with Outage Control Center for each shift.
- Unannounced drills took place throughout the outage.

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Comprehensive training was integrated with communication tactics (SOER 09-01 recommendation 11 on communication) to insure an efficient design, installation and use of the EHCP.

Beyond incorporation of the EHCP into IPEC procedures, extensive communication and assistance by members of the dry cask team, and others at Indian Point’s design engineering, maintenance and operations groups all contributed to a valuable team process. Together, a productive and efficient implementation of the EHCP was achieved.

“The entire team contributed ideas and hard work to get the EHCP constructed and tested prior to installation. It was a real group effort that paid off during the outage,” said Joe Goebel, Senior Project Manager, team lead.

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Weld Overlays to Enhance Safety

By Electric Power Research Institute.

In an industry-first implementation, FirstEnergy Nuclear Operating Company’s Davis Besse pressurized water reactor preemptively enhanced plant safety by applying optimized weld overlays to large-diameter coolant piping susceptible to stress corrosion cracking. EPRI’s Welding & Repair Technology Center developed the optimized weld overlay technique and performed testing and analysis to provide the technical basis for Code Case N-740-2, which supported Davis Besse’s relief request to use the technique during a refueling outage instead of applying a full structural weld overlay.

The ability to implement optimized weld overlays:
- Permits a thinner overall weld thickness that requires less welding time than a full structural weld overlay.
- Results in lower worker dose and shorter outages.
- Reduces the volume of weld deposit, improving the ability to complete inspection and improving the inspectability of the underlying weld location.

Applying four optimized weld overlays at Davis Besse enabled FENOC to save approximately $1.5 million in welding and downtime costs. FENOC’s pioneering application paves the way for other nuclear power plants to use optimized weld overlays to save time and money while improving safety.

New Method for Alloy 600 Mitigation

For more than a decade, EPRI’s Welding & Repair Technology Center has been developing new methods to mitigate primary water stress corrosion cracking (PWSCC) in Alloy 600 materials. EPRI also performs testing and analyses to provide the technical basis for applying advanced mitigation techniques and inspection procedures. Optimized weld overlays are one example of an advanced technique that can help nuclear plants...
reduce the time and difficulty associated with Alloy 600 mitigation.

This work has helped utilities overcome some of the limitations associated with other mitigation techniques. The mechanical stress improvement process, for example, involves use of a clamp to deform the pipe adjacent to a weld, leaving a compressive stress on the inside surface of the weld. Because the process can only be used if the weld is free of large cracks, the weld must first be inspected using nondestructive evaluation. Many susceptible locations have access limitations that make examination difficult. For this reason many plants opt to apply weld overlays to Alloy 600 configurations.

The weld overlay process deposits PWSCC-resistant alloy 360 degrees around the outside diameter of a dissimilar metal weld location. A full structural weld overlay is thick enough to take the full loading and stress of the underlying weld, so it can be used to replace underlying material that is cracked completely through.

An optimized weld overlay is thinner than a full structural overlay, and can be used where the cracking in the underlying material is less than half the original wall thickness.

To help utilities apply the new technique, EPRI performed comprehensive testing and analyses using full-scale mockups of large-diameter piping connections to demonstrate that the optimized overlay technique was effective in achieving a compressive residual stress profile on the inside diameter. The test results supported American Society of Mechanical Engineers, Section XI, Code Case N-740-2.

First Use at Davis Besse

The Code Case supported FENOC’s relief request to the Nuclear Regulatory Commission (NRC) to use the technique on large-bore core flood dissimilar weld locations, instead of using full structural weld overlays that would require approximately twice the amount of welding time. The NRC accepted the relief request, enabling FENOC to proceed with the optimized overlay project.

FENOC applied optimized weld overlays at Davis Besse as a preemptive mitigation measure to enhance plant safety. During refueling outage 1R15 the overlays were successfully applied to four pipe locations susceptible to cracking, but where cracks did not exist.

Results and Benefits

The successful application of optimized weld overlays at Davis Besse improved safety, saved money, and reduced personnel exposure.

FENOC calculated that the four optimized overlays applied at Davis Besse provided $1.5 million in savings—based on one-half day savings for each overlay at $375,000 per day.

