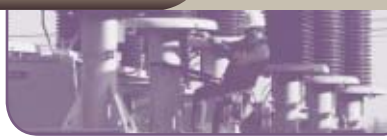
DATA POINTS



	NUCLEAR ELECTRICITY GENERATION 2006		REACTORS OPERABLE January 2008		REACTORS UNDER CONSTRUCTION January 2008		REACTORS PLANNED January 2008		REACTORS PROPOSED January 2008		URANIUM REQUIRED 2008
	billion kWh	% e	No.	MWe	No.	MWe	No.	MWe	No.	MWe	tonnes U
Argentina	7.2	6.9	2	935	1	692	1	740	1	740	123
Armenia	2.4	42	1	376	0	0	0	0	1	1000	51
Bangladesh	0	0	0	0	0	0	0	0	2	2000	0
Belarus	0	0	0	0	0	0	2	2000	0	0	0
Belgium	44.3	54	7	5728	0	0	0	0	0	0	1011
Brazil	13	3.3	2	1901	0	0	1	1245	4	4000	303
Bulgaria	18.1	44	2	1906	0	0	2	1900	0	0	261
Canada*	92.4	16	18	12652	2	1540	4	4000	2	2200	1665
China	51.8	1.9	11	8587	5	4540	30	32000	86	68000	1396
Czech Republic	24.5	31	6	3472	0	0	0	0	2	1900	619
Egypt	0	0	0	0	0	0	0	0	1	1000	0
Finland	22	28	4	2696	1	1600	0	0	1	1000	1051
France	428.7	78	59	63473	1	1630	0	0	1	1600	10527
Germany	158.7	32	17	20339	0	0	0	0	0	0	3332
Hungary	12.5	38	4	1826	0	0	0	0	2	2000	271
India	15.6	2.6	17	3779	6	2976	10	8560	9	4800	978
Indonesia	0	0	0	0	0	0	2	2000	0	0	0
Iran	0	0	0	0	1	915	2	1900	1	300	143
Israel	0	0	0	0	0	0	0	0	1	1200	0
Japan	291.5	30	55	47577	2	2285	11	14945	1	1100	7569
Kazakhstan	0	0	0	0	0	0	0	0	1	300	0
Korea DPR (North)	0	0	0	0	0	0	1	950	0	0	0
Korea RO (South)	141.2	39	20	17533	2	2000	6	7600	0	0	3109
Lithuania	8	69	1	1185	0	0	0	0	2	3200	225
Mexico	10.4	4.9	2	1310	0	0	0	0	2	2000	246
Netherlands	3.3	3.5	1	485	0	0	0	0	0	0	98
Pakistan	2.6	2.7	2	400	1	300	2	600	2	2000	65
Romania	5.2	9	2	1310	0	0	2	1310	1	655	174
Russia	144.3	16	31	21743	7	4920	8	9600	20	18200	3365
Slovakia	16.6	57	5	2064	2	840	0	0	0	0	313
Slovenia	5.3	40	1	696	0	0	0	0	1	1000	141
South Africa	10.1	4.4	2	1842	0	0	1	165	24	4000	303
Spain	57.4	20	8	7442	0	0	0	0	0	0	1398
Sweden	65.1	48	10	9086	0	0	0	0	0	0	1418
Switzerland	26.4	37	5	3220	0	0	0	0	1	1000	537
Thailand	0	0	0	0	0	0	0	0	4	4000	0
Turkey	0	0	0	0	0	0	0	0	3	4500	0
Ukraine	84.8	48	15	13168	0	0	2	1900	20	27000	1974
United Kingdom	69.2	18	19	11035	0	0	0	0	0	0	2199
USA	787.2	19	104	99049	0	0	7	10180	25	32000	18918
Vietnam	0	0	0	0	0	0	0	0	2	2000	0
WORLD**	2658	16	439	372,059	34	27,798	93		222	193,095	64,615
	billion kWh	% e	No.	MWe	No.	MWe	No.	MWe	No.	MWe	tonnes U
	NUCLEAR ELECTRICITY GENERATION 2006		REACTORS OPERABLE January 2008		REACTORS UNDER CONSTRUCTION		REACTORS PLANNED January 2008		REACTORS PROPOSED January 2008		URANIUM REQUIRED

