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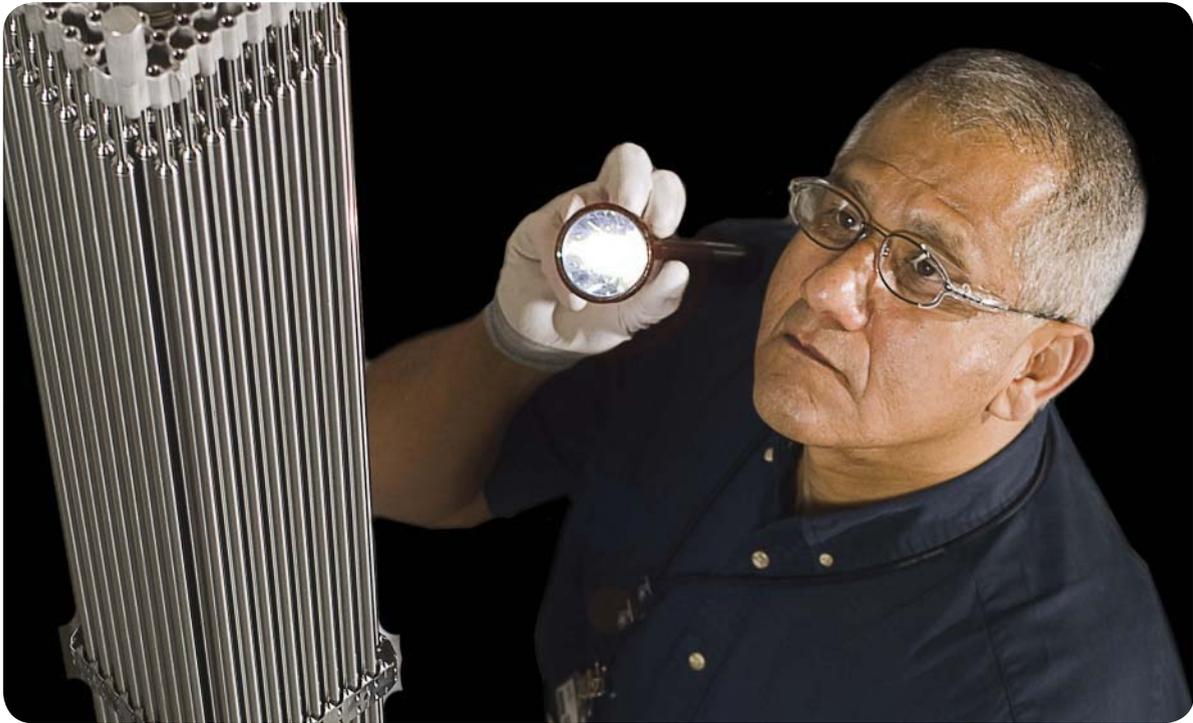
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NUCLEAR POWER

Conference Schedule At-a-Glance, page 2

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全球第一 AP1000 示范工程

1000 自主化依托项目——浙江三门核电一期工程开工

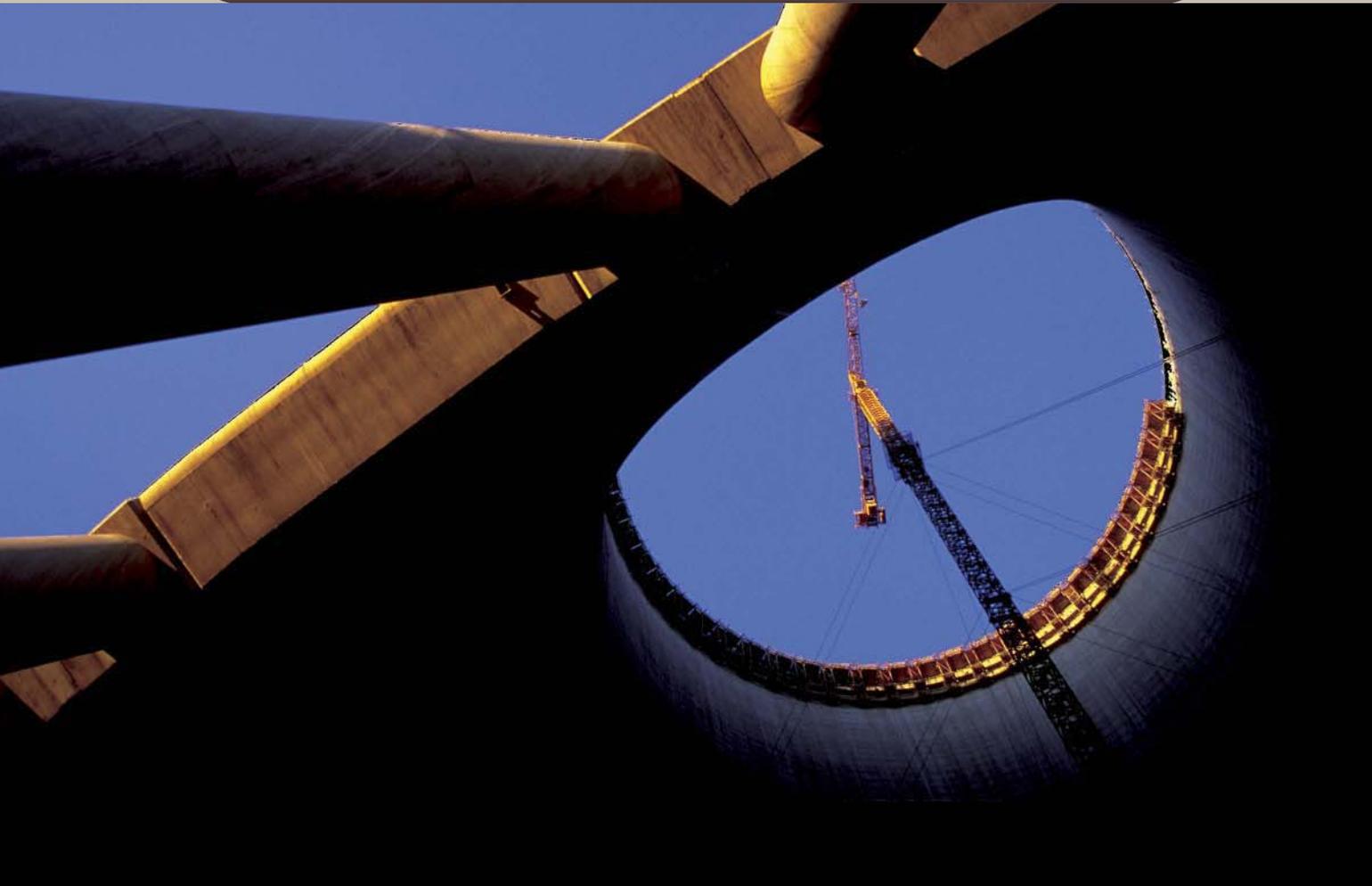
Doing Nuclear Business In China

EUCG Going Global

Nine Mile Point gained
20 MW with Improved
Condenser Performance

B&W on the North
American Nuclear Market





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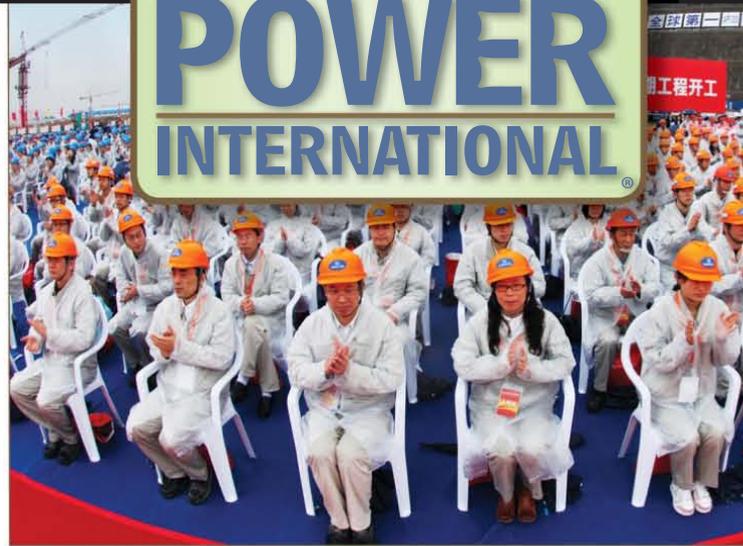
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Chinese workers at Westinghouse construction site. Story page 28.
Photo by Westinghouse, courtesy U.S. Commercial Service.

NUCLEAR POWER INTERNATIONAL



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DECEMBER | 2009

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ENRICHMENT

Nuclear Business

Nancy Spring, Editor

While the new nuclear build may grab the headlines—just look at our cover photo this month and our *Nuclear World* story about Westinghouse in China—maintenance and repairs represent a great business and technological opportunity.

In North America alone, there are 124 aging nuclear reactors. Nuclear plant operators are busy uprating, upgrading and extending their units' operating license lives—good news for electric customers and businesses that can tap into the market.

When the U.S. Nuclear Regulatory Commission renewed the operating licences of FirstEnergy's Beaver Valley Units 1 & 2 for another 20 years, moving their expiration dates out to 2036 and 2047 respectively, that brought the total number of U.S. reactors with license renewals to 57 out of 104.

"Most of these reactors were put into service prior to 1980 so they are getting old," said Richard Reimels, president of The Babcock & Wilcox Company Nuclear Power Generator Group during our interview for this month's *Fuel for Thought*. "One of our key focuses is to keep them running. Like an old car or an old house, they need a lot of repairs and maintenance."

Replacing steam generators is one of the most common projects at the aging plants. The new steam generators have been redesigned to incorporate stronger materials such as

Alloy 690. Reimels said units built with the 690 material have been running about 15 years with no signs of stress corrosion cracking so far.

The Davis-Besse plant in Ohio has just ordered steam generator replacements from B&W and Progress Energy's Crystal River received two units in October, but most of the reactors in North America have already completed their steam generator replacement. On the Canadian side, B&W is building replacement steam generators for Bruce Station and that will probably take care of replacements north of the border as well.

Uprating a nuclear plant is also a good value proposition. Because power from the older reactors is fairly low-cost, completing a 100-MW uprate at an existing nuclear power plant is less expensive than building a 100 MW natural gas plant or any other kind of generation.

At the NUCLEAR POWER International conference this year, many of our sessions are about the business of nuclear power. (See *Conference at a Glance* below.) Clearly, there are opportunities on both sides of the equation, old plants and new. To paraphrase the president and CEO of Southern Nuclear Operating Co., Jim Miller, if you're looking for a stimulus package, all you've got to do is look at nuclear power.

NUCLEAR POWER INTERNATIONAL / CONFERENCE AT A GLANCE

Sunday, December 6, 2009 – COMPETITIVE POWER COLLEGE Pre-Conference Workshops				HALF-DAY WORKSHOPS				TWO-DAY COURSES			
8:00 AM – 5:00 PM	CPC 101 (Room N102) Basic Gas Turbine Metallurgy & Component Repair	CPC 102 (Room N103) Understanding Fossil Power Plant Performance Using First Principles Models	CPC 103 (Room N107) An Introduction to the Design, Operation and Evaluation of Parabolic Trough Solar Power Plants	CPC 104 (Room N108) Power Plant Construction Management – A Guide to Survival	1:00 PM – 5:00 PM	CPC 402 (Room N101) Turbine Generator Torsional Vibration Failures	CPC 403 (Room N115) Intellectual Property Fundamentals for Renewable Energy Developers, Licensees and Licensees	CPC 201 (Room N109) Heat Rate Awareness & Carbon Reduction			
Monday, December 7, 2009 – COMPETITIVE POWER COLLEGE Pre-Conference Workshops WORKSHOP HALF-DAY											
8:00 AM – 5:00 PM	CPC 301 (Room N103) Capital Project Analysis at Power Plants	CPC 302 (Room N107) Essential Practices for Outage Management	CPC 303 (Room N108) Turbine Generator Failures: Prediction & Prevention	CPC 304 (Room N111) Lost Efficiency: Finding Lost Efficiency: Finding	8:00 AM – 12:00 PM	CPC 501 (Room N101) Why Good Projects Don't Get Built	CPC 502 (Room N102) Temperature Measurement & Data Acquisition in Power Plants	1:00 PM – 5:00 PM	CPC 503 (Room N101) Key Considerations & Best Practices in EPC Contracting for Wind Farms (Developer's Perspective)	CPC 504 (Room N102) Turbine Inlet Cooling: The Energy Solution to Increase Power Output, Lower Emissions, Decrease Carbon Footprint & Improve Heat Rate	CPC 505 (Room N113) Combustion Dynamics in Gas Turbine Power Plants
Tuesday, December 8, 2009											
9:30 AM – 11:30 AM	OPENING KEYNOTE ADDRESS – Las Vegas Hilton, Barron Room			Mr. Michael Yackira, President & Chief Executive Officer, NV Energy		Mr. Pierre L. Gauthier, President & CEO, ALSTOM Canada Inc. & ALSTOM US Inc.		Mr. Keith Rattie, Chairman, President & CEO, Questar Corp.			
Conference Tracks & Sessions	MEGA-SESSION (Room N115)										
1:30 PM – 3:30 PM	Economics of Nuclear Power – Panel Discussion										
Wednesday, December 9, 2009											
7:30 AM – 9:00 AM	NETWORKING BREAKFAST – Las Vegas Hilton, Ballroom C										
Conference Tracks & Sessions	TRACK I (ROOM N115)				TRACK II (ROOM N116)						
9:30 AM – 11:30 AM	Construction Management: Delivering On-time and On-budget Projects				Vendor 101: How to Be Successful – Panel Discussion						
1:30 PM – 3:30 PM	Beyond the Nuclear Island...				Nuclear Lessons Learned						
Thursday, December 10, 2009											
7:30 AM – 9:00 AM	NETWORKING BREAKFAST – Las Vegas Hilton, Ballroom C										
9:30 AM – 11:30 AM	MEGA-SESSION (Room N115)										
Completing the Fuel Cycle – Panel Discussion											



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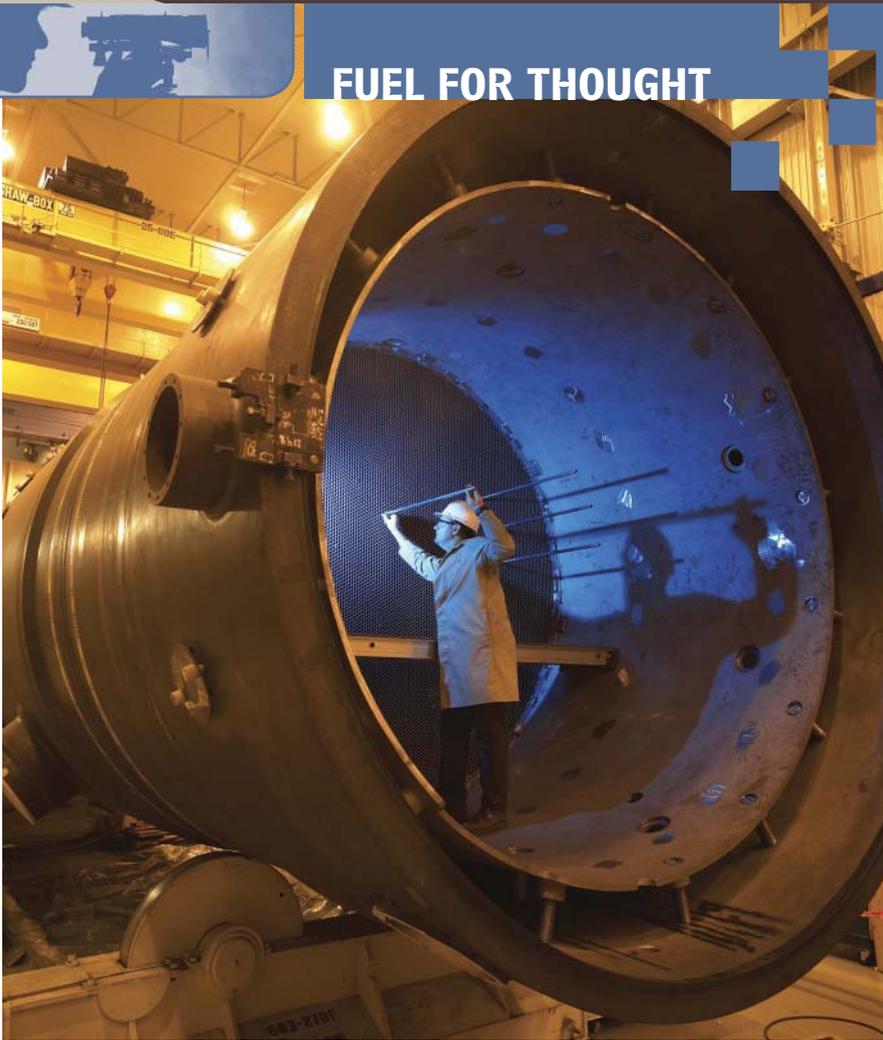
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FUEL FOR THOUGHT



A Babcock & Wilcox worker adjusts a tube support plate assembly in a nuclear steam generator at the B&W facility in Cambridge, Ontario. Photo, B&W.