“A key element of the optimized weld overlay project was the manner in which the EPRI Welding & Repair Technology Center, Materials Reliability Program and Nondestructive Evaluation Center worked together to achieve this success,” said Dan Patten, Fleet Manager, Programs and Component Engineering, FENOC. “No project succeeds without teamwork! FENOC highly values these EPRI resources.”

Ongoing Work

EPRI’s Welding & Repair Technology Center supports nuclear power industry efforts to develop and apply welding and repair techniques that improve plant safety and availability, inform regulatory issues, and reduce maintenance costs.

EPRI also hosts welding technology conferences and code issues meetings that provide forums for utilities to exchange information and lessons learned, and to guide ongoing research efforts.

Contact: Greg Frederick, Electric Power Research Institute, 3420 Hillview Avenue, Palo Alto, CA 94304; telephone: (704) 595-2571, email: gfrederi@epri.com.
An Environmental Steward

By PPL Corporation.

History
Located on a hilltop overlooking the scenic Susquehanna River in northeastern Pennsylvania, the Susquehanna nuclear power plant is a 2,501-megawatt facility with two boiling water reactors and two closed-cycle cooling towers.

The plant is owned by PPL Susquehanna LLC, a subsidiary of PPL Generation LLC (90 percent), and Allegheny Electric Cooperative Inc. (10 percent). PPL Susquehanna operates the plant with 1,100 full-time employees on-site and 170 in Allentown, Pennsylvania.

PPL applied to the Nuclear Regulatory Commission for a construction permit in April 1971. The NRC issued the permit November 2, 1973, and construction began later that month. Unit 1 began commercial operations in 1983 and Unit 2 in 1985. The units began generating electricity under 40-year operating licenses. In November 2009, following a rigorous process and review, the NRC granted a 20-year extension of the original licenses, allowing the units to operate until 2042 and 2044 respectively.

The 1,200-acre Salem Township, Luzerne County site was chosen for its stable geology, available cooling water from the Susquehanna River, accessible power supply lines to other parts of PPL’s service area and convenient highway and rail transportation.

General Electric Co. designed the Susquehanna plant’s twin reactors. Bechtel Power Corp. was the prime contractor.

Environmental and community commitment
The people of PPL Susquehanna go above and beyond when it comes to community service and involvement. We take our environmental and social responsibilities very seriously. We conduct our business in an environmentally sensitive manner. We are active in our local communities to improve the quality of life where we live and work.

You’ll find our team members actively volunteering with Scout and church groups, fire and ambulance companies, the YMCA and local hospitals. You’ll find them donating blood to the Red Cross, serving as elected officials and coaching youth sports. From record-setting fundraising campaigns for United Way to a Christmas Angel program that provides gifts for children in need to a backpack drive that ensures kids have school supplies, you’ll find PPL Susquehanna’s employees and the company contributing generously.

Our commitment to the environment began before the Susquehanna plant was built. In 1972, we began the plant’s environmental monitoring program. By the time the first reactor started commercial operation in 1983, PPL’s environmental monitoring program had established a 10-year baseline of data to use for comparison purposes throughout the plant’s operation.

Across the road from the Susquehanna plant is the Susquehanna Riverlands Environmental Preserve. Since August 1980, the Riverlands has been providing the people of north central Pennsylvania with quality recreation and environmental education. At the Riverlands, which is located on 1,200 acres on both the east and west banks of the Susquehanna River, the land is managed in harmony with the environment, whether it’s used for farmland, wood products, wildlife habitat or educational use.

Key features at the Susquehanna Riverlands include:
• A 400-acre recreation area on the west side of the river that is ideal for picnicking, group outings, hiking, sports and play.
• Fishing at Lake Took-A-While, a prime habitat for largemouth bass and other species of fish.
• Riverlands Nature Center where visitors can get a close look at some of the area’s wildlife, learn about wetlands and the river, and enjoy nature programs. The nature center is located in the Susquehanna Energy Information Center.
• Wetlands Nature Area, a 100-acre tract of riverine forest, marsh, swamp

(Continued on page 50)
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An Environmental...
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and vernal pools that has been set aside as an area for nature study and education.

- Council Cup Scenic Overlook, a 700-foot-high bluff across the river from the Susquehanna plant that affords a breathtaking view of the Susquehanna River Valley. Three trails in the 88-acre site provide opportunities for hiking, hunting and fishing.