Sources:
Reactor data: World Nuclear Association (WNA) to 1/14/08.
IAEA- for nuclear electricity production & percentage of electricity (% e) 5/07.
WNA: Global Nuclear Fuel Market (reference scenario) - for U.
Operating = Connected to the grid;
Building/Construction = first concrete for reactor poured, or major refurbishment under way;
Planned = Approvals, funding or major commitment in place, mostly expected in operation within 8 years, or construction well advanced but suspended indefinitely;
Proposed = clear intention or proposal but still without firm commitment. Planned and Proposed are generally gross MWe;
TWh = Terawatt-hours (billion kilowatt-hours), MWe = Megawatt net (electrical as distinct from thermal), kWh = kilowatt-hour.
64,615 tU = 76,200 t U3O8
* In Canada, 'construction' figure is 2 laid-up Bruce A reactors.
** The world total includes 6 reactors operating on Taiwan with a combined capacity of 4884 MWe, which generated a total of 38.3 billion kWh in 2006 (accounting for 20% of Taiwan's total electricity generation). Taiwan has two reactors under construction with a combined capacity of 2600 MWe.

MARCH 2008 : Volume 1 No. 1

NUCLEAR POWER INTERNATIONAL™

Ensuring a Strong Nuclear Safety Culture

New Build Challenges

A Global View of Nuclear Energy

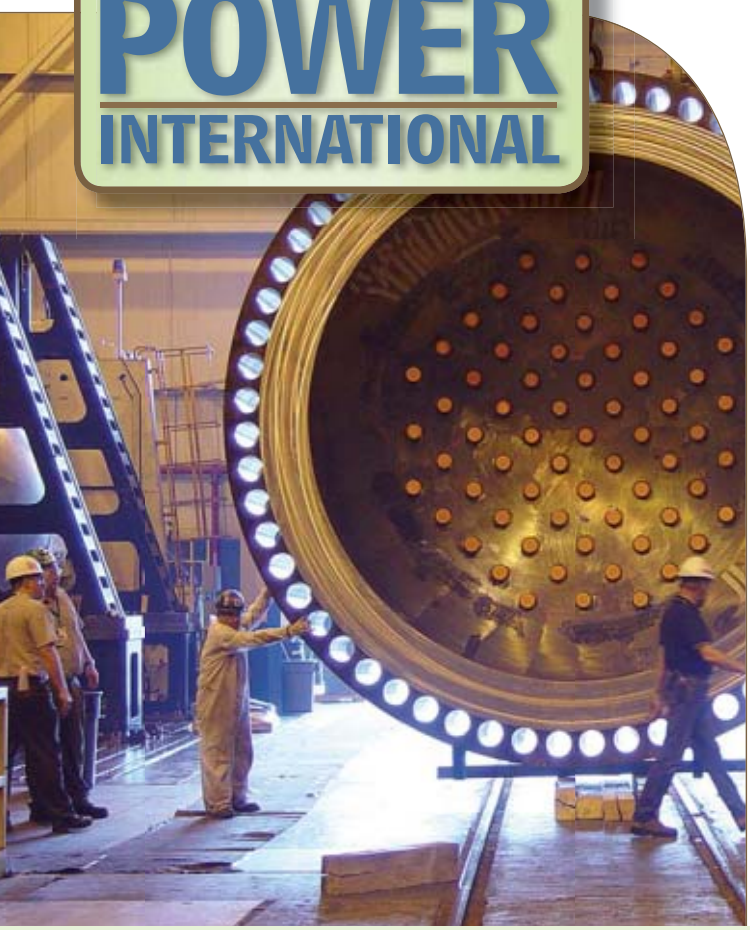
Dale Klein: Roadmap to the 80-year License

A POWER Engineering Publication

PennWell

NUCLEAR POWER INTERNATIONAL™

Cover photo: Vertical view of new reactor vessel closure head. Photo courtesy of The Babcock & Wilcox Co.