The Commercial Nuclear Market

An interview with Rich Reimels, President, Nuclear Power Generation Group, Babcock & Wilcox

By Nancy Spring, Editor

Richard E. Reimels is the president of The Babcock & Wilcox Company Nuclear Power Generator Group Inc. (NPG), headquartered in Lynchburg, Va. NPG provides services and components to the worldwide commercial nuclear utility industry. Prior to being named to his current position in January 2007, Mr. Reimels was president of B&W Canada, responsible for the design and supply of nuclear and fossil generator equipment and services.

NPI: Babcock & Wilcox (B&W) is one of the few companies that continued manufacturing heavy components for the nuclear industry all these years. What do you have planned for the future?

Reimels: In commercial nuclear, we look at it as two markets. One is the new-build market—the industry calls it the nuclear renaissance—and our modular reactor would

be part of that. Today I'd like to focus on the other market, the existing fleet of reactors.

There are 104 nuclear reactors operating in the U.S. and they produce about 20 percent of our electricity today. In Canada, where we also do a lot of work, there are 20 reactors in operation and they probably produce a little higher percentage. In Ontario, for instance, about 50 percent of their power comes from nuclear. Most of these reactors were put into service prior to 1980 so they are getting old. And most of them are now getting a license extension. They can get a 20-year lifetime extension that will drive most of these plants to an average age of over 60 years. One of our key focuses is to keep them running. Like an old car or an old house, they need a lot of repairs and maintenance.

One of the issues that we're seeing now is for materials that have been irradiated, we are seeing different types of material fatigue. We have labs that can analyze the impact of that so we help support the utilities in finding ways to ensure that these plants can go for another 20 or even 40 years.

We do a lot of work on steam generators and the other components. Most units come down for inspection either once a year or once every 18 months. We go in and inspect that equipment to see how well it's holding up and what kind of maintenance or repairs they need.

In the replacement market, one of the things the utilities in the U.S. have had to do is replace the steam generators as they got older. B&W has built replacements for all the technologies, like the B&W technologies that were built in the '60s and '70s, the Westinghouse technologies and another company called Combustion Engineering.

And they're not just replacements in kind. They are redesigned. The utilities found materials that would last longer and to put those in you have to redesign the entire steam generator.

[CONTINUED ON PG. 27]

NUCLEAR EVENTS

NUCLEAR POWER International will be in Orlando, Florida, U.S., next year, from Dec. 14 - 16.

DECEMBER | 2009

8-10 PennWell NUCLEAR POWER International
Las Vegas, Nevada
www.nuclearpowerinternational.com

8-10 PennWell POWER-GEN International
Las Vegas, Nevada
www.power-gen.com

7-11 International Conference on Fast Reactors and Related Fuel Cycles: Challenges and Opportunities FR09
Kyoto, Japan
<http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=35426>

14-18 International Conference on Effective Nuclear Regulatory Systems: Further Enhancing the Global Nuclear Safety and Security Regime
Cape Town, South Africa

<http://www-pub.iaea.org/MTCD/Meetings/Announcements.asp?ConfID=35791>

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JANUARY | 2010

26-27 Nuclear Power Asia 2010
Shangri-La, Kuala Lumpur, Malaysia
http://www.nuclearpowerasia.com/Event/Home_5356.aspx

29-31 International Conference on Nuclear, Plasma and Radiological Engineering
Cape Town, South Africa
<http://www.wasct.org/conferences/2010/capetown/icnpre/>

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FEBRUARY | 2010

26-28 2010 International Conference on Nuclear and Radiological Engineering (ICNRE 2010)
Singapore, Singapore
<http://www.iacsit.org/icnre/index.htm>

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MARCH | 2010

14-18 International Conference on Human Resource Development For Introducing and Expanding Nuclear Power Programs
Abu Dhabi, UAE

21-24 1st International Nuclear and Renewable Energy Conference
Amman, Jordan
<http://inrec10.inrec-conf.org/>

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AT THE CORE

Political Parallels

By Dr. A. David Rossin

A

fter last year’s election, a new crowd took over in Washington, D.C., and one of the first signals the nuclear lobby saw was how smoothly Sen. Harry Reid (D-Nev.) killed Yucca Mountain. Frankly, it was hard to figure how a program that Congress had supported and utility customers had generously funded for three decades could be turned around without lengthy debate and negotiations. But it sure happened!

Industry reps in Washington heard a number of stories about newly elected senators and even congressmen who visited the new majority leader. Asked about their goals and interests, Sen. Reid let it be known that he didn’t want much in return, but that he would be pleased if they did not interfere with Nevada business as he shut down the Yucca Mountain Project.

As new nuclear power plant licensing applications reach public hearing stages, groups are there to challenge how a nuclear plant can be allowed to be built “when they don’t even know how to dispose of their waste.” We’ve obviously known for a long time how to dispose of nuclear waste and on three occasions the Atomic Energy Commission or Nuclear Regulator Commission (NRC) conducted an extensive Waste Confidence Hearing that found that indeed, the required confidence was in hand.

But now, say the intervenors, even if a technical case is offered, it collapses under the fact that people don’t want it and can stop it, even in a state where more than 100 nuclear explosions took place in the same rocky soil in which magnificently engineered canisters will seal radioactive waste forever or at least for 10,000 years.

Philosopher George Santayana said, “Those who cannot remember the past are condemned to repeat it.” His target is decision-makers who have not done their history homework. Decisions for the Yucca Mountain repository parallel the political history of the 1970s, when President Jimmy Carter became convinced that we could prevent proliferation.

President Carter announced his “comprehensive strategy” in 1977, during his first 100 days in office, catching the nuclear world almost completely by surprise. At the time, our first large commercial reprocessing plant in Barnwell, S.C., was ready for testing with cold uranium and an important new licensing hurdle lay ahead: a generic environmental statement on reprocessing spent fuel and recycling the plutonium. The hearing board had been appointed and was laying out its hearing schedule for yet another acronym: “GESMO,” the Generic Environmental Statement on Mixed Oxide Fuels.

The Carter White House made it clear that they had no intention of letting GESMO run on and on. Astonished nuclear energy people watched from the sidelines as hopes for new plant orders waned.

As with Sen. Reid and Yucca Mountain, that ship had sailed. France, Britain and Japan went ahead with their fuel cycle work despite U. S. pressure. And historians will try to find evidence that Carter’s strategy had any impact on proliferation.

More than 30 years ago, Carter labeled nuclear power “the energy source of last resort.” Today, the Global Nuclear Energy Partnership (GNEP), an international program for research and development of new designs and fuel cycles, has had its funding cut and the remains of GNEP is told that the mere existence of separated plutonium, such as in Areva’s La Hague reprocessing plant in France, is unacceptable because it might become a proliferation risk.

No nuclear plant ordered after 1973 was ever completed. Today, new plants to be built with designs already certified for safety on previously approved sites face extended NRC hearings.

Happily, there is one bit of good news that might improve nuclear energy’s future. The White House announced two experienced candidates to fill empty seats on the NRC.

George Apostolakis is a professor of nuclear science and engineering at the Massachusetts Institute of Technology and a fellow of the American Nuclear Society, and William Magwood served under former Presidents Bill Clinton and George W. Bush as director of nuclear energy with the Department of Energy.

This is an important step and it is long overdue. **N P T**

Author: Dr. A. David Rossin has worked with trade associations, companies, national laboratories and universities on nuclear and advanced energy technology, non-proliferation, radioactive waste management and low-level radiation issues. Dr. Rossin served as president of the American Nuclear Society from 1992-93 and as U. S. DOE assistant secretary for nuclear energy from 1986-1987. He was the director of the Nuclear Safety Analysis Center at EPRI from 1981 to 1986. Since 1996, Dr. Rossin has been a Center Affiliated Scholar at the Center for International Security and Cooperation at Stanford University, where he is researching and writing a book on the U. S. policy decision in 1977 to abandon reprocessing spent nuclear reactor fuel.



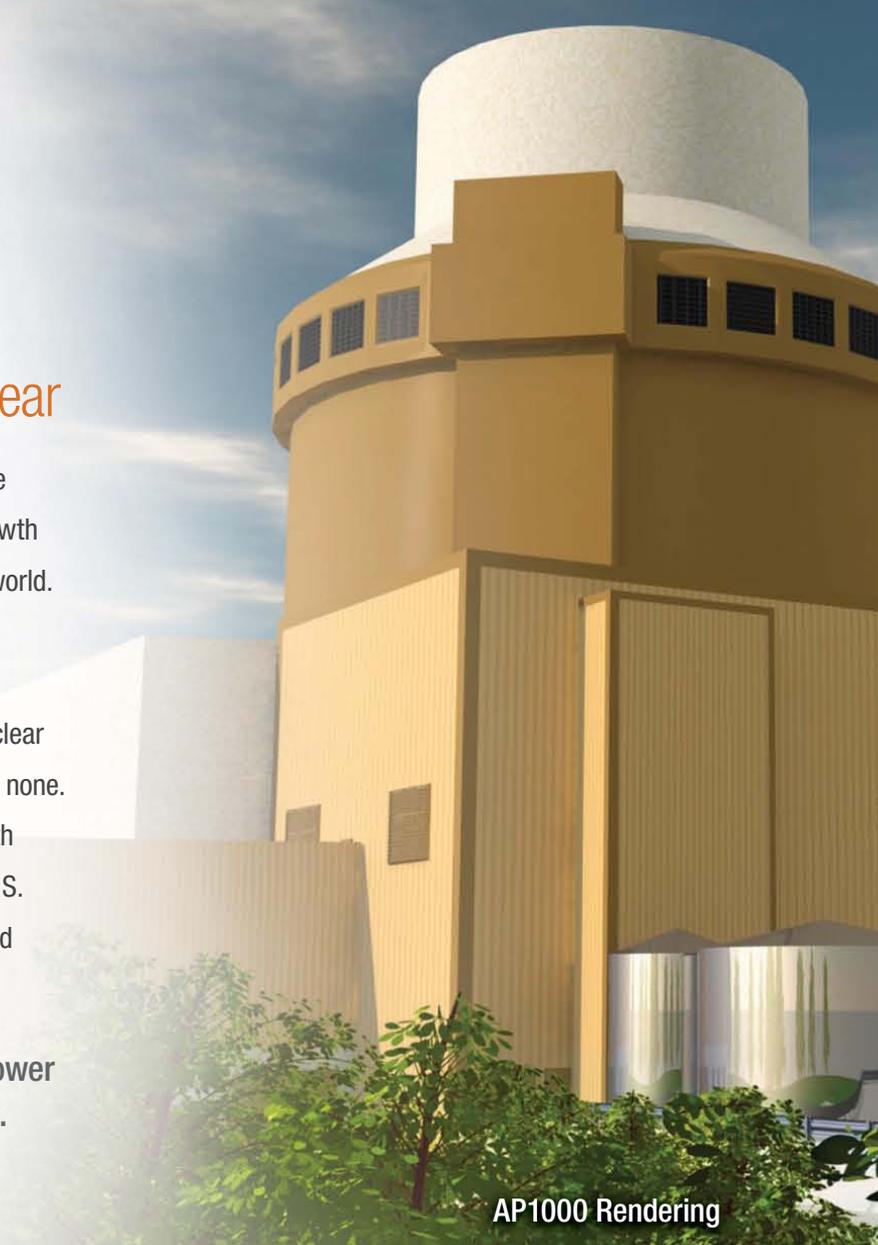
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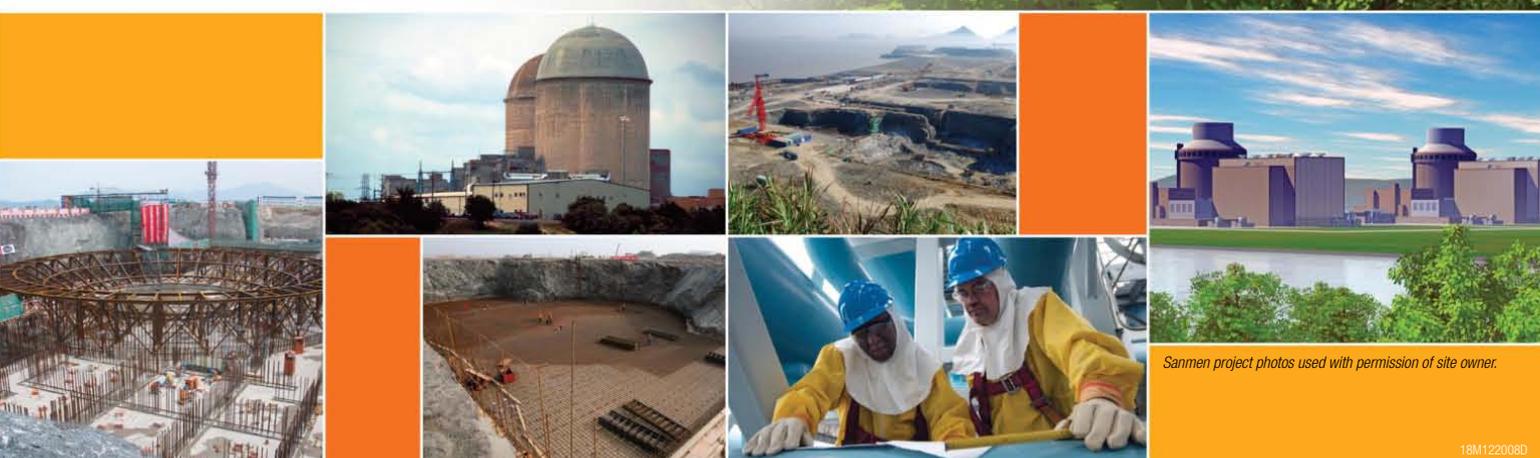
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AP1000 Rendering



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18M122008D



NEWS

WORLD NEWS

EdF/Constellation deal goes through

State regulators in Maryland have granted Electricité de France (EdF) conditional rights to take over part of Constellation Energy. EdF's bid for 49.99 percent of Constellation Energy's nuclear generation was slowed down by issues related to Constellation's state-regulated subsidiary, Baltimore Gas and Electric (BGE). In order to allow the transaction, the Maryland Public Service Commission had to determine whether it would be "consistent with the public interest, convenience and necessity, including benefits and no harm to consumers."

EdF made a number of commitments to the state at a total cost of \$110.5 million, including a new \$20 million visitor center at Calvert Cliffs nuclear power plant. The commission said that EdF would also have to make a one-time payment of \$110.5 million to BGE's residential customers.

Plans to build a new reactor at Calvert Cliffs by EdF and Constellation through their UniStar joint venture are now on track. The Maryland Public Service Commission passed a certificate of need for the reactor in June and the Nuclear Regulatory Commission is still working on its assessment of the Areva EPR reactor design and a combined construction and operating license application that has already been submitted. The U.S. Department of Energy (DOE) has accepted the project as one of four finalists for a DOE loan guarantee.

Calvert Cliffs could be just the start for UniStar.



Calvert Cliffs nuclear power plant. Photo, Constellation Energy Group Inc.

"What makes us somewhat unique is that we have a four-unit model," said UniStar Nuclear Energy President and CEO George Vanderheyden in a recent interview with *Nuclear Power International's* sister publication, *Power Engineering* magazine. "Our intention is to build a minimum of four identical nuclear power plants at various places in the country and we want to do that about a year or two apart. And the plans will be standardized."



Point Lepreau nuclear power plant. Photo NB Power.

Point Lepreau nuclear power plant.

Hydro-Quebec would pay an amount equivalent to NB Power's debt, approximately C\$4.75 billion (US\$4.4 billion), thereby completely eliminating the deficit.

The Point Lepreau nuclear power plant (after the completion of its refurbishment), the hydro facilities, the peaking power plants and the transmission and distribution assets of NB Power are part of the proposed transaction. Hydro-Quebec would not assume any liabilities with respect to the Point Lepreau refurbishment project, which prepares the reactor for another 30 years of service.