Among the innovative ways we’ve found to help the environment is a simple solution for a chronic soil erosion problem near the plant: Let Mother Nature work.

With the Susquehanna plant located at the top of a hill overlooking the nearby river, heavy rains would cause runoff from the plant complex to cascade down the hillside with little resistance from the manicured lawns. So in 2002, we decided to let the grass grow on about 65 acres near the entrances to the plant, access roads on the plant grounds and land bordering employee parking lots. Known as “vegetative mitigation,” it also enhances animal and wildlife habitats.

Providing more carbon-free generation

The Susquehanna plant has a proven record of safe and reliable operation. Increasing its generating capacity is a cost-effective way to meet future energy demand from an existing source that emits no greenhouse gases.

With equipment and system upgrades completed during the 2010 refueling and maintenance outage, Unit 1 at the Susquehanna plant became the largest BWR in terms of thermal power and generating capacity in the United States.

When operating at 100 percent power, Susquehanna’s Unit 1 has a capacity of 3,952 megawatts thermal (a measure of the heat produced in the reactor) and over 1,300 megawatts electrical (a measure of the electricity produced by the generator).

The completion of upgrades during the 2010 Unit 1 outage continued a seven-year project begun in 2005 to increase the amount of electricity the Susquehanna nuclear plant can safely and reliably generate. Actual increases in reactor power output commenced in a phased approach starting in 2008. The extended power uprate (EPU) project is expected to conclude in 2011 after further upgrades to Unit 2 are completed, at which point Unit 2 will have a similar capacity to Unit 1 for thermal and electrical energy.

During the EPU project, more than 100 modifications were implemented, involving well over 1 million person-hours of effort and more than 3,300 work orders over the past four years.

The modifications were installed with the objective of not only allowing the increase in power, but also of maintaining or increasing design and operational margin and improving equipment reliability.

These modifications included:

- Replacement of high-pressure turbines on both units.
- Installation of a new digital Integrated Control System (ICS) for improved control of reactor water level, recirculation pump speed control, and feedwater pump speed control on Unit 1. ICS for Unit 2 will be installed during the 2011 refueling and maintenance outage.
- Reactor vessel steam dryers were replaced with stress margins increased to 100 percent, and outlet moisture content significantly reduced. Unit 1 had the first dryer to have final assembly completed on site.
- Emergency Service Water Cooling to Residual Heat Removal (RHR) pumps realigned to increase RHR pump availability in a post-accident event.
- Standby Liquid Control Enriched Boron implemented to reduce suppression pool temperatures in a post-Anticipated Transient Without SCRAM event.
- Replacement of six feedwater heaters to address potential erosion concerns.
- Replacement of Condensate Pump impellers and Reactor Feed Pump Turbines to increase flow margin.
- Enhancements to Reactor Water Clean-Up, and installation of additional Condensate Filter and Condensate Demineralizers to improve water chemistry.
- Installation of a new digital Power Range Neutron Monitoring System.
- Installation of new switchyard capacitor banks.
- Numerous piping support and instrument setpoint changes.
- Addition of instrumentation to monitor systems during power ascension.

Detailed Margin Reports were developed and reviewed with plant staff to identify design and operational margin changes. Engineering analysis for the uprate has been validated by successful Power Ascension Test Programs which ensured that modifications and assumptions were correct. Both power ascensions for Phase 1 were completed error free and ahead of schedule, with minimal test exceptions. While testing for Unit 1, some improvement opportunities were identified. These lessons learned will be incorporated in the Unit 2 power ascension, following completion of the 2011 refueling and maintenance outage. Many other plant parameters, including various system flows, pressures, temperatures and vibration were monitored during the power ascension and found to be as predicted.

In 2008, replacement of the Susquehanna plant’s Unit 1 turbine was the subject of the first episode of the National Geographic Channel’s series “World’s Toughest Fixes.” During the Unit 1 refueling and maintenance outage in March 2008, series host Sean Riley and a National Geographic Television production crew spent nearly three weeks at the Susquehanna plant filming the turbine replacement.

“World’s Toughest Fixes” is produced by National Geographic Television for the National Geographic Channel.

PPL Susquehanna will share its experiences with the Extended Power Uprate Project.

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