NUCLEUS

CASE STUDY

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MARCH | 2008

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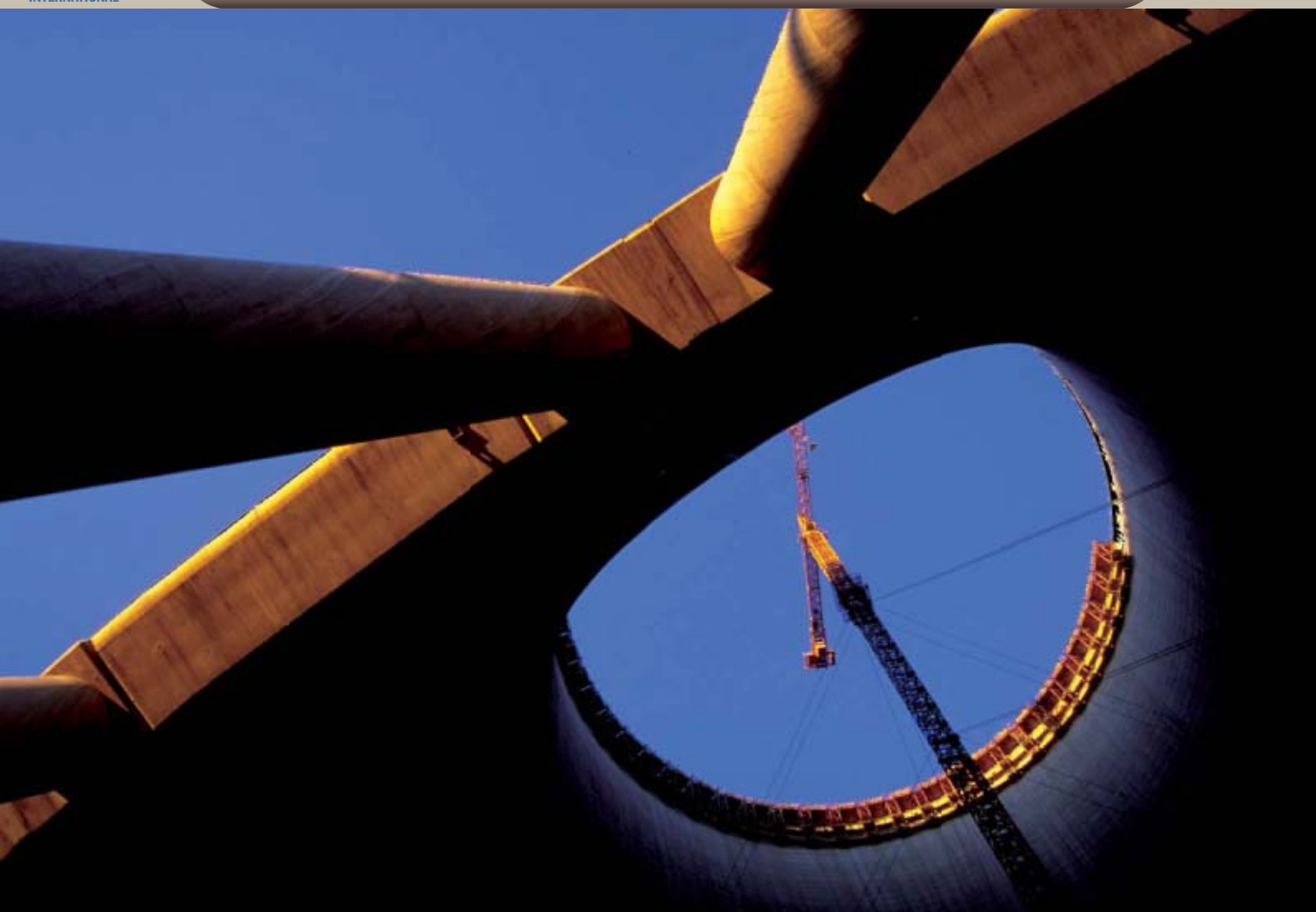