Hydro-Quebec to acquire NB Power assets

The premiers of the Canadian provinces of Quebec and New Brunswick have signed a memorandum of understanding (MOU) under which Hydro-Quebec will acquire most of the assets of New Brunswick Power, including the refurbished

When complete, the exchange will mark NB Power's exit from nuclear generation, Point Lepreau being its only reactor. Hydro-Quebec meanwhile would double its nuclear generating capacity to 1,260 MWe as the acquisition joins Gentilly 2. The two Candu-6 units are considered twins and Hydro-Quebec has already decided to refurbish Gentilly 2 as an alternative to closing it in 2011.

A coal-fired power plant at Belledune and an oil-fired plant at Coleson Cove will continue to be owned and operated by the province of New Brunswick and would supply electricity to Hydro-Quebec under the terms of tolling agreements. Under the terms of the MOU, Hydro-Quebec could direct New Brunswick to shut down these plants with one year's prior notice.

The majority of NB Power's assets could be transferred to Hydro-Quebec by the end of March 2010. Assuming the successful completion of the refurbishment of Point Lepreau and the restart of the plant, Point Lepreau would be taken on by Hydro-Quebec toward the end of January 2011. Once the transaction is completed, NB Power would continue to operate as a separate entity, using its existing name and corporate identity.

NEWS



EDF/E.ON plan swap

Electricité de France SA, Europe's biggest generator, and E.ON AG, Germany's largest utility, agreed to swap assets to cut debt and meet antitrust regulations.

E.ON will get the 35 percent it doesn't own in French energy supplier SNET and rights to 800 MW of nuclear output in return for giving up 1,215 MW of atomic and coal-fired generation in Germany.

Both utilities are seeking to sell more than 15 billion euros of assets to pay down debt accrued by buying up rivals. E.ON has now divested more than 4,400 MW of the 5,000 MW it pledged to end a European Commission probe and avoid a potential penalty for violating European Union antitrust rules. The transaction is still subject to approval by regulators and the companies' supervisory boards.

MHI opens turbine plant

Mitsubishi Heavy Industries Ltd. (MHI) has completed the construction of a new manufacturing plant at its Takasago Machinery Works in Hyogo Prefecture, Japan, dedicated to the production of steam turbine rotors for nuclear power. The new facility is capable of the integrated production of rotors, from material processing to finished products, at a rate of 10 units per year.

The new plant will play a key role for advanced pressurized water reactors in the U.S. and Europe by producing one of the world's largest nuclear power plant turbines, featuring 70-inch-class turbine blades.



The Tricastin nuclear site, location of Areva's Georges Besse II. Photo, N. Spring, *Nuclear Power International*.

Toshiba opens new engineering facility

Toshiba began operations at the new engineering facilities at its main nuclear power engineering center in Yokohama, Japan. The new facility will be responsible for engineering work to construct two advanced boiling water reactors (ABWRs) for the South Texas Project in the U.S.

Construction of the facility at the Isogo Nuclear Engineering Centre (IEC) began in October 2008. The IEC is Toshiba's core facility for promoting nuclear power plant engineering work for boiling water reactors, fast breeder reactors and the nuclear fuel cycle.

Luvata wins contract for ITER

Luvata, the global metals-manufacturing and technology company, was awarded a \$26 million contract in early October by the U.S. Department of Energy to supply superconductive material for the International Thermonuclear Experimental Reactor (ITER) project.

The contract was awarded to Luvata Waterbury Inc., a subsidiary of Luvata Fabrication North America, to supply materials for the world's largest nuclear fusion initiative.

Luvata will be responsible for supplying 86 percent of the U.S. commitment for superconductive wire and copper wire needed to complete the project over the next two years.

Using a \$15 billion plasma device designed by ITER scientists, the project will work to demonstrate the scientific and technological feasibility of fusion power. (See story on page 24 for more on ITER.)

The U.S. contribution to ITER's construction is a DOE Office of Science project consisting of procurement of hardware (including supporting R&D and design); assignment of personnel (U.S. engineers and scientists) to the ITER site; and cash contributions for the U.S. share of common expenses such as personnel infrastructure, assembly and installation.

Japan's Amano named new IAEA chief

The International Atomic Energy Agency (IAEA) formally appointed Japanese diplomat Yukiya Amano as its new director general of the U.N. nuclear watchdog. Amano is replacing Egypt's Mohamed ElBaradei, who is ending a 12-year run as head of the IAEA.

Amano has held increasingly senior positions in the Japanese Foreign Ministry since starting there in 1972. He has had extensive experience in disarmament, non-proliferation and nuclear energy policy and also served in the Japanese embassies in Washington, Brussels and Vientiane.



Japanese diplomat Yukiya Amano, new director general of the IAEA. Photo, Dean Calma/IAEA.

Areva centrifuge cascade will spin by end of year

Full testing of the new Georges Besse II uranium enrichment plant entered its final phase in early November and Areva said that the first centrifuge cascade will begin spinning at the end of the year, with full production capacity targeted for 2016.

Work is proceeding according to plan, despite complications. Areva recently discovered anomalies in inspections of a certain number of non-conforming welds but a corrective action plan was rolled out

to repair the welds in question.

Located at the Tricastin nuclear site between the Drôme and Vaucluse departments in Provence, France, the plant, which has been under construction for three years, will ultimately consist of two enrichment units. Thanks to its modular structure, overall production will reach 7.5 million separative work units (SWU) per year in 2016, two years ahead of schedule. Areva supplies nearly one fourth of all enrichment services worldwide.

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The Future of Spent Nuclear Fuel

U.S. National Nuclear Waste Policy and the Pursuit of a Comprehensive Solution

By Christopher F. Tierney & Patrick M. Jensen, The Kenrich Group LLC

At nearly 20 percent of our current electricity production, U.S. energy policy must include commercial nuclear power to satisfy our increasing demand for electricity over the next century, yet certain political and technological barriers remain for an otherwise promising source of clean energy.

New technologies are being explored for constructing the next generation of commercial nuclear power plants, but some of the same issues that have plagued the country's older legacy reactors for the past three decades will continue to affect the industry for the foreseeable future—in particular, what to do with spent (or more correctly, used) nuclear fuel.

For years, the policy set forth by the U.S. government, through the Department of Energy (DOE), was to establish a permanent geologic repository in which to store spent fuel from the nation's commercial nuclear reactors. Only very recently, under the Obama administration, has that course of action been called into question, if not potentially dismissed entirely as an option. But whatever goals the administration may have in mind for setting a new course in nuclear waste management, it may ultimately find that the most prudent approach may be what has been the aim all along—a central repository to dispose of spent nuclear fuel.

Certainly, much of the appeal for new nuclear generation is explained by concerns over man-made carbon-emissions and the potential impact on climate change, since nuclear generation is a source of power with near-zero carbon emissions. Nevertheless, electricity produced by nuclear power does result in a relatively small but highly consequential amount of waste product, spent nuclear fuel. Two predominant approaches to managing spent nuclear fuel waste, reprocessing and permanent storage, have been part of the worldwide commercial nuclear power industry for many years, but even after decades of consideration, the U.S. has apparently not been able to definitively make up its mind as to which approach it should take.

U.S. WASTE POLICY HISTORY

Though reprocessing was intended when commercial nuclear plants were first built, President Jimmy Carter eliminated that option in the late 1970s. The decision effectively kept reprocessing off the table as an option and led to the Nuclear Waste Policy Act of 1982, which required each utility to sign a standard contract with the U.S. DOE, whereby the government would remove spent fuel from nuclear plant sites beginning in 1998. The Nuclear Waste Policy Act established that the method for handling spent nuclear fuel in the U.S. was to ship it to a centralized repository. To fund DOE's efforts, each utility would pay quarterly fees to DOE based on the amount of electricity generated, about \$8 million per year for a typical 1,000 MW plant.

What happened, though, was something entirely different. DOE never completed the repository and no spent fuel has been removed from the nuclear plant sites under the contract. Confronted with mounting inventories in onsite wet storage pools, utilities had to find another way of safely holding their spent fuel until DOE would perform. While some utilities have been able to expand the capacity of their storage pools, in most cases, doing so provided



A tunnel boring machine reaching daylight in April 1997 at Yucca Mountain. In 1987, Congress directed DOE to study Yucca Mountain, choosing that site from three under consideration. Photo, U.S. DOE.

only a temporary solution due to continual growth in inventories of spent fuel as the plants continue to operate. The next step was “dry storage” technology, which entails the transfer of sufficiently cooled spent fuel from the pools into vaults or dry casks. Stored in a protected area on the site of the nuclear power plant, the dry casks provide safe, contained storage for decades.

But implementing a dry storage system is very costly. The Nuclear Energy Institute states that it costs approximately \$10 million to \$20 million to build a dry storage facility and related modifications add another \$5 million to \$7 million annually for the operations and maintenance of dry storage. Such costs add up quickly, considering that there are 104 commercial nuclear power reactors in the U.S. In fact, DOE estimates the costs incurred by the industry to date at \$11 billion as a result of its non-performance under the standard contracts with utilities, assuming DOE begins picking up spent fuel in 2020. According to DOE estimates, that liability will increase an additional \$500 million each year that DOE continues to not take spent fuel. It is not surprising that more than 70 utilities have filed suit against DOE since the time the 1998 contractual deadline passed.

Industry observers heightened their expectations that DOE would eventually open a repository after the location at Yucca Mountain, Nev., was formally approved by President George W. Bush in 2002 and a design certification application was submitted to the Nuclear Regulatory Commission (NRC) in 2008. Despite these signs that the federal government might yet take responsibility for the industry's spent

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fuel according to contracts with utilities (albeit untimely), President Barack Obama has all but reversed course on U.S. national spent fuel policy. In early 2009, the funding for the Yucca Mountain repository was eliminated from the federal budget but for a relatively miniscule amount needed to keep the design review process active at the NRC. At the same time, Obama announced plans to form a “blue ribbon panel” to study what to do with commercial spent nuclear fuel and recommend a course of action.

It seems a foregone conclusion that the panel will consider reprocessing as an option for spent fuel. Current and expected future technologies point to new efficiencies from reprocessing. And, of course, other countries around the world have been recycling spent fuel for decades. But there are drawbacks. Reprocessing is expensive and currently not economical compared to mining new uranium. Countries currently reprocessing might not be doing so if their reprocessing plants were not already a “sunk cost” and their decommissioning not so expensive. Of course, reprocessing also does not eliminate the need for permanent waste storage for the remaining waste—even smaller in amount but more radiologically active. France, the country with by far the most extensive reprocessing operations, is pursuing its own deep geologic repository for remaining wastes, estimated to be in service by 2025.

It is apparent that the U.S. is at a crossroads on the question of spent nuclear fuel. Any solution that is chosen today, whether permanent storage in a repository or pursuing reprocessing, will still require years of development and implementation. And DOE’s current breach of its contracts to take possession of commercially produced spent fuel further complicates matters. The government appears reluctant to pursue reasonable settlement terms with many utilities in the nuclear industry, presumably because of the substantial liability owed. At this point, the government is using every means possible in federal court to postpone reimbursing these utilities for their onsite spent fuel storage costs.

The first lawsuits addressing DOE’s liability date back to the mid-1990s, with most of the recent group of suits on economic dam-

ages beginning in 1998—the latest date by which DOE was contractually obligated to begin taking spent fuel. More than 10 years later, only a dozen or so cases have reached trial and even fewer have court-issued decisions. Even with the court decisions in favor of the utilities, virtually no damages have been paid to date due to continuing appeals by the government to higher courts. In fact, one case currently under appellate review is subject to a jurisdictional dispute, the outcome of which could have industry-wide implications.

The ongoing litigation has been costly to the industry and taxpayers. Overall, about 10 cases have settled, with about 50 cases still active. According to Deputy Assistant Attorney General Michael Hertz in House Budget Committee testimony earlier this year, these efforts have cost the Department of Justice more than \$150 million in attorney, expert and litigation support fees to defend. For utilities, it costs several million dollars from filing a complaint through trial, excluding expert witness fees and other litigation support costs. (Marcia Coyle, “Billions in Damages on the Line in Federal Circuit’s Nuclear Fuel Case,” *National Law Journal*, Sept. 14, 2009.) In addition, because of potential legal barriers to the recovery of interest in damages claims against the federal government, until the utilities are reimbursed for the expenditures they have made to date for storing spent fuel onsite, the financing costs alone for the industry run as much as \$200 million to \$300 million a year.

THE FUTURE FOR WASTE POLICY

Ultimately, although existing processes of storing spent fuel in dry casks have become a safe and routine operation at nuclear plants, the concern by the utilities is a result of broken promises and uncertain guidance on national waste policy. Once reprocessing was eliminated as an option decades ago, the utilities relied on DOE to take the spent fuel as it contractually stated it would. Now the utilities are in a situation where the federal government is in a holding pattern, very possibly having abandoned the direction the government said it would be taking since the early 1980s.

Earlier this year, in an attempt to help solve the political and logistical issues surrounding a national policy for spent fuel storage, a consortium of Midwestern universities professors released a white paper, *‘Plan D’ for Spent Nuclear Fuel*. The white paper explored several options: send spent fuel to a long-term underground repository, pursue reprocessing, maintain spent fuel in dry storage at nuclear plant sites for an extended period while alternative solutions are further evaluated, or simply phase out commercial nuclear power altogether and abandon further consideration of reprocessing. Of these options, the conclusion the professors reached was to continue to pursue at-plant dry storage, allowing time to evaluate other options in the coming decades, if not centuries—an approach they labeled “Plan D.” *Plan D* would also entail a radical change to the existing policies between federal and state governments and the individual utilities regarding spent fuel management.

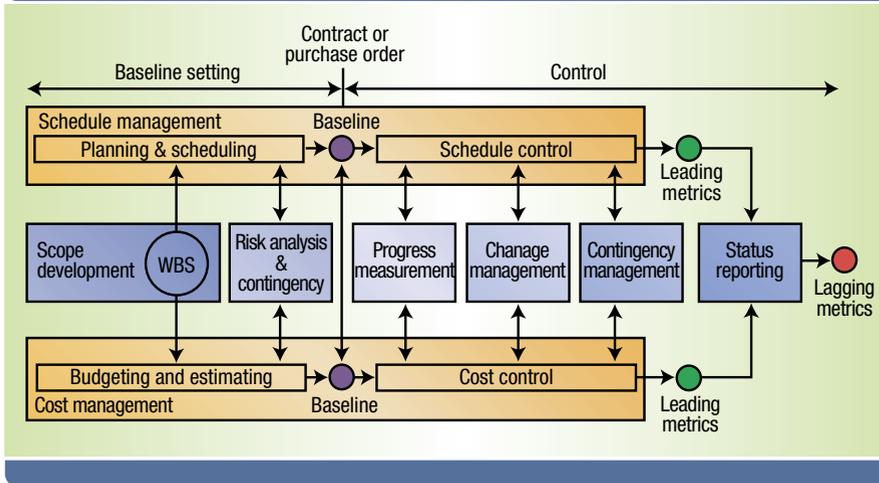
Plan D, in part, seeks a practical approach to spent fuel management and storage. *Plan D* acknowledges that most utilities have already implemented dry storage to store spent fuel that will no longer fit in their storage pools. Dry storage has been demonstrated to be safe and there is vast experience for implementing, maintaining and operating dry storage installations. While recognizing the limitations of dry storage as a long-term solution, *Plan D* embraces dry storage as a means to buy time while other technologies emerge and a coordinated, viable national policy can be developed and executed.

But the authors of *Plan D* go a step further and propose a complete overhaul of the current arrangement between the federal government and the utilities—that is, transfer responsibility for the long-term management and storage of spent fuel from the federal government to the states and the commercial utilities that produce spent fuel. Given the dismay over the more than \$25 billion that has been paid by the utilities to DOE into the Nuclear Waste Fund with no commensurate performance to date, *Plan D* proposes that the federal government remove itself entirely from a management role and relegate itself to a regulatory role

[CONTINUED ON PG. 23]

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Figure 1 THE INTEGRATED PROJECT CONTROLS PROCESS



retrenching until the worldwide economy started to recover.

Today some capital project activity is starting to resume in the oil/gas sector, but other sectors remain slower to recover. The one industry that continues to show high levels of activity is the power sector, especially as current energy strategy calls for an increased contribution of nuclear power for U.S. energy needs. This has stimulated a number of nuclear projects that are now in the planning stages.

How does the nuclear industry take advantage of recent fluctuations in project delivery while also taking advantage of the lessons that other industries have learned during periods of peak project growth? What can be learned from these other industries and their roller coaster ride of project activity and capital spending? One thing is sure, the capital project planning and execution industry will go through cycles and those who can best interpret these cycles can benefit in capital cost savings and shortened execution times.

Cross-Industry Project Management Lessons Learned

The nuclear industry can learn from the “roller coaster ride” other industries have taken on project activity and capital spending.

By Stephen Cabano, President, Pathfinder LLC

For the past 15 or 20 years, every industry sector has experienced its growth and lull periods and consequently a fluctuation of capital project investment.

The pharmaceutical sector flourished in the early 2000s and is now at a low point; the chemical industry has endured several peaks and valleys; the manufacturing industry has been sluggish for a number of years; and in the past five years, the oil sector has survived severe price fluctuations. All of these industries share contractors and suppliers who are also feeling the pain of the recent “roller coaster ride” of activity.

As the nuclear power sector prepares for the forecasted surge in work, we can benefit from “lessons learned” from other industry sectors and develop our strategy around the value-added lessons in planning, resourcing, implementation and execution of future power/energy sector capital projects.

A number of studies have been conducted in recent years on how to assure effective and efficient utilization of an owner or operator’s capital. Industry project management best practices have been established that cross all industry sectors, but in the heat of an active project environment we often circumvent these best practices due to time constraints, resource limitations or a lack of respect for the benefits of the practice.

And history now tells us that these best practices are equally as important when capital spending is high. In the oil sector during the boom in project activity from 2006 through 2008, capital project pricing nearly doubled, execution times were pushed out 20 percent to 30 percent longer than planned and safety incidents increased at an alarming level. As 2008 ended and we entered 2009, the bottom dropped out of the oil industry and we saw project slowdowns or cancellations, massive layoffs, increased claims and owner/operator

RECOMMENDATIONS

Traditional project management tools and techniques assist in selecting the optimum capital project portfolio and executing the projects more effectively. Many organizations have these imbedded into their work approaches but implement them poorly or inconsistently, which has resulted in projects being pushed through the approval process with ill-conceived scopes of work, poor execution plans and less than accurate cost and schedule expectations. The final results have been less than satisfactory because the efforts encountered numerous project changes during project execution and constant conflict with management and contractors.

After some post-project reviews and root-cause analysis, indications were that many of these project issues could have been avoided through well-known, but often misused, project management techniques.

Capital Project Delivery Process – Most industries have well-established owner capital project delivery processes. These processes were established a number of years ago when the industry last encountered massive

overruns and schedule delays.

Benchmarking results indicated that formal project reviews/approvals at key points in the project planning and development stages would help to minimize project issues during execution. These practices have proven to be extremely effective but as we get busier or staff gets cut, we become less committed to and more complacent about the use and potential benefits of the process.

All projects, no matter how small or large, need to be evaluated using a consistent project approach with clearly defined phase deliverables and decision gates. This will assure that management has the opportunity to challenge the scope, quality, cost and schedule for any given project opportunity and evaluate the project against the defined business case or industry opportunity.

Project Execution Planning (PEP) – For future nuclear power projects, project execution planning (PEP) is the most important and influential deliverable that a project team can develop.

The PEP is developed early in the planning stages and is constantly kept “ever-green” as the project evolves. The PEP provides the roadmap for all project activities and assures that all activities are considered and addressed. This roadmap would include the project schedule, resources, regulatory compliance issues, project staffing, project control plan, commissioning/start-up details, etc. This owner/operator-developed document is the communication device that all project participants use to assure full team alignment of roles, responsibilities, deliverable commitments and project risk mitigation strategies.

Due to the massive size and complexity of nuclear power projects, one cannot conceive of a case where a PEP would not be mandatory. In fact, the owner/operator should require every engineering/construction contractor, supplier/vendor and support consultant to provide their respective plans for their assigned scopes of work that would be incorporated into the owner/operator overall master PEP. This then becomes the guiding “playbook” for the project that is equally as important as the engineering

drawings and specifications. The “playbook” must be maintained and updated throughout the project to incorporate the latest information and alternatives.

PROJECT CONTROL SYSTEMS

An excellently conceived and planned project can quickly become a nightmare if the project team does not consistently and aggressively oversee the project’s scope, cost, schedule, and change status, and proactively forecast project deviations early. This allows the project team to be fully aware when the project is not adhering to the plan. A comprehensive project control process/system needs to be established and communicated to all team members, including the contractors/suppliers, to assure everyone is well aware of their status and reporting requirements. (See Fig.1.)

Nuclear power projects have a number of regulatory reporting requirements that mandate an effective and efficient project control system be established. If this is not executed satisfactorily, project decisions can be made with inadequate project status information, which can result in regulatory issues and poor overall project management.

Risk Management – In any large capital project expenditure, especially in the nuclear project environment, there are a number of potential project execution risks that can interfere with a project meeting its expectations. The identification of potential project risks and execution vulnerabilities in the early planning stages and the incorporation of these risks/vulnerabilities and associated mitigation strategies in the PEP are essential. These risks are then tracked and managed during the execution phase.

In today’s fast-paced and resource-limited environment, many companies have difficulty making the appropriate adjustments to address these risks. This is an issue in the power industry. Many identify the risks, but do not adjust the plan or their approach to incorporate the selected mitigation approach.

Execution risks and vulnerabilities must be at the forefront of all project execution activities. They need to be reported on at

each defined reporting period and acted on early to not minimize mitigation options. They should be incorporated into all revised PEP efforts. Schedules need to be adjusted accordingly, cost estimates must reflect the impact of the mitigation approach and the team needs to be totally aligned regarding the approaches agreed upon when addressing the risks.

Typical risk management steps include:

- Risk management planning
- Risk identification
- Qualitative risk analysis
- Quantitative risk analysis
- Risk response planning
- Risk monitoring and control.

Risks should also be classified in terms of probability of severity of occurrence to determine how the risk will be dealt with.

Typical risk response aspects must also be defined, which include such factors as avoidance, partial or full transfer, mitigation, and acceptance.

A diligent approach to risk management needs to be incorporated during the execution phase. Many organizations have identified a project risk manager (for large projects) who is solely responsible for tracking the identified risks and how they are being managed, identifying new risks and developing strategies to minimize their impact. For smaller projects, these same techniques are incorporated into the project manager’s responsibilities.

Another important aspect of risk management is the communication with the execution contractors on how risk will be addressed. If this aspect of risk management is not addressed, changes become numerous and the potential for claims is increased. Contractors should also be encouraged to bring forward potential risks as they are identified and not wait for them to have negative impacts on the project.

Effective Staffing – In the engineering, procurement and construction industry over the past five years, the most critical issue facing the industry has been the availability of experienced, qualified human resources.

[CONTINUED ON PG. 23]

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Remote box lid bolt replacement. Photo, BNS Nuclear Services.

Decommissioning Bunkers at Hunterston A

By Phil Reade, SAWBR Project Manager, BNS Nuclear Services



Hunterston A power station is located on a promontory of the Ayrshire coast, near West Kilbride, 30 miles southwest of Glasgow, Scotland. It is a twin reactor Magnox power station now shutdown and being decommissioned. The station, Scotland's first civil nuclear generating station and the largest in operation anywhere in the world when it came online, had a generating output of some 360 MW.

The station comprised two Magnox-fueled, graphite-moderated, steel pressure vessel reactors. One of its unique features was that load refueling operations were conducted from below the reactors. Six 60 MW turbo alternators provided electricity to the grid. Throughout its 25-year operational life, Hunterston A was at or near the top of the World Nuclear Performance charts.

Reactor 2 was shutdown on Dec. 31, 1989, followed by Reactor 1 on March 30, 1990. Defueling commenced on Aug. 16, 1990, and was completed on Jan. 21, 1995, with the last fuel being dispatched from the site on Feb. 8, 1995.

The current preferred strategy for decommissioning Hunterston A, like all U.K. Magnox nuclear power stations, is deferred site clearance, allowing for total site clearance about 100 years after cessation of generation. This strategy minimizes risk to workers, the public and the environment, minimizes waste volumes, is technically straightforward and makes financial sense.

U.K.-based BNS Nuclear Services has completed all the mechanical plant and electrical systems for the U.K.'s Magnox North Hunterston A site solid active waste bunker recovery (SAWBR) project. BNS worked closely with the lead contractor, Costain Oil, Gas and

Process Ltd., and Magnox North Sites Ltd., on the design, manufacture and integrated works testing. BNS will also provide engineering support to Costain during site installation and will carry out inactive commissioning at the site prior to hand-over to Magnox North.

Magnox North is applying its expertise to accelerate the decommissioning work plan, which doesn't preclude a reduction in the 100-year period to total site clearance.

SCOPE OF THE SAWBR PROJECT

The object of SAWBR is the retrieval and processing for storage of intermediate level waste (fuel element debris). Once this objective has been achieved, the decontamination and demolition of the five reinforced concrete bunkers can begin. (This element of the project will be undertaken by Magnox North under the provisions of a separate contract.)

Three of the bunkers were built in the 1950s and two were built in the 1980s. The bunkers contain approximately 3,000 square meters of solid intermediate level waste. Costain has demolished a redundant stairwell and corridor adjacent to the bunkers and is constructing a new building to house the SAWBR plant, which should be completed by the end of 2009 and operational by June 2010.

The bunkers contain several different types of waste. To reduce any risk of fire, the retrieval operations will be carried out in an oxygen-reduced atmosphere. The vent plant was designed and manufactured by Studsvik Alpha Limited, with Costain designing and supplying the oxygen reduction atmosphere (ORA) system.

THE RETRIEVAL PROCESS

Two Brokk remotely operated vehicles (ROVs) are the first stage of the retrieval process. The ROVs have been successfully operated at a number of sites, including Trawsfynydd in Wales and Sellafield in Northern England.

The first ROV will be bunker-based and will rake and sweep waste to fill a waste

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bucket. The second ROV will collect the filled waste bucket and deliver it to the wall-mounted conveyor. To achieve the plant throughput criteria, the ROV operators must retrieve enough waste to fill a 3-square-meter radioactive waste management directive (RWMD) box every four hours.

At an intermediate position along the conveyor, the waste bucket stops and the activity of the waste is monitored. This allows the operator to ensure that each 3-square-meter box does not exceed the maximum activity limit set for export from SAWBR to storage. The waste bucket is then conveyed to the elevator/tipper.

BNS has integrated an industrial loader tipper from Lodematic Ltd. The waste bucket engages onto its forks and the bucket is then automatically elevated and tipped, with its contents being fed into a 3-square-meter box via a chute. The chute is designed to contain the material and guide it into the box.

When the operator has filled the box to the desired level, a roof-mounted industrial robot is deployed and performs a pre-programmed routine to level the waste pile to ensure that the box lid can be effectively replaced. To ensure the sealing system is not compromised by the build-up of dust or debris, the robot has the facility via a tool changer to vacuum clean around the box-filling aperture and around the critical sealing faces of the waste chute and delidder. There is also a facility for the operator to remotely attach a gripper and in manual mode, control the robot to remove any rogue items of waste that may prevent the box lid from being replaced. The operator has to be satisfied that there is a sufficient void at the top of the box for the grout cap to be added later and that the box is cleanly filled with no contamination on the top edge or sides.

Once a box is filled, the operator initiates an automatic sequence to raise the waste chute, the delidder closes and automatically replaces and releases the box lid. The box is then automatically returned to the box preparation area, where the swabbing and bolting robot replaces the lid bolts. A local

gamma monitor performs a final dose check of the activity in the box to confirm that it is within acceptable limits for export. The robot also performs a number of swabbing routines to confirm that there is no loose contamination on the external surfaces of the box. To meet RWMD requirements, even the base of the box can be swabbed, necessitating the opening of the gamma gate and the use of the import/export overhead crane to lift the box to enable the robot to swab the base.

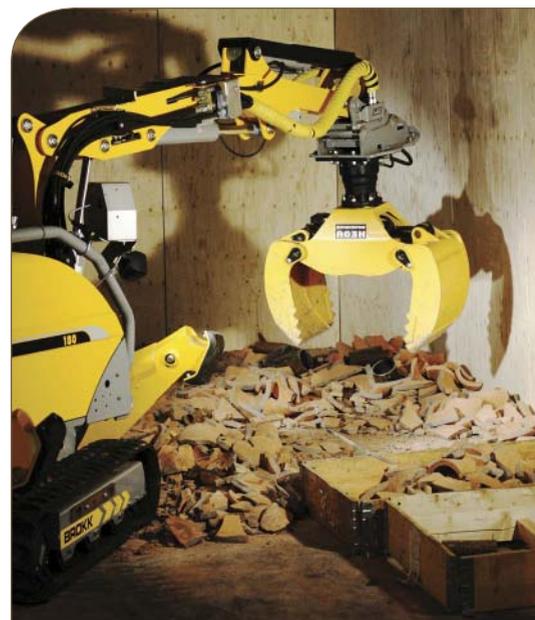
The operator has closed-circuit television of all the retrieval and process operations via the ROV's on-board cameras, as well as via the overview cameras strategically placed to follow the entire process.

BNS was responsible for the design and supply of the modular control room and the associated power distribution and control ISO containers. They have been fully tested during integrated testing of equipment at their works and will be delivered and situated adjacent to the SAWBR building for interconnecting cabling to be installed.

TRANSPORTATION

The SAWBR processing facility anticipates producing approximately 1,000 boxes of intermediate level waste (ILW). Once the box has passed both dose and contaminant checks, it is available for export across the Hunterston A site in a purpose-built cross-site shielded transporter.

The vehicle is reversed into position below the import/export shielded gamma gate. To guarantee position accuracy, the vehicle is fitted with an automatic guidance system. When in position, the control of the vehicle is handed over to the control room and the vehicle is elevated before the doors of the onboard shielded overpack are opened. The box-handling crane lowers the box into the overpack and releases the grapple. The crane then rises to its parking height and the gamma gate closes, as does the gate on the shielded overpack. Control of the vehicle is then transferred back to the driver. The driver is then able to lower it off its stabilisers and vacate the building.



Remote waste retrieval. Photo, BNS Nuclear Services.

MAGNOX NORTH AND HUNTERSTON A

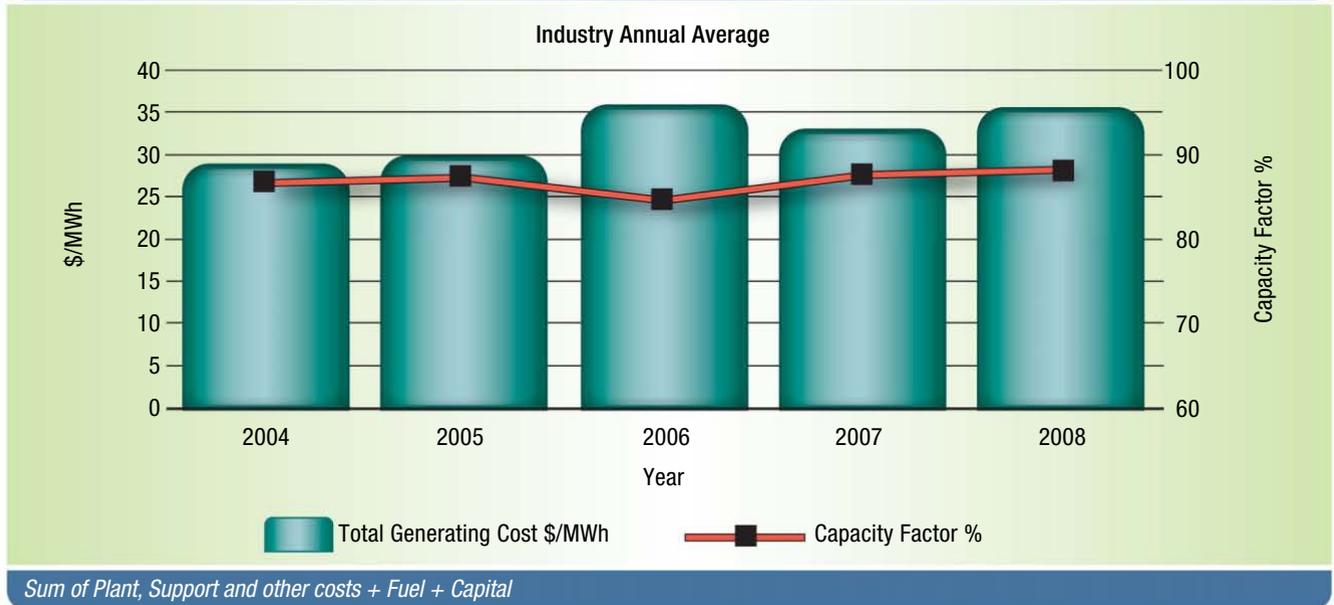
Magnox North is responsible for the safe delivery of the operations and decommissioning programmes on five sites in the U.K. Besides the decommissioning of Hunterston A, the company's site operations include electricity generation at Oldbury in Gloucestershire, Wylfa and Maentwrog in North Wales, and defuelling and decommissioning of the former generating power stations at Chapelcross in Dumfriesshire and Trawsfynydd, also in North Wales. Magnox North is the management and operations contractor responsible for the day-to-day operation of its site under contract to the U.K.'s Nuclear Decommissioning Authority.