Bechtel Nuclear: Building on the Past Powering the Future

Since the earliest commercial nuclear reactors a half century ago, Bechtel has played a pivotal role in every phase of the industry's development. We designed and/or built more than half of the nuclear power plants in the United States. Worldwide, Bechtel has played an important role on more than 150 nuclear units. Today, we continue our commitment to the nuclear power industry, providing quality operating services and support to nuclear power plants throughout the world.

Bechtel offers the most complete selection of nuclear support services available. New nuclear generation, including COL support. Operating plant services. Steam generator replacements. Reactor pressure vessel head replacements. Plant license renewal and life extension. Operations improvement programs. A center of excellence dedicated to process improvement and innovation. And a commitment to nuclear power that started with the industry's inception.

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ENRICHMENT

Reporting on the Sensible Solution

Teresa Hansen, Editor

"Sensible people will conclude that there isn't a solution to climate change without nuclear power." Guy Chardon, a senior vice president with Alstom Power Systems, made this statement during a presentation at CERAWeek, held recently in Houston. I agree 100 percent with his statement; however, I also agree with his follow-up assessment: "Unfortunately, not everyone is sensible."

The mostly irrational opposition to nuclear power that has dogged the industry for so many years is still prevalent today, but it looks as though the sensible people may be making some headway. As I've written in the past, while no ground has yet been broken on a nuclear power plant in North America, plants are currently being built in Asia, China, India, Russia and Western Europe. The United States and United Kingdom are getting close.

It is now clear that nuclear power will continue to play a significant role in global electricity generation. As Chardon said, nuclear power will be instrumental in reducing CO_2 around the world, which is one of the reasons for its new-found popularity. However, it will also be instrumental in allowing countries to meet future electricity demand, which many predict will double by 2030.

Because of the worldwide attention being focused on the nuclear industry, we at PennWell believe it is time to publish a magazine dedicated solely to the global nuclear power industry. I'm proud to introduce you to that publication—*Nuclear Power International*, an entirely digital magazine. Many of you have likely received *Power Engineering* magazine's quarterly nuclear e-newsletter during the past 12 months. This new quarterly digital magazine replaces that e-newsletter and will provide you with even more relevant and interesting content from around the world.

This is, after all, a global magazine. It will focus on new nuclear plant build-out around the world, as well as many operation and maintenance issues that affect the 435 existing reactors that are generating electricity across the globe.

In this inaugural issue, you'll read U.S. Nuclear Regulatory Commission Chairman Dale Klein's ideas for extending the life of operating plants up to 80 and perhaps 100 years, a strategy that could prove to be extremely important in meeting future electricity demand.

You'll also read an article by Ian Hore-Lacy of the London-based World Nuclear Association discussing nuclear power's global prospects. Hore-Lacy outlines key issues that will influence the world's nuclear revival.