Having successfully defueled Hunterston's twin reactors and dispatched the irradiated fuel to Sellafield for reprocessing, Magnox North is currently midway through the care and maintenance preparations of the site's decommissioning programme. **N P I**

Author: Phil Reade is SAWBR project manager, BNS Nuclear Services. He has 25 years of experience with nuclear engineering at leading U.K. firms. He has worked as a project manager during his last eight years with BNS and its predecessor, INS. The projects he led during this time include the design of high active cells for the BNFL Technology Centre and equipment design for the Berkeley Active Waste Vault Project.

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Figure 1 TOTAL GENERATING COSTS AND CAPACITY FACTOR



Crossing International Boundaries

The benefits of comparing nuclear operating costs and performance internationally

By David R. Ward, Jr., Duke Energy–Charlotte, N.C., and Electric Utility Costs Group (EUCG) Nuclear Committee Chair

In a seamless world such as ours, there are very few boundaries aside from those that demarcate national territories and prevent the flow of information, ideas, trade and people. It is often pointed out that those who do not recognize that the “world is flat” and that globalization is a levelling factor in all aspects of trade, ideas and practices will be left behind in the global race to excellence. Those who fail to recognize this feel they are different or they that they have the best, so why look?

Globalization is particularly relevant and important for companies that want to succeed given current global issues such as shrinking economies, credit availability, demographics and climate change. There is a need to better understand real value drivers, the ability to act with agility and

exploit good opportunities. The sources of these factors for success are not just national, but global.

The Electric Utility Costs Group (EUCG) Nuclear Committee came to recognize the significant positives about “going global” a number of years ago and began its initiative to expand membership beyond North America. It has turned out to be a very progressive move in all respects, not only fostering the exchange of good ideas, but creating a meaningful way to forge positive links toward improving and sustaining the nuclear world community.

GOING GLOBAL

The EUCG started out as a cooperating group of member utilities primarily exchanging financial data in a forum that comprised mainly U.S. and Canadian utilities. In early 2000,

the EUCG adopted a strategy to look for international members beyond North America and into Europe and the Far East. At the same time, there were overtures by some internationals that saw value in participating in the EUCG. The EUCG seized the opportunity to foster these connections premised on the fact that there was valued experience in nuclear operations in Europe and there was an expanding nuclear industry in the Far East.

Along with the strategy to bring in new member utilities, the EUCG also saw the opportunity to strengthen its role in related international associations. This forged a partnership with the International Atomic Energy Association (IAEA) to drive projects and initiatives of mutual interest.

Aside from the Canadian utilities who have been long-standing members of the association, the EUCG now includes members from Spain, Romania, France, China

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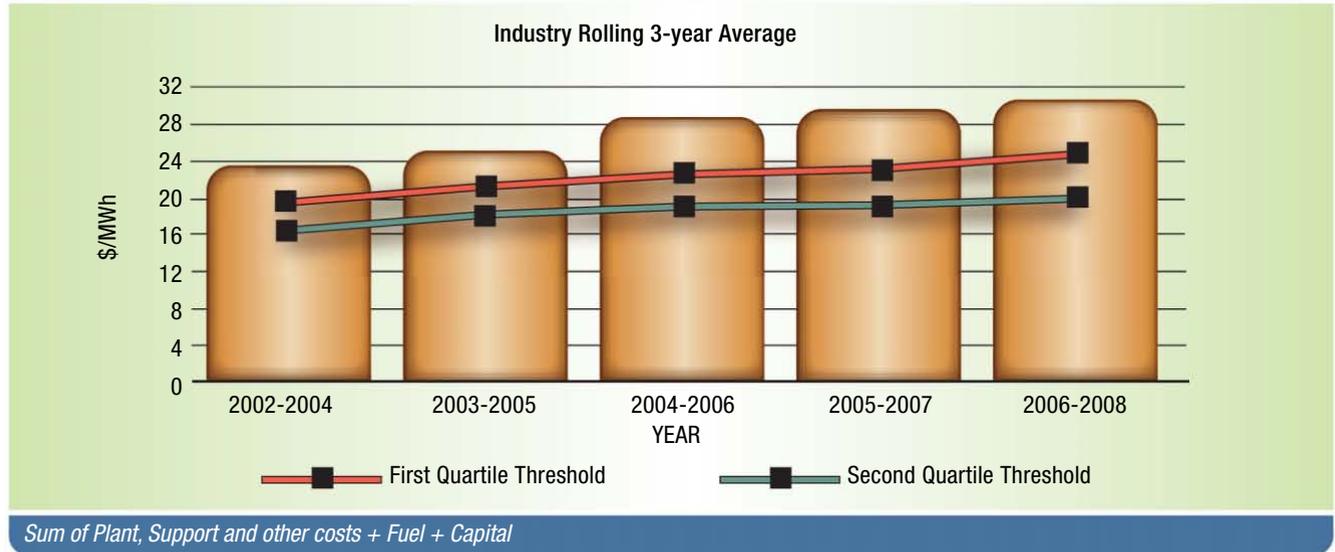
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Figure 2 TOTAL OPERATING COSTS



and Japan. This representation brings with it almost as many operating units as there are in the U.S. today, providing a larger population from which to select benchmarking peers. It also brings:

- Lessons and practices from different nuclear technologies
- Information on new nuclear build
- Lessons and practices from different operating modes, socio-economic conditions and regulatory umbrellas.

This variety in practices brings valuable mutual benefits to all members who actively participate and importantly, provides a list of contacts for utilities to exchange ideas.

In its effort to improve benchmarking costs across nations (currencies), the EUCG developed a feature in its nuclear integrated information database (NIID) called the purchasing power parity feature that factors out the “currency vacillations” and drives to a truer basis for benchmarking costs. The NIID is the cornerstone of the EUCG. The Nuclear Committee’s vision is to be the recognized industry source for economic and performance benchmarking data and information used by member companies to improve plant and industry performance.

The NIID not only captures plant and

unit cost, performance and staffing data, it also provides qualitative information that enables better understanding of the data. The fundamental purpose of this database is to support benchmarking and target-setting and improve members’ access to industry best practices.

One limiting factor when nuclear energy stations try to benchmark operating costs with plants in other countries is the currency exchange issue. Some databases use a point-in-time currency exchange rate, which is for a specific date in the reporting period. However, database reporting periods can cover multiple periods such as monthly, quarterly and in most cases, annually. An exchange rate between two currencies can fluctuate significantly during a reporting period, so trying to determine which rate is the most effective can be difficult.

The EUCG Nuclear Committee databases have been collecting data since 1986 and consist of plant/unit performance and cost data, operating and outage cost data, capital cost data and staffing information. The databases are updated annually by participating members and are recognized as the most comprehensive source of nuclear plant data in the world. EUCG data is shared on a “give-to-get”

basis among members, meaning that the data is only available to members that participate by providing their plant data. In 2007, the EUCG Nuclear Committee Leadership Team approved an initiative to address this issue.

A task team of member representatives—North American and internationals—developed a proposal to utilize the purchasing power parity (PPP) published by the Organization for Economic Co-operation and Development (OECD). This PPP is the most suitable and internationally accepted currency conversion that both converts to a common currency and equalizes the purchasing power of different currencies. In other words, the differences in price levels between countries in the process of conversion is eliminated.

As noted on the OECD website, the use of PPP is a first step in making inter-country comparisons in real terms of gross domestic product (GDP) and its component expenditures. GDP is the aggregate used most frequently to represent the economic size of countries and, on a per capita basis, the economic well-being of their residents. Calculating PPP is the first step in the process of converting the level of GDP and its major aggregates, expressed in national currencies, into a

NUCLEUS

common currency to enable these comparisons to be made.

The recommended PPP initiative was approved by the Nuclear Leadership Team and the Nuclear Committee membership so the next step was implementing the recommendation into the annual data exchange process. This required programming changes to the EUCG cost databases. The EUCG database manager reconfigured each cost database to allow each participating member to select its respective country's currency to enter plant cost data into the databases. The input data would then use the respective year/country PPP factor and convert the stored data into U.S. dollars. This saved time for the international members of EUCG by not having to use a currency exchange rate to recalculate the currency then enter the data. The output side also realizes time savings by allowing a country to select the desired currency and then all reports/graphs are displayed as requested. This type of output saves time for additional analysis and allows "last minute" management requests to be met in a timely manner. The EUCG Nuclear Committee databases have many years of historical data that required confirmation and then transformation using the given PPP factor for each related year.

Even though the original intent of this change was to benefit the international members of the EUCG Nuclear Committee, the North American companies have increased usage of the international data because of the ease of obtaining cost and performance information. With increased usage, data definitions are being refined to recognize international elements in order to ensure data consistency across the different countries. An additional benefit that is being realized at the nuclear committee workshops, which are held twice a year, is the increased participation/discussion by the international members during the presentations. This provides all attendees with insight to nuclear energy operations in different areas of the

world and identifies the similarities in the issues all companies face. This also allows for differences to be uncovered for possible consideration in other parts of the world to improve the benchmarking capabilities.

Sharing data and best practices has gone a long way toward the transformation of the EUCG into a more global association. It is important to note that the aforementioned "give to get" principle not only applies to the annual data exchange but also implicitly applies to the level of participation in workshop discussions and agenda-setting by members who attend workshops. The workshops provide a very useful forum to table company issues, better understand data analysis issues, engage in discussions, exchange ideas and set future workshop agendas. This forum now has greater importance and benefit with the infusion of members from many countries.

The nuclear industry data in Figures 1 and 2 were retrieved using the latest EUCG data. The graphs shown include all current EUCG Nuclear Committee members. Each member company can drill down into more details of this information to identify relevant differences that each company can address when comparing to its peers.

Going forward, the EUCG's strategy is to increase the exchange of valued ideas and practices across international boundaries by continuing its effort to make the database more global without sacrificing the good aspects of its current configuration and by holding workshops with a similar focus. For more information about the EUCG please contact David Ward at 704-382-4943 or visit the EUCG website at eucg.org. 

Author: David R. Ward, Jr., is a senior business consultant in the nuclear generation department of Duke Energy—Charlotte, N.C. He is currently the EUCG nuclear committee chair and has served on numerous industry task teams in regards to nuclear cost and staffing-related initiatives.

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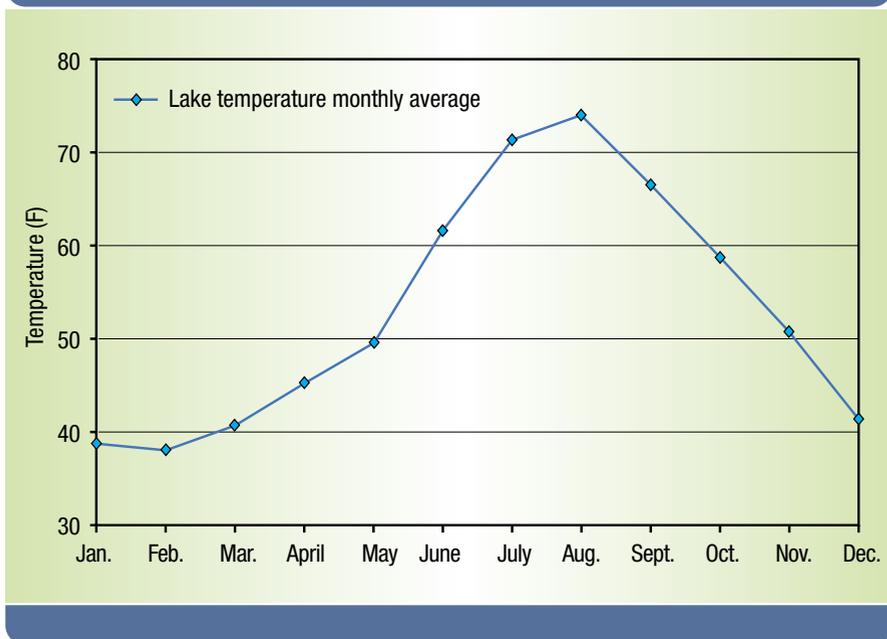
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CASE STUDY

Figure 1 LAKE TEMPERATURE MONTHLY AVERAGE



Cleanliness Program Improved Condenser Performance

Nine Mile Point gained 20 MW of capacity and saved \$1 million.

By Daniel Cicero, Nalco, Gerald Munyan, Constellation Energy, and Scott Reich, Nalco

Nine Mile Point Nuclear Station is located on Lake Ontario in Scriba, N.Y., just outside Oswego. The plant operates two boiling water reactors (BWRs), generating about 1,700 MW. Nine Mile Point is a once-through, parallel flow condenser with two water boxes. The unit draws cooling water from Lake Ontario, which varies from about 35 F to approximately 75 F, as shown in Figure 1. In the cooler months when lake temperatures are at their lowest, condenser fouling impact is low. As lake temperatures rise, the impact of existing fouling increases. Biological activity also increases during the summer months. As shown in Figure 2, the condenser fouling factor varies throughout the year in response to changing temperatures.

The impact of condenser fouling was greatest during the even years, the second year of each two-year refueling cycle. This, coupled with high temperatures during the summer months, resulted in condenser back pressures and discharge temperatures

approaching, respectively, their manufacturer and state-mandated limits.

Figure 3 shows the output curves for the years prior to the de-silting of Unit 1's condenser. In the second week of June 2006, Unit 1's condenser was cleaned to avoid problems caused by excessive back pressures predicted for August. Following the cleaning, periodic chemical treatments were started. Their frequency increased over time. Cleaning, in conjunction with chemical injection, improved plant performance for the remainder of the cycle. This improvement in generation continued through the first half of the cycle started in 2007. In 2008, the cycle started to repeat and back pressure curves predicted that operations would again face challenges during high lake temperature months.

THE SOLUTION

The efficacy of a cleaning program was proven, but holding on to gains from any cleaning required follow-on maintenance. A team formed to address the issue developed an online condenser cleaning program designed to restore condenser performance by removing the maximum amount of fouling deposits in the shortest period of time. A maintenance dispersant program would "hold the gains."

Organic material and microbial deposits bind inorganic material like silt, iron oxides and other solids into amorphous, insulating deposits. High-level halogenation (using bleach) oxidized the microbial deposits and made the cleaning environment more alkaline. The bleach was followed up with bromine, which improved microbial kill and penetrated the deposits. A bio-detergent was added to disperse and flush the deposits from the system.

Following the chemical cleaning, total residual halogen (TRO) was reduced using sodium bisulfite to meet the plant's discharge requirements.