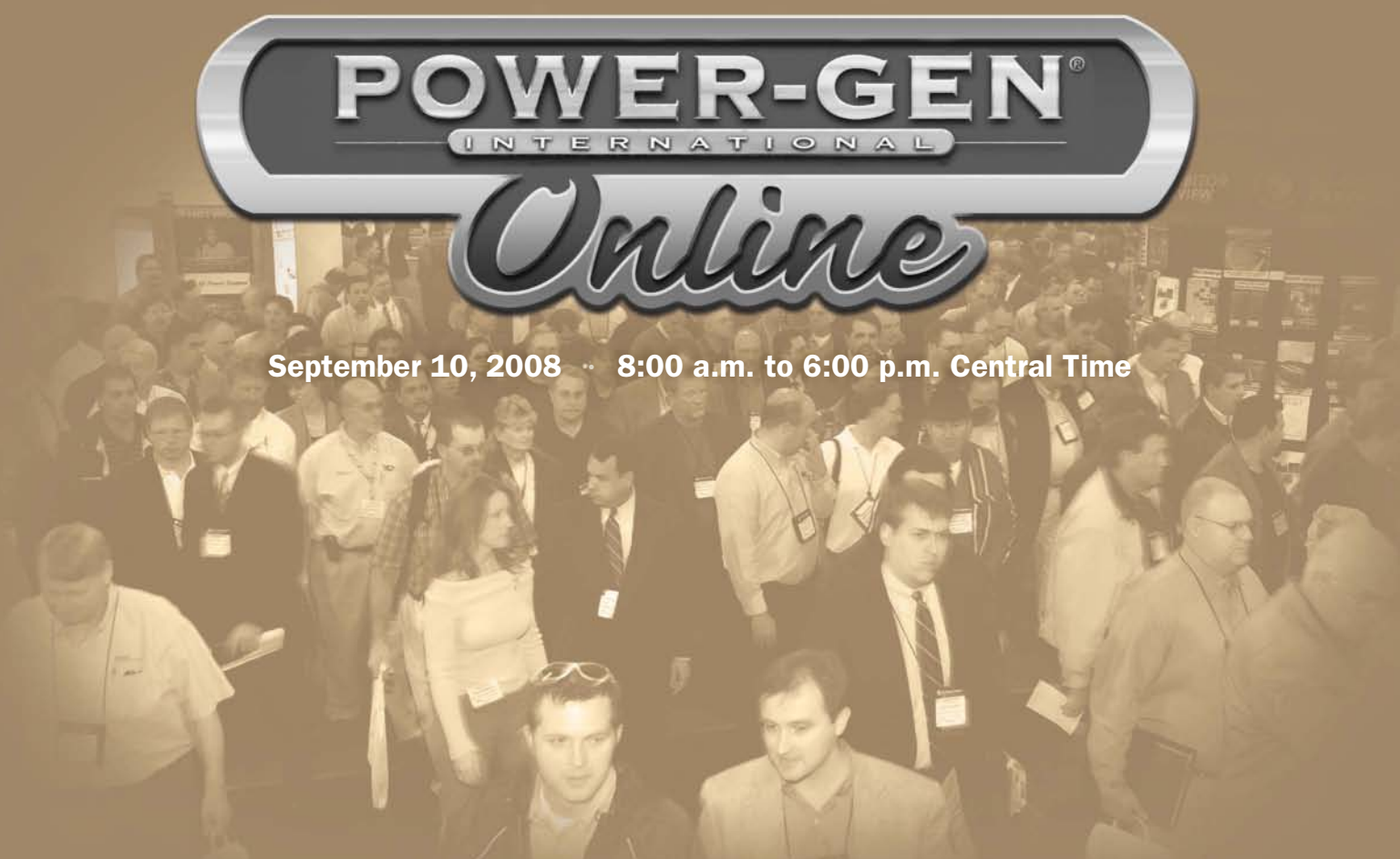
You'll also find out how an engineering, procurement, construction (EPC) and maintenance company is preparing for the nuclear revival. The senior vice president of Fluor's nuclear power business discusses with me the challenges EPC companies face when it comes to new plant build-outs and some of the strategies he believes will help them effectively meet those challenges.

This inaugural issue also contains other interesting articles, a case study, nuclear statistics and data and a lengthy news section featuring announcements and updates, all of it aimed at providing you with a global perspective of the nuclear power industry.

This is an exciting time to be a part of the nuclear power industry. Those of us at PennWell and *Power Engineering* magazine are pleased to publish this new nuclear power magazine. However, as exciting as the nuclear possibilities are right now, it is also clear that the industry faces many challenges, one of the most formidable being negative public opinion.

As Chardon said, not everyone is sensible. While it seems so clear to those of us in the power industry that nuclear power has been a key player in electricity generation for 40 years and must continue that role for years to come, that message hasn't always been clearly and convincingly conveyed to the public. To the contrary, even after years of safe, efficient operation, many people in the developed world still believe nuclear power is dangerous, dirty and much too expensive.

While many of the issues the industry faces are out of our hands, educating the public about the benefits of nuclear power is something we can do. I urge each of you to help the industry by taking advantage of every opportunity to promote nuclear power's attributes and increase the number of "sensible people" around the world. You might want to start by sharing a copy of this digital magazine with them.



September 10, 2008 · 8:00 a.m. to 6:00 p.m. Central Time

Power Engineering Presents the 2nd Annual POWER-GEN International Online

POWER-GEN International Online was met with enormous success in 2007. This innovative online conference and exhibition uses leading-edge technology to bring the global industry of power decision-makers together with power solution providers all at the convenience of your desktop.

More than 62% of attendees of the 2007 event were logged in from an international destination. Don't miss this opportunity to network globally with other industry professionals as well as get a sneak peak at the new products and services that will be displayed in Orlando at POWER-GEN International's 20th Anniversary event December 2-4, 2008.

What are attendees from the 2007 event saying?*

- 93% of attendees polled said they would attend next year's event
- 92% of attendees said they would visit the archived event
- 75% of attendees said they would recommend the archived event to a colleague

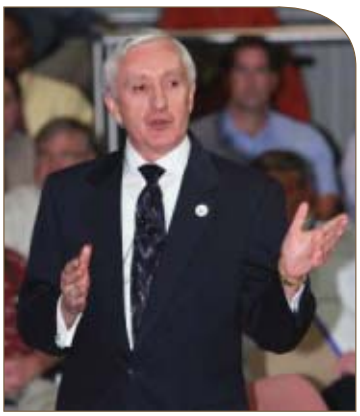
For more information visit www.power-gen.com.

**Results are from a survey sent to attendees after the event*

FUEL FOR THOUGHT

Moving Toward a 100-Year Plant

By Dale E. Klein, Chairman, Nuclear Regulatory Commission



When reflecting on the future of nuclear power in the United States, most people understandably focus on the proposed new reactors that the commercial power sector wants to build. The NRC has received, to date, five applications for new reactor construction and operation licenses and more are expected.

But even assuming that any of those license applications meet our strict standards for safety and security, it would still be years before any new plants were built and electrons starting flowing into the grid. And it would be decades, rather than years, before there were enough new plants to replace the 104 reactors currently supplying about 20 percent of America's electricity needs.

What, then, does the future hold for these currently operating plants? In the United States a nuclear plant—once approved—is licensed for 40 years under continuous on-site NRC inspection. A license renewal may be granted if the NRC determines that the plant can continue to operate safely. Today, more than half of the operating plants—most of which were built in the 1970s and 1980s—have either been granted, or are in the process of applying for, a 20-year license extension.

When the question of license renewals was first being considered about 15 years ago and the NRC commissioned studies on aging effects and possible degradation in the plants, it was very much an open question whether plants could safely be granted life extensions.

Today, it is widely acknowledged that the license renewal process allows for a thorough safety review and is working. Many—perhaps most—of today's commercial nuclear plants, therefore, could have another 20 years of productive life. But then what? One of the most challenging projects under way at the NRC right now is asking whether these plants could continue to operate safely beyond that—for 80 or even 100 years.

That is an important, and difficult, question. In principle, there is no reason to assume that they could not. But there are a great number of complicated questions we would need to ask, and answer, before the NRC could consider implementing a process for a second round of license renewals—which is why we are thinking 10 to 15 years ahead.

Beginning with a workshop in February of this year, the NRC embarked on a major research effort, in conjunction with the Department of Energy and private groups such as the Electric Power Research Institute, to address these technical considerations. There are myriad scientific and engineering issues that need to be understood: about aging cables and concrete, about the effects of radiation on reactor vessels and vessel heads, about instrumentation and controls, including possible retrofitting, among others. We need to have confidence that we thoroughly understand these issues before we can take the next step.