Holding the gains achieved by the chemical cleaning required new technology. Nalco's 3D Trasar technology com-

CASE STUDY

Figure 2 GROSS OUTPUT VS LAKE TEMPERATURE

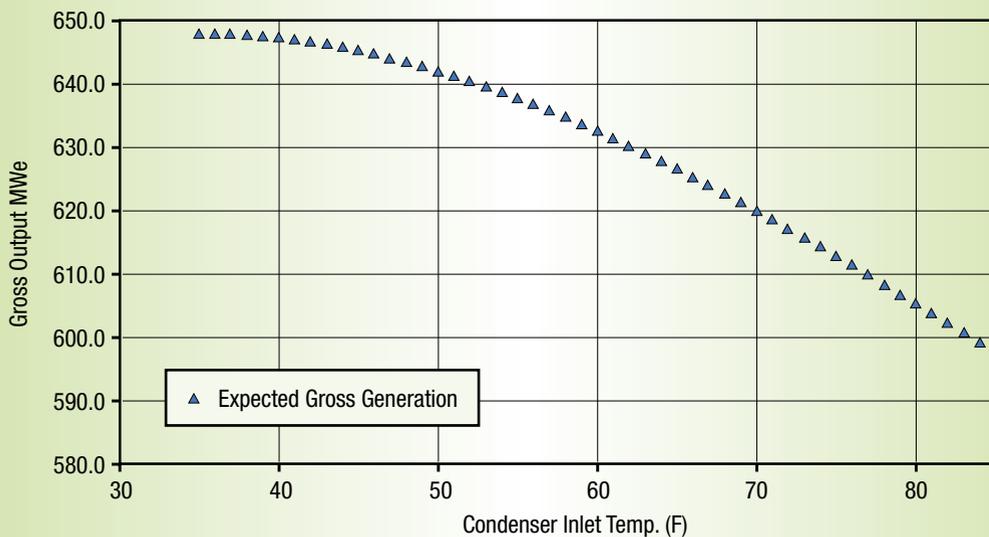
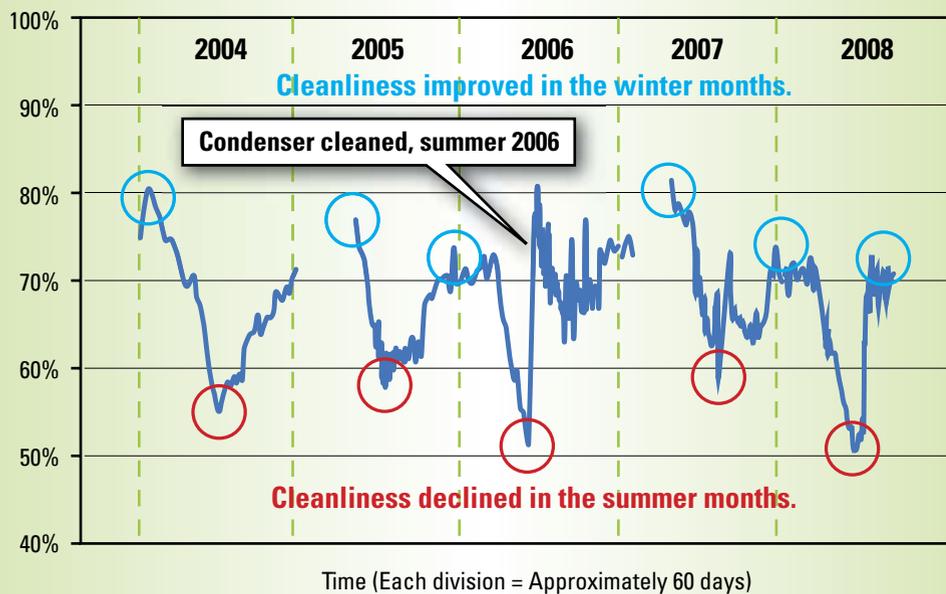


Figure 3 CONDENSER CLEANLINESS FACTORS, 2004-2008



bins an inert, fluorescent signal with a fluorescent functionality attached to a polymer backbone—a chemical “tag” that reacts to stress on the dispersant poly-

mer—to deliver dispersion and deposit control. Measured using a multi-channel fluorometer, the inert material acts as a benchmark; a measure of total polymer

in generating capability. Over the next week, this improvement increased to 20 MW. After 60 days using the new

[CONTINUED ON PG. 22]

present. The chemical tag, measured by a different channel in the fluorometer, registers the amount of active polymer present. Comparing the concentrations of inert and active polymer—and the rates at which they change—delivers dispersant control based on the amount of dispersant needed at any given time.

Results were dramatic. (See Figure 4, p. 22.) Lake temperatures increased in 2008 as expected and also as expected, condenser cleanliness declined.

In June 2008 when the new treatment program was initiated, instead of condenser cleanliness continuing to decline as the lake temperature increased, cleanliness factors increased, clearly demonstrating the efficacy of the program.

The financial implications were also dramatic. During the first two days of treatment—during the hottest part of the year, when electricity demand (and prices) are highest—the plant saw an increase of 16 MW

PRODUCTS

New Japanese Research Facility Measures High Performance Flowmeters

In a study of higher performance flowmeters to improve the efficiency of Japanese nuclear power plants, the National Metrology Institute of Japan (NMIJ) has put one of the world's most accurate research and test facilities into operation for the measurement of ultra-large flows.

At the heart of the facility are four Krohne Altosonic V flowmeters arranged in series, each with one electromagnetic Krohne Optiflux flowmeter as a technology-independent plausibility check.

Inaccuracy of flow and temperature measurement amounts to a total of 2 percent to 3 percent, with about 90 percent of

the inaccuracy originating from the flowmeter due to the uncertainty of the measurement. The NMIJ project's goal was to reduce the inaccuracy of this measurement to a more acceptable 1 percent, thereby increasing the overall efficiency of the reactor.

The NMIJ test facility was built to simulate flow rates that would typically be found in a functioning nuclear power plant. Construction of the facility, whose water tower supplies 12,000 cubic meters of water per hour, began in 2004. The entire program is expected to represent a total capital investment of approximately 3 billion yen (US\$33.3 million). With the insights gained, the effectiveness of all nuclear power plants and thermal power plants could be improved by 1 percent to 2 percent.

By using five parallel paths, the Altosonic V provides a good representative sample of the mean flow velocity distribution throughout the cross-sectional area. To ensure a constant cross-sectional area, the Altosonic V is machined from a single block of steel for resistance to expansion due to line pressure. To compensate for thermal expansion and contraction, a temperature sensor is located in the meter body, allowing for corrections.

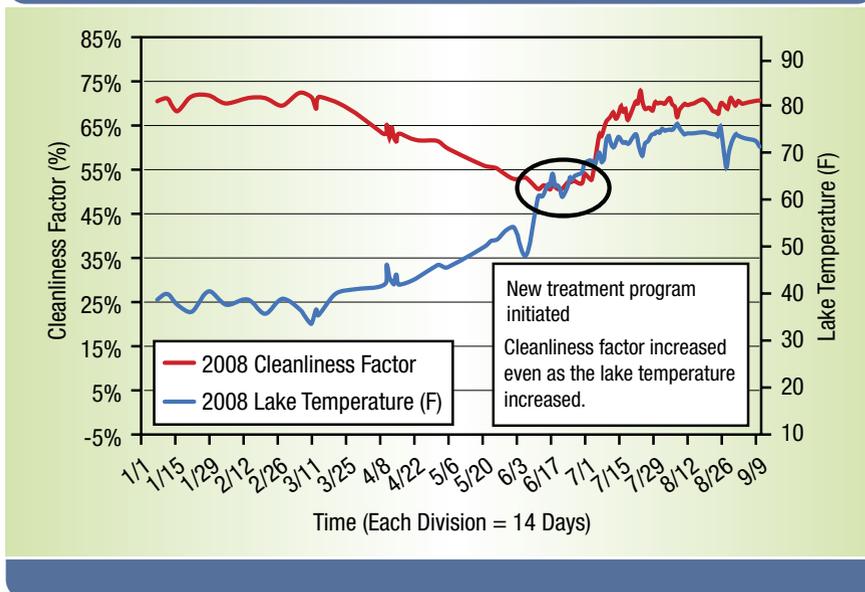
The specified accuracy of the Krohne Altosonic V flowmeter is +/-0.15 percent of the measured flow rate. Additional uncertainties occur in the high temperature regimen, due mostly to the inability to calibrate at the elevated operating Reynolds Numbers. The target is the industry requirement of +/-0.25 percent of the mea-

sured flow rate on the flow element and it allows for an additional +/- 0.05 percent on the differential pressure measurement or a combined uncertainty of +/- 0.3 percent. Whether or not this performance is actually being achieved with the traditional flow solution has been questioned throughout the industry.

The Krohne Altosonic V ultrasonic flowmeters have no obstructions or moving parts in the pipe, which ensures no wear or pressure loss. This, in combination with larger meter sizes, permits simplified configuration of metering systems. No strainers and fewer parallel lines are required. Operation of the flowmeters is maintenance-free and no periodic calibration is required. —Krohne

[CONTINUED FROM PG. 21] **Cleanliness Program Improved Condenser Performance**

Figure 4 **CLEANLINESS FACTOR (%) AND LAKE TEMPERATURE (F)**



treatment program, the plant realized an economic recovery of approximately \$1.05 million. **N P I**

Authors: Daniel Cicero is the industry development manager in Nalco's power group. Since joining the company in 1991, he has worked in a number of sales, product management and new product development roles.

Gerald Munyan is a thermal performance engineer at Nine Mile Point, Constellation Energy. He has been with Constellation for nine years and before that, with the Department of the Navy for 15 years.

Scott Reich is an executive account manager in Nalco's power group. Since joining the company in 1987, he has worked in a number of sales and management roles across the U.S. He is a graduate of Illinois State University with a B.S. in industrial engineering.

NUCLEUS



[CONTINUED FROM PG. 11] The Future of Spent Nuclear Fuel

through NRC oversight. Instead of paying a generation fee to DOE, the utilities would be required to set aside an equivalent sum into an escrow fund, similar to the required arrangement for utilities to set aside funds for decommissioning nuclear plants. The existing balance of the Nuclear Waste Fund would also be transferred to the escrow fund and a new government corporation would administer the fund, tracking individual accounts for each utility. To the extent that a permanent storage solution turned out to be less expensive than the monies collected, utilities would be reimbursed depending on how much they paid in.

This arrangement would allow greater assurance that the funds would be readily accessible without the need to go through an annual Congressional approval process. In addition, rather than having the federal government designate an area for national waste storage in a state where residents are opposed to spent fuel storage, the escrow fund could be used as a source of compensation for states willing to host a spent fuel facility, whether a central repository or a reprocessing plant. The escrow fund would also introduce a

cooperative arrangement between the commercial nuclear industry and host states, one which would avoid potentially costly litigation from locals not keen on nuclear waste, no matter how safely it is stored in their proverbial backyards.

The conclusions reached in *Plan D* represent some common sense options that could satisfy many in the commercial nuclear power industry. It would remove uncertainty in national policy by relegating the federal government's involvement to that of a regulatory body only and establish incentives for states to cooperate in the effort to manage spent fuel. The utilities would also gain confidence through the establishment of an escrow fund where the fees they would pay in based on generation would actually be available and used for developing and implementing a long-term storage solution. Such a situation would likely be especially welcome given that DOE recently rejected requests made by several utilities to suspend collection of the generation fee even though the utilities are receiving no commensurate benefit in return.

What the commercial nuclear power industry needs right now is a comprehen-

sive approach to spent fuel management and storage that has straightforward and achievable results. While new technologies may make reprocessing a more economical and achievable option, the fact is that even after reprocessing, there will ultimately be some smaller amount of nuclear waste that will have to be addressed. Though at a significant cost, onsite dry storage can continue to serve as an intermediate solution that will buy the industry many years that can be used for research and development of workable longer-term solutions. But the political and legal tangles regarding spent fuel need to be resolved for the focus to be placed back on a paramount concern for the nation's energy policy—providing safe, clean energy solutions for the next century, of which nuclear power must play a significant part. **N P L**

Authors: Christopher F. Tierney is vice president and treasurer of The Kenrich Group. Patrick M. Jensen is a managing consultant of The Kenrich Group. Both are based in Washington, D.C. Their consulting work is focused on financial, accounting, economic and damages matters in areas including the electric power industry.

[CONTINUED FROM PG. 13] Cross-Industry Project Management Lessons Learned

The industry has been facing a huge “aging” issue. Approximately 50 percent of the industry will reach retirement age within five years and we are not attracting new people to the industry fast enough. This will also be a major issue facing the nuclear power projects of the future. Since there has not been a new nuclear power project in the U.S. in more than 30 years, finding experienced resources is an issue now, and the exodus of personnel due to retirements will only serve to add to the problem, causing major execution challenges.

With the recent slowdown of many major projects and the overall world economic slowdown over the past two years, this resource drain trend has decelerated, but it is still a major concern when looking at staffing a major project. The nuclear power industry needs to capture some of the more experienced resources now available throughout the industry and leverage

their knowledge in the planning stages in execution planning, risk assessments, constructability analysis and other related project support functions. If we do not capture these resources today and allow them to mentor our future leaders, their knowledge and experience will be lost.

THE FUTURE

The future of projects in the nuclear power sector looks promising. Projects are being identified and are moving through the approved procedures. The industry is developing new execution strategies that will minimize some of the regulatory time and schedule constraints; material and equipment pricing is starting to stabilize at reasonable levels; and engineering and execution resources are presently available.

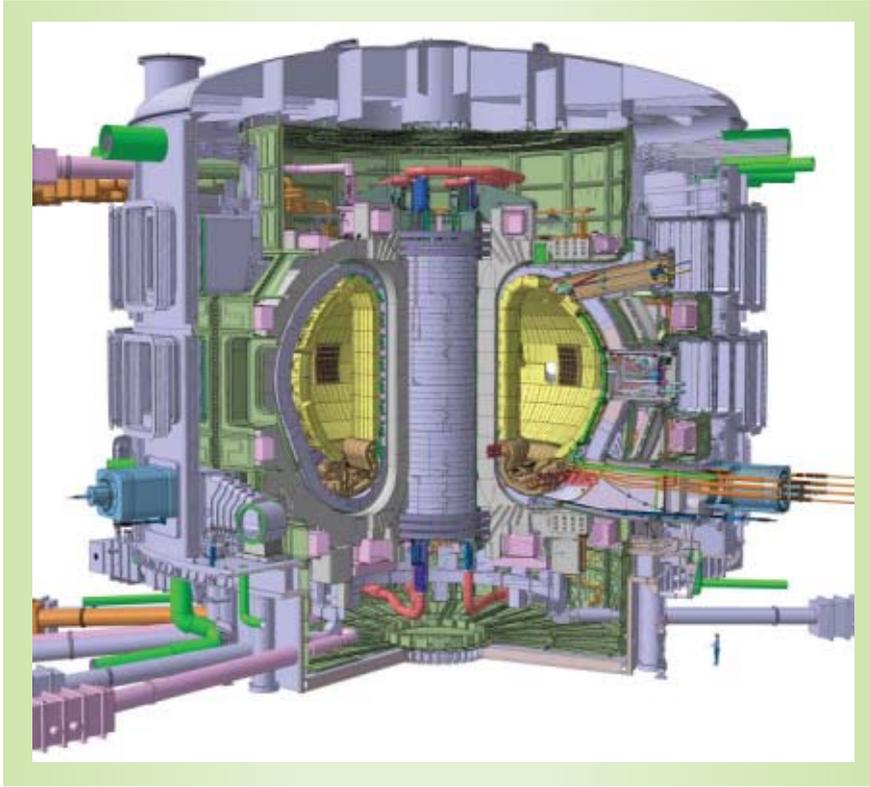
To assure that we do not encounter some of the “train wrecks” of past nuclear projects, we must learn from those mishaps and

also take some lessons from the last round of major projects in other industry sectors. One aspect always seems to rise above all others: if we implement the proven project management tools and techniques and communicate effectively to all team members (management as well as contractors), the odds of completing a project within acceptable expectations are increased dramatically. **N P L**

Author: Steve Cabano is the president of Pathfinder LLC, a project management consulting firm specializing in the planning, development and execution of domestic and international capital plant construction projects. With 25 years of project engineering and project management experience in the industrial and commercial facilities industry, he has provided project-related services in the petroleum, petrochemical, chemical, power, environmental and pharmaceutical industries in the U.S. and worldwide.

TECHNOLOGY

Figure 1 THE WORLD'S LARGEST TOKAMAK



The ITER machine is based on the “tokamak” concept of magnetic plasma confinement, in which the fusion fuel is contained in a doughnut-shaped vessel. With a height of 29 metres and a diameter of 28 metres, ITER will be the world’s largest tokamak. Diagram, ITER Organization.

buildings that will house the ITER fusion experiments.

In ITER, the fusion reaction will be achieved in a device called a “tokamak” that uses magnetic fields to contain and control the hot plasma. (See Figure 1.) The fusion between deuterium and tritium (D-T) will produce one helium nucleus, one neutron and energy. The helium nucleus carries an electric charge that will respond to the magnetic fields of the tokamak and remain confined within the plasma. However, some 80 percent of the energy produced is carried away from the plasma by the neutron that has no electrical charge and therefore is completely unaffected by magnetic fields.

The neutrons will be absorbed by the surrounding walls of the tokamak, transferring their energy to the walls in the form of heat. This heat will then be dispersed through cooling towers. In the demonstration fusion plant prototype and in future industrial fusion installations, the heat will be used to produce steam and via turbines and alternators, electricity.

During its operational lifetime, ITER will test key technologies necessary for the next step—the demonstration fusion power plant that will capture fusion energy for commercial use.

ORGANIZATION OVERVIEW

Nuclear fusion is the energy source of the sun and stars. Harnessing it as a new energy source for mankind is the goal of ITER, the largest fusion energy research project in history. First discussed in 1970, its objective is to build a demonstration fusion power plant capable of producing electricity in a safe and environmentally friendly way.

ITER is an international organization comprised of the central ITER body and seven domestic agencies: the People’s Republic of China, the European Union, India, Japan, the Republic of Korea, the Russian Federation and the United States. Eventually, ITER will employ approximately 700 people.

Global Coordination at ITER

I/T resources must deliver a unified vision at the world’s largest fusion research project.

By Rolf Gibbels, Dassault Systèmes

ITER is a large-scale scientific experiment that aims to demonstrate that it is possible to produce commercial energy from fusion.

If you haven’t yet heard about the organization, that will likely change in the near future. The scale and scope of the ITER project—originally called the International Thermonuclear Experimental Reactor—rank it among the most ambitious scientific endeavors of all time. With the organization comprising contributors from around the world and the initial site work completed, scientists are now poised to begin construction on the

TECHNOLOGY

Each domestic agency will be responsible for developing different elements of the ITER power plant. The plant will cost 10 billion euros (US\$14.7 billion) to construct and operate and will be located in the town of Cadarache in southern France. As of 2008, construction on the plant began and tokamak assembly is scheduled to begin in 2012. Plasma operations could commence in 2018.

COOPERATION AND COLLABORATION ARE VITAL

The key business challenge facing ITER is to orchestrate a pioneering international scientific research project via a small central team. The project's end product is a one-of-a-kind fusion plant that will become a global energy showcase and have an indelible impact not only on global energy advancement but also on the domestic agencies and their people. The whole world will be watching to see whether this high-risk venture succeeds. Conversely, if the project fails it will represent a monumental setback—not exactly the “average” business problem.

Real-time global coordination and collaboration are vital to ITER's success. The project's political organization spans the globe and procurement packages break down along geopolitical rather than functional lines. All seven domestic agencies may simultaneously work on a single component of the project; however, even this is overshadowed by the coordination challenges of designing a complex facility made up of 10 million separate parts that in turn must be reconciled with extremely rigorous quality requirements. Even the slightest mistake can wreak significant damage. Varying time zones certainly don't help.

Without a doubt, collaboration isn't an expendable choice; the whole premise of the project is predicated upon the idea of international knowledge-sharing, synthesizing the very best practices and scientific ideas from a variety of

specialties and anthropological lenses. ITER is at the forefront of nuclear fusion research and each of its many research partners is highly knowledgeable in a particular domain. Bringing together that expertise to optimize development of the

engineering over a widely distributed network and ensure control by a small central design team.

ITER collectively decided to use three elements of Dassault Systèmes Product Lifecycle Management (DS PLM)



An aerial view of the ITER construction site in Cadarache, France. At the far end of the platform, the tokamak pit can be discerned. Photo, Agence ITER France.

tokamak and plant presents a formidable challenge. ITER must foster a mindset of cooperation and provide the means for concurrent, collaborative work across the domestic agencies, most of which do not share a common language other than the passion for nuclear physics.

In pursuing a solution for its collaboration and communication challenges, ITER specifically looked to companies with a cross-cultural, authentically international operations structure. With scientists and researchers using a particular product in different parts of the world, there would undoubtedly be a need for extensive support and regional liaison. Furthermore, ITER sought an integrated solution that could deliver a unified vision of the mechanical and plant design data, enable concurrent

technology suite, a virtual design tool to structure design methodology for the project, a global collaborative PLM tool to ensure long-term data interoperability across the organization and a virtual construction planning tool to engineer the tokamak and the plant.

Additionally, ITER chose a Microsoft platform for the organization's underlying IT backbone. “We needed a single, stable, easy-to-administrate system that complies with standards and fits into the global desktop environment,” said Hans Werner Bartels, senior technical officer for IT, ITER.

MAXIMIZING IT EFFICIENCY

ITER opted to build its information processing resources around the Microsoft Windows Server System and

TECHNOLOGY

is an early adopter of Microsoft's 64-bit architecture. The platform includes Microsoft Exchange Server, Microsoft SQL Server and Windows Server.

ITER uses CATIA as the master 3D design solution for both the tokamak and the plant that will house it. The ITER design office creates what it calls a plant breakdown structure up to the "build-to-print" level, at which point it is ready to be engineered. Domestic agencies then take over the design of specific components.

Using the 3D solution's digital mock-up (DMU) capabilities, the design office ensures that the millions of complex critical parts in and around the tokamak will interface clash-free at assembly time.

ITER is introducing DELMIA as its process analysis platform to optimize resource usage throughout assembly and maintenance. The process detailing features, including tools for defining equipment kinematics and robotics, will allow deeper analysis of critical processes and the associated equipment, using 3D models directly linked to the latest digital mock-up. By linking with Primavera, the solution also simulates and validates critical parts of the assembly schedule and ITER is considering a possible integration to provide remote-handling supervision tools. To simulate collision-free paths in the assembly and maintenance context, ITER works with Kineo CAM, a Dassault Systèmes software partner.

ENOVIA, installed on the Microsoft Windows Server, acts as a single repository for all design and engineering data. It enables engineers to work together on the most current designs within the context of a part, a large assembly or an entire product. These are important capabilities that both improve decision-making and promote design reuse.

The product also provides integral search capabilities. For example, plant design engineers use virtual "room books" that provide full details of all assemblies and systems found in a given

"room" (otherwise defined as a physical demarcation) within the plant. This enables the engineers to use 3D to search and download all of the components for a given room, simplifying the impact of a design change and helping to verify whether components are compliant with one another.

By regulating and organizing version control, when designers update or discard design iterations every team member in every domestic agency now knows what the correct version is and can easily access it.

While ensuring data interoperability seems like a tangential back-end PLM task beyond the actual process of design and simulation, it is absolutely crucial to solving ITER's actual business problem. By regulating and organizing version control, when designers update or discard design iterations every team member in every domestic agency now knows what the correct version is and can easily access it.

ITER design office engineers use virtual design to create "skeletons" or design templates. By providing a structured yet flexible framework to the actual subcontractors who will manufacture the millions of complex components of the tokamak and plant, these skeletons are completely compliant with pre-determined quality standards. The reuse of design skeletons also reduces the time needed to make duplicate components, since designers don't have to spend time "recreating the wheel."

Concurrent design also permits ITER to keep the size of its design office to a minimum.

Using PLM, the ITER design office provides master designs to distributed teams of designers, engineers and subcontractors around the world. The ability to delocalize has given domestic agencies a sense of local ownership of their work. It is also crucial in a project where fusion

expertise is rare and cooperation among multi-national teams is essential.

PLM offers multiple ways for distributed stakeholders to consult the project database for a 3D perspective on progress. By ensuring constant product structure congruency, PLM enables everyone, from designers to procurement officers

and non-technical domestic agency executives, to easily access up-to-date product information and evaluate milestones in real time. And with 64-bit design software turning on Microsoft-based 64-bit workstations, ITER can manage its large assemblies rapidly with no memory limitations.

THE FUTURE

ITER plans to expand its multi-faceted solutions to drive the project forward and further optimize control over the data and its distribution. For example, it will use a single source database to provide the backbone for a procurement tool, enabling bidding agencies to have upstream access to complex data.

The organization is also investigating the use of other tools to manage project workflows and as a repository for all engineering data, including product/geometry breakdown structure views, documents, configurations, requirements, 2D/3D coherency, and more, in a collaborative mode.

Finally, a key element of the digital assembly and manufacturing implementation will be to verify virtually whether the intended plant assembly will operate to specifications. This could save hundreds of millions of euros in testing the project's numerous interfaces before building begins. 

FUEL FOR THOUGHT

[CONTINUED FROM PG. 4]

NPI: Where do you build the steam generators?

Reimels: The majority are built in Cambridge, Ontario, and we have a facility in Mount Vernon, Indiana, which built most of the B&W components back in the '60s and '80s. We got our nuclear N-stamp back there a little over three years ago and so we're doing some replacement reactor heads there, for Diablo Canyon for example, but the majority of the work over the last 20 years has been done at our Canadian facility. Indiana was doing work for our navy customer, so it was government work instead of commercial work.

NPI: Can you give me some specific examples of materials fatigue?

Reimels: On the steam generators, most of the original units were built with a tube that was Alloy 600 and that material was sensitive to stress corrosion cracking. By going to Alloy 690, the problem appears to have been solved. Units with the 690 material have been running about 15 years with no signs of stress corrosion cracking so far. And looking at the internals, we've gone to stainless steel.

NPI: Are there any of the U.S. reactors that still have steam generators made with Alloy 600?

Reimels: Most of the units have been replaced. B&W has the order right now to build the replacements for Davis-Besse and we just shipped two units to the Crystal River plant that were delivered last month and there may be one or two other units but that will probably cover the majority of those 104 reactors. On the Canadian side, for the Bruce Station we're building the replacement steam generators there and then I think that's probably it for steam generator replacements north of the border as well.

Another issue was dissimilar weld. For instance, if you're welding on the reactor vessel or the pressurizer and piping coming off is another alloy steel, at those dissimilar welds there was stress corrosion cracking. There were a lot of fixes for that. We're developing phase array technology that allows the utility to see through the pipe to determine the effects and how big they are. That allows them to determine if they have to do a repair or not. Otherwise, the NRC requires them to cut the weld out just to be safe.

NPI: What other areas is B&W involved in?

Reimels: The other things utilities are looking at are updates to the existing plants, modifying the plant to get more power, so a unit that generated 1,000 MW now generates 1,100 MW. We're in negotiations with three or four utilities to replace and upgrade condensers and heaters and that type of thing. There are still quite a few units that can be updated. Typically, the payback is pretty good. Once nuclear plants are up and running,

they are fairly low-cost generators of electricity. What would it cost you to put in a 100 MW gas plant or 100 MW of anything else? Basically, 100 MW of uprate is the cheapest alternative.

NPI: What other trends are you seeing?

Reimels: This is not an area where B&W is involved, but they continue to upgrade controls, going from analog to digital. You can get better inspection and with more instrumentation, you can better operate and maintain the plants. There is also a lot of work by the utilities improving operator training and security at these plants has been a big issue. They're extending to 18 months or even two years between outages. That's pretty remarkable for a 40-year-old unit.

We're seeing a trend toward the modular reactors, like our mPower reactor. The NRC has been looking at them and will start licensing at least two modular reactors and the DOE is looking at programs to help them get through the licensing process. The value proposition seems to be very good.

NPI: What's the size of those modulars?

Reimels: Ours is 125 MW and some are 30 or 40 MW, but you're actually getting too small there in terms of what's practical. We think for most of the larger utilities, 250 MW to 500 MW is the amount that fits their growth plans. The total capital cost for the bigger units is \$8 billion plus for one unit, which is still a competitive price but there are few utilities that have a balance sheet that can support an \$8 billion project. So the small reactors are more affordable, so to speak, and the risk is down in the sense that we are going to build the entire reactor in our facilities.

NPI: How is the mPower refueled?

Reimels: The design we have has a fuel cartridge. You run it for five years, then you take that bundle out and replace it. Our reactor is all underground and we have enough storage built in that we can store 60 years of fuel below grade. If we ever get a solution for spent fuel in the U.S., you still have the option of taking it out for reprocessing.

NPI: What's your view of the international market?

Reimels: For the mPower, our initial thrust is in the U.S. but we are working with a European utility and a Canadian utility and as soon as we get it licensed and built here we'll expand out there.

We know some of our service capabilities can be used worldwide. China has six units under construction and plans to build 30. We work with the folks in Washington and we're keeping our eye on the Indian market—that's the next big market we think—but our main thrust right now is in North America. 

NUCLEAR WORLD



The Sanman site in China. The Sanman project is the most advanced of the four Westinghouse AP1000s currently under construction there. Photo, Westinghouse.

Doing Nuclear Business in China

Westinghouse turned to the U.S. Commercial Service to secure a \$5 billion contract for four nuclear plants.

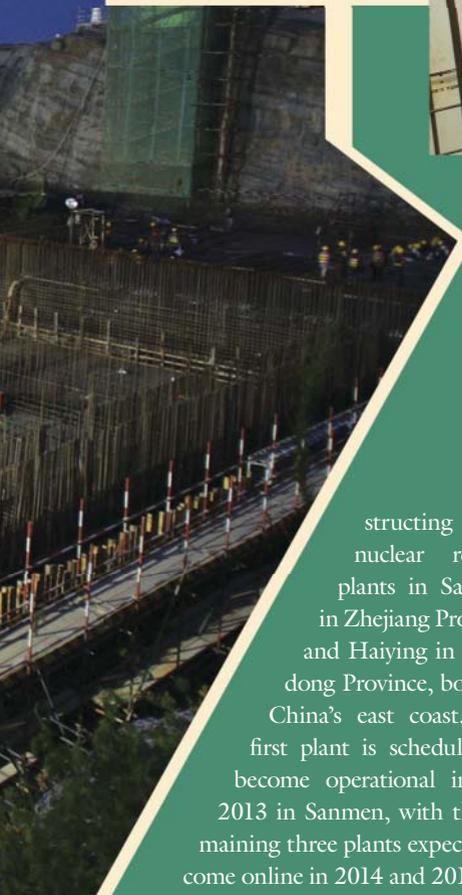
By Curt Cultice, Senior Communications Specialist, and Xiaobing Feng, Senior Regional Manager for China and Mongolia with the Trade Advocacy Center, U.S. Commercial Service

In early 2009, the Westinghouse Consortium—comprising Westinghouse Electric Co. and its partner, The Shaw Group Inc.—broke ground on a \$5 billion project in China. Not only is it the largest transaction in Westinghouse’s history, but it serves as an excellent example of how U.S. businesses, with help from the U.S. government, are tapping opportunities in China’s growing infrastructure market.

The Westinghouse Consortium is con-

NUCLEAR WORLD

CR-10 module with lower rebar installed at Sanmen. Photo by Westinghouse, courtesy U.S. Commercial Service.



structing four nuclear reactor plants in Sanmen in Zhejiang Province and Haiying in Shandong Province, both on China's east coast. The first plant is scheduled to become operational in late 2013 in Sanmen, with the remaining three plants expected to come online in 2014 and 2015.

To help win the contract, Westinghouse turned to the U.S. Commercial Service, the trade promotion unit of the Commerce Department's International Trade Administration, and its Trade Advocacy Center to navigate the many layers in China's complex government procurement market and solidify the firm's position in the bidding process. It was a familiar working relationship, since the company had utilized Trade Advocacy Center assistance in pursuing other projects. The Trade Advocacy Center helps level the playing field for American companies competing on foreign government tenders.

WASHINGTON LENDS A HAND

Headquartered in Pittsburgh, Pa., Westinghouse Electric was long familiar with the Chinese market, having established business relationships with the Chinese beginning in the 1990s on smaller projects. The company also worked to train Chinese engineers visiting the United States. A few years ago, with its consortium partner, The Shaw Group, of Baton Rouge, La., Westinghouse began pursuing new international markets for its advanced nuclear energy technology.

The consortium identified a tender issued by the Chinese, who were interested in developing their nuclear energy industry to help address energy shortages in their country. By the fall of 2003, the Westinghouse Consortium began actively pursuing the Chinese project tender for civilian nuclear reactors but had no illusions about the challenges that lay ahead in securing a winning project bid.

"We knew a deal with China would really open doors for us but that it wouldn't be easy, as it was a multi-billion dollar project that would draw intense international interest," said Westinghouse Board Chairman and former CEO Steve Tritch. "We had some of the best cutting-edge technology and expertise to offer, but wanted to ensure that key Chinese decision-makers understood the full benefits and merits our proposal would bring to bear."

To help make its case with the Chinese government for the project bid, Westinghouse lined up direct support from the

U.S. Commercial Service's Trade Advocacy Center—the coordinating point for advocacy issues among the U.S. government's Trade Promotion Coordinating Committee (TPCC), a group of 20 federal agencies involved in supporting U.S. exports.

Meanwhile, international competition was heating up as French and Russian companies sought support from their respective governments as well. By February 2005, Westinghouse and others had submitted bids for the project and the race was on. The Trade Advocacy Center coordinated letters of support from officials at the Departments of Commerce, Energy and State, as well as then U.S. Ambassador to China, Clark T. Randt. The U.S. Commercial Service offices in China were instrumental in the effort, introducing Westinghouse officials to high-level Chinese decision-makers. The U.S. Commercial Service also helped Westinghouse impress upon the Chinese the advantages of U.S. technology, its quality and the level of after-sale service. This effort was reinforced by the consortium members' participation in a November 2006 trade mission to China led by Carlos M. Gutierrez, Secretary of Commerce at the time.

In a key move that helped finalize the deal, U.S. government officials worked with their Chinese counterparts to draft a memorandum of understanding (MOU). This established the terms for mutual cooperation and support for commercial nuclear power projects and was signed by (then) U.S. Secretary of Energy Samuel Bodman and Chinese

NUCLEAR WORLD

National Development and Reform Commission Chairman Ma Kai in December 2006. The MOU further signified to the Chinese that the U.S. government would take all appropriate action to enable Westinghouse to carry out the contract.

Shortly thereafter, the Chinese completed their review of the international bid proposals and made their decision: The winner was the Westinghouse Consortium.