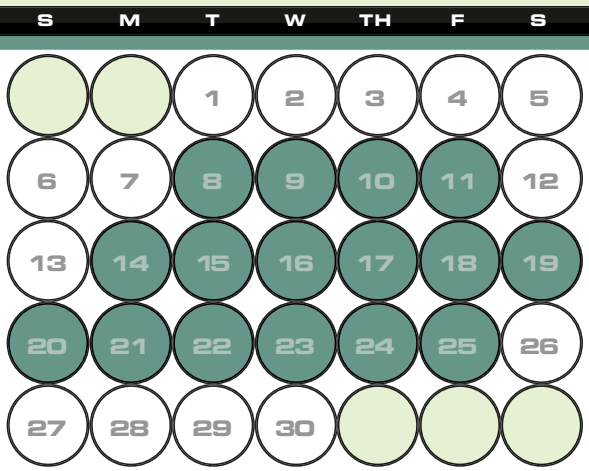
The commercial reactors currently operating were not built with any specific expiration date. A nuclear power plant is not like a carton of milk. They were, however, designed and built to be highly robust. Like anything that is well-constructed and well-maintained, they can last a long time and still function perfectly well. Many Americans, or their parents, probably have household items that are still providing service after 40 or 50 years. The Capitol Building in Washington, D.C. has been restored and expanded over time, but its basic structure has been intact for 150 years. With proper maintenance, it should last for centuries. Going back even further, there are aqueducts built by the Romans that are still in use today.

Yet nuclear power plants are different, because the physics and chemistry of aging are different. How the aging process is different and how it affects a plant's inherent robustness after 60 or more years are the scientific questions we need to answer. We know that eventually there will be indicators telling us that a plant is reaching the end of its useful life-span. We need to know what those indicators are. And we need to know whether a different mode of regulatory oversight may be appropriate for reactors as they begin to approach that point. It is possible that more frequent inspections may be an appropriate course for power plants beyond a certain age. Perhaps other options will be deemed appropriate. We won't know until we start looking.

Above all, we need to ensure that both the industry and the NRC prepare as carefully and as comprehensively as possible to ensure that a second round of life extensions for nuclear power plants—if it occurs—maintains the very high standards of regulatory independence and oversight the American people expect and deserve. Protecting the safety and health of the American people and the environment has always been our top priority and always will be. NPI

NUCLEAR EVENTS

APRIL | 2008

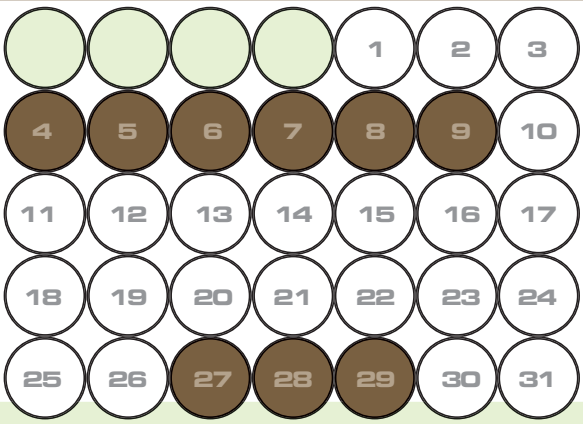


8–9 European Nuclear Assembly
Brussels, Belgium
www.foratom.org

8–11 World Nuclear Fuel Cycle
Miami, Florida, US
www.nei.org

14–25 Review Meeting of the Convention on Nuclear Safety (CNS)
Vienna, Austria
www-pub.iaea.org

MAY | 2008

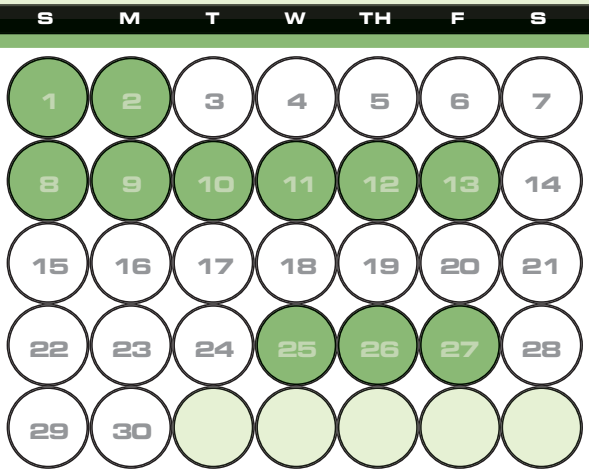


4–9 Nuclear Engineering Science, Technology Education, Training (NESTet) 2008
Budapest, Hungary
www.euronuclear.org