NEW SALES, NEW OPPORTUNITIES

By the end of 2006, initial design, engineering and long-lead procurement work began and a comprehensive agreement was signed with China's State Nuclear Corporation at the Great Hall of the People in Beijing on July 24, 2007.

"This China deal is a real breakthrough,"

Tritch said. "Not only is this the first-ever deployment of advanced U.S. nuclear power technology in China, but it's a win-win for both China and the United States."

According to Westinghouse, the new power plants will greatly increase China's ability to generate significant additional baseload electricity in a clean, safe and economical manner. The United States and China will also benefit from the creation of new jobs that support mutual economic growth. On the U.S. side alone, Westinghouse reports that the estimated \$5 billion project will create or sustain a minimum of 5,000 U.S. jobs within Westinghouse and among its suppliers from small and medium-sized companies located in at least 20 states. These include well-paying jobs in both the design/engineering and traditional manufacturing sectors that are vital to the U.S. economy.

Robert Zoglman, a senior consultant to Westinghouse who had served as the company's vice president for government and international affairs, said the four new plants will serve as the standard for future nuclear power plants. This could provide Westinghouse with an advantage in winning future contracts, including maintenance and servicing. Altogether, the Chinese government plans to spend \$50 billion on at least 30 nuclear reactors over the next decade.

"China's potential market for nuclear energy technology is virtually unlimited," said Zoglman. "Even when they complete the 30 reactors, nuclear energy will still only account for 4 percent of China's total electricity output and their energy needs are

Chinese workers at Westinghouse construction site. Photo by Westinghouse, courtesy U.S. Commercial Service.



NUCLEAR WORLD



Sanmen Unit 1. In spring 2009, the first concrete placement was finished. The pour encompassed 5,200 cubic meters of concrete, 950 tons of reinforcing steel and 1,000 anchor bolts. Photo by Westinghouse, courtesy U.S. Commercial Service.

beneficial business in China,” Tritch said. “Having the backing of the U.S. government brought an added degree of credibility to the negotiation process with the Chinese, and without this advocacy support, this deal wouldn’t have happened for us.” **N P I**

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of Commercial Service export assistance programs through the news media. He has also written several articles on trade and exporting. Xiaobing Feng is senior regional manager for China and Mongolia with the U.S. Commercial Service’s Trade Advocacy Center. In her capacity, Ms. Feng advises and counsels businesses on developing strategies to compete successfully on international project opportunities.

The U.S. Commercial Service is part of the International Trade Administration, which is dedicated to creating economic opportunities for American workers and businesses by promoting trade and investment. In 2008, the U.S. Commercial Service helped facilitate nearly \$70 billion in U.S. export sales.

only going to keep growing.”

Zoglman said that one of the major challenges for Westinghouse and for other U.S. companies selling to China is the strong international competition for local nationals—that is, Chinese managers who speak fluent English—who are needed to help maintain and build up a strong network to support ongoing nuclear energy projects, a priority for Westinghouse.

The Westinghouse Consortium deal in China ranks as one of the largest non-aerospace successes generated by the U.S. Commercial Service’s Trade Advocacy Center and the TPCC, which continues to facilitate billions of dollars in export successes annually for U.S. companies. With the China deal signed, Westinghouse sees great potential for sales in other countries as well.

Like many other U.S. companies, it has found the presence and efforts of the Trade Advocacy Center reassuring in its quest for new business.

“I want to emphasize just how hard the United States government has worked to support Westinghouse ... and in assuring us an opportunity to compete for this rewarding and mutually

U.S. Commercial Service resources for U.S. companies and international buyers

The U.S. Commercial Service is part of the International Trade Administration (ITA), which is dedicated to creating economic opportunities for American workers and businesses by promoting trade and investment. In 2008, the U.S. Commercial Service helped facilitate nearly \$70 billion in U.S. export sales.

Commerce’s manufacturing and services unit (MAS) (www.trade.gov) works to enhance the global competitiveness of U.S. industry, including the civilian nuclear power sector and provides key economic and industry analysis for U.S. businesses.

MAS leads the department’s civil nuclear trade initiative, which includes:

- A new civil nuclear industry advisory committee
- Promotion activities includ-

ing overseas trade missions to key markets, an industry promotion program at the annual IAEA General Conference and official U.S. government advocacy in international bidding processes

- Other resources for U.S. companies, like the new Civil Nuclear Exporters Guide (www.ita.doc.gov/td/energy/Civil) and industry briefings on topics like export controls
- Commerce’s market access and compliance office (www.trade.gov) works to help U.S. industry identify and overcome trade barriers, resolves trade policy issues and ensures that U.S. trading partners fully meet their obligations under U.S. trade agreements.

U.S. Commercial Service’s (www.trade.gov/cs) global network of trade professionals is located in offices across the U.S. and in American embassies and consulates in nearly 80 countries.



DATA POINTS

GLOBAL NUCLEAR DEVELOPMENT POTENTIAL

Excerpted from “Nuclear Perspectives: Regional opportunities for a sector in renaissance”

By Ernst & Young

In the first of Ernst & Young's annual Nuclear Perspectives series, the authors assess the attractiveness of 21 countries that are either pursuing new nuclear development or have a large fleet of nuclear stations in need of replacement.

The 21 countries selected were chosen for their nuclear poten-

tial. Most, but not all, have a current nuclear capability and they represent both short- and long-term opportunities for investors.

Five clusters of countries sharing similar drivers were identified, giving investors insight into the relative strengths of one country over another and the relevant issues within each group.

The Country Positioning Map shows the relative position of countries based on three leading factors:

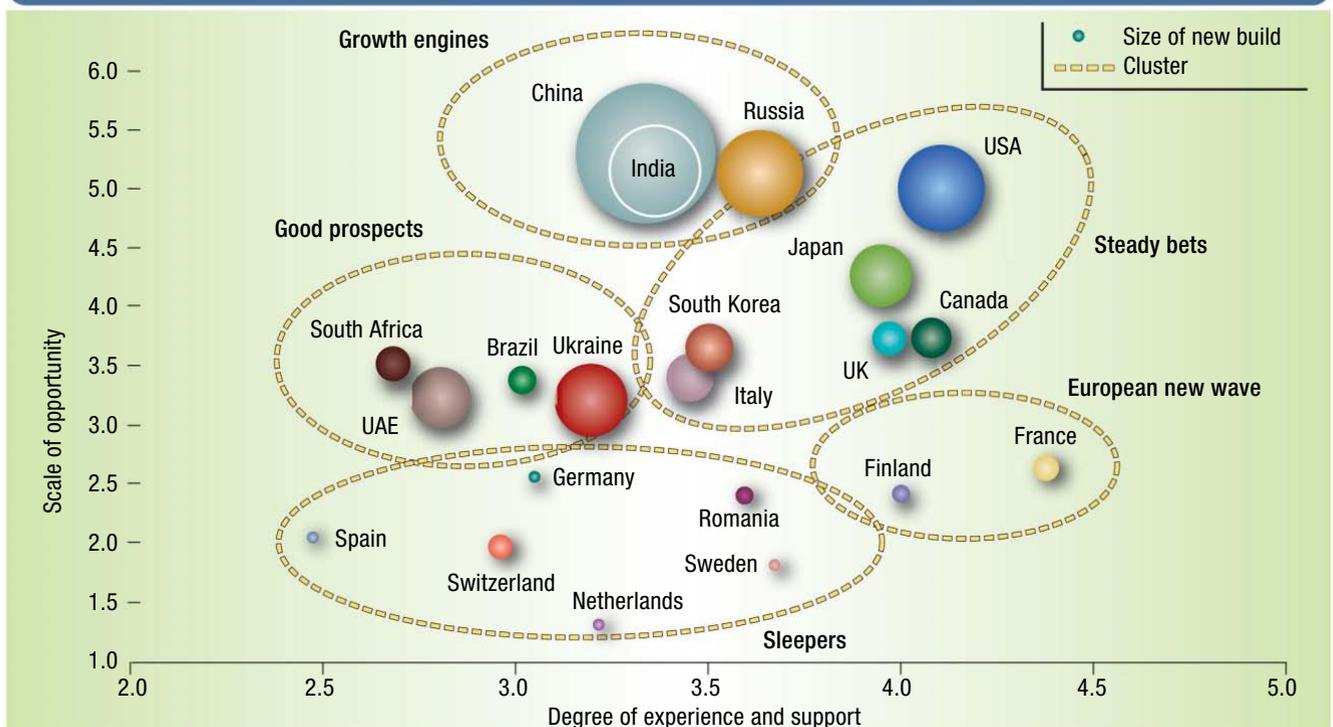
- **Scale of opportunity:** assessed by both the size of capacity needed (present and future) and the urgency for new investment.
- **Government support and regulatory capacity for new nuclear development:** includes the regulatory framework, previous experience with nuclear across regulatory and licensing bodies, level of government support and public opinion.
- **Market and investment framework:** includes ease of access to international market capital, power market competitiveness and available economic incentives for nuclear.

Analysis by country is important for all stakeholders—utilities, regulators, governments, construction companies and technology vendors—to plan their investments and/or encourage investment in their countries. We recognize interested parties will select countries based on different criteria and also that a country may be attractive to different investors for different reasons.

The countries fall into five clusters, as shown in the figure:

- **Growth engines:** countries with major build programs that are meeting an urgent capacity need (China, India, Russia)
- **Steady bets:** existing nuclear countries with plans to renew their fleets or re-enter the market (Canada, Italy, Japan, South Korea, U.K., U.S.)
- **European new wave:** the only two European countries building new generation, passively safe reactors at present (Finland, France)
- **Good prospects:** emerging markets with existing programs that need to be renewed, and new countries with a stated desire to enter the market (Brazil, South Africa, Ukraine, United Arab Emirates)
- **Sleepers:** either existing nuclear countries with no current plans to replace their fleet or very low requirements for new build (Germany, the Netherlands, Romania, Spain, Sweden, Switzerland)

COUNTRY POSITIONING MAP



Sources include information published by the World Nuclear Association, Datamonitor, OECD and IEA, and Ernst & Young research.

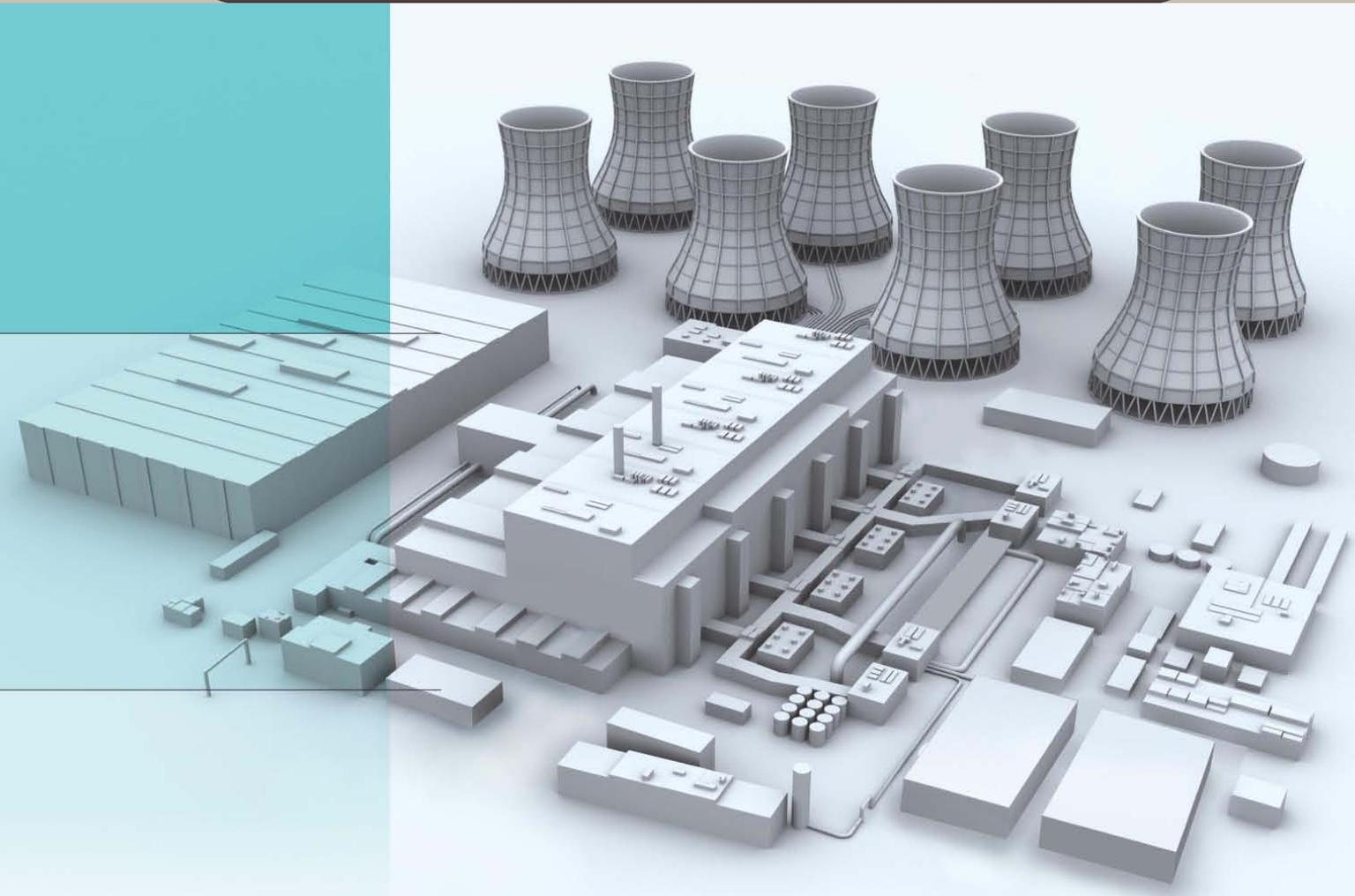
DATA POINTS



Figure 2 AT A GLANCE: CURRENT AND FUTURE NUCLEAR CAPACITY FOR COUNTRIES ANALYZED

COUNTRY	Cluster	Installed capacity (MW)	Expected additional future capacity (MW)	Comments
Brazil	Good prospects	1,901	5,245	Government supports new build but nuclear energy faces strong competition from other sources
Canada	Steady bets	12,652	11,400	Major uranium producer; needs to replace half its fleet over the next 10 years and intends to expand it further
China	Growth engines	8,587	123,760	Potentially the largest market for new nuclear in the world; future will depend on government's economic and energy strategy
Finland	European new wave	2,636	2,600	First European country to undertake construction of a next generation plant; closely watched by many
France	European new wave	63,473	4,890	One of the most experienced countries with nuclear power; large new build program expected post-2020
Germany	Sleepers	20,339	0	Second largest existing fleet in Western Europe, but due to be phased out; elections in September 2009 will be key
India	Growth engines	3,779	44,476	With strong demand, the priority is getting plants on the ground; it is shaping up as a good market for midsize plants
Italy	Steady bets	0	17,000	Government eager to return to nuclear power after 20 years; government and utilities need international cooperation
Japan	Steady bets	46,236	21,500	Nuclear power remains bedrock of energy policy; new stations have been in continuous development for 40 years
Netherlands	Sleepers	485	0	Government started exploring opportunities for new build in spring 2009
Romania	Sleepers	1,310	1,965	Strong government support for two new plants
Russia	Growth engines	21,743	41,130	Plans to double nuclear energy output by 2020, amidst changes to the market and industry structure
South Africa	Good prospects	1,842	7,565	One of the most interesting markets for investment in new nuclear until December 2008, when Eskom shelved its plans on cost grounds
South Korea	Steady bets	17,716	12,100	Nuclear remains key priority in the government's energy policy
Spain	Sleepers	7,448	0	Government commitment to the future of nuclear energy is uncertain
Sweden	Sleepers	9,016	0	Good reputation for safe and reliable nuclear power; in February 2009, coalition government said it would abolish act banning construction of new nuclear reactors
Switzerland	Sleepers	3,220	4,000	Five nuclear reactors currently generate 40% of electricity; national vote has confirmed support for nuclear energy
Ukraine	Good prospects	13,168	28,900	Heavily dependent on nuclear energy (about 50% of generation mix); strong government commitment to 2030 — requires substantial new build
United Arab Emirates	Good prospects	0	20,000	New to nuclear power; plans to have three commercial nuclear power reactors online before 2020, may be stretch target
United Kingdom	Steady bets	11,035	9,600	Progressing steps from the Nuclear White Paper 2008; site consultation under way; utilities continue to explore plans for new stations
United States	Steady bets	101,119	40,980	Excellent market for new nuclear; government is still overall supportive and industry very keen on new developments

Source: World Nuclear Association, July 2009, Ernst & Young Analysis



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