5–7 Nuclear Energy Assembly
Chicago, Illinois, US
www.nei.org

27–29 Annual Meeting on Nuclear Technology
Hamburg, Germany
www.dbcm.de

JUNE | 2008



1–2 29th Annual CNS Conference and 32nd Annual CNS/CAN Student Conference
Toronto, Canada
www.cns-snc.ca

8–12 2008 International Congress on Advances in Nuclear Power Plants (ICAPP '08)
Anaheim, California, US
www.inspi.ufl.edu

9–10 Emergency Preparedness and Communication Forum
Dana Point, California, US
www.nei.org

10–13 2008 China Nuclear Energy Congres
Beijing, China
www.alt-power.com

25–27 14th Annual Nuclear Generator & Supplier Executive Summit
Niagara Falls, Canada
www.usainc.org

25–27 1st International Exhibition and Congress on Nuclear Technologies
Moscow, Russia
www.atomcon.ru

NEWS

China's first 3G nuclear plant breaks ground

CHINA'S SANMEN POWER PLANT, the country's first third-generation nuclear plant, broke ground late last month, the *China Daily* said, citing State Nuclear Power Technology Co. (SNPTC). The plant in Zhejiang Province is expected to be operational by August 2013. Concrete pouring could begin next year.

It will be the world's first nuclear plant to use AP1000 technology from Westinghouse Electric, the paper said, citing SNPTC chairman Wang Binghua. Construction of the Haiyang nuclear power plant in Shandong province, also with AP1000 technology, will start later this year, the paper said.

China currently has 11 nuclear generating units in operation and will have an installed nuclear power capacity of 40,000 MW by 2020, accounting for 4 percent of the country's total, according to the *China Daily* article.

Groundbreaking ceremony for the AP1000 Sanmen nuclear plant, China's first third-generation nuclear plant, which would also become the world's first AP1000 nuclear plant.

Nuclear utilities on world's "most sustainable" list

The fourth annual Global 100 list of the most sustainable large corporations in the world was recently announced and includes six energy companies and five utilities, some of which operate nuclear power plants.

The list, released by Corporate Knights and Innovest Strategic Value Advisors, includes companies from 17 countries encompassing all sectors of the economy that were evaluated according to how effectively they manage environmental, social and governance risks and opportunities, relative to their industry peers.

By country, the Untied Kingdom had the most companies in the Top 100, with 24, plus two that are jointly based there. It was followed by the United States with 16 and Japan with 13.

Included in the list under the energy sector are: Neste Oil (Finland), Nexen (Canada), OMV (Austria), Royal Dutch Shell (UK), Saipem (Italy) and Transcanada (Canada). The utilities listed are: Centrica (UK), Fortum (Finland), FPL Group (US), Iberdrola (Spain) and Pinnacle West Capital (US).

Fortum owns the Loviisa nuclear power plant in Finland, as well as shares in the Finnish Olkiluoto power plant and in the Swedish Oskarshamn and Forsmark nuclear power plants. FPL operates the Turkey Point and St Lucie nuclear power plants in Florida, as well as the Seabrook plant in New Hampshire and the Duane Arnold plant in Iowa. Iberdrola has interests in seven of Spain's nuclear power plants. Pinnacle West's largest affiliate, Arizona Public Service (APS), is the operator and co-owner of the Palo Verde nuclear power plant.

The Global 100 Most Sustainable Corporations in the world is a project launched by Corporate Knights and Innovest in 2005. The list is announced annually at the World Economic Forum in Davos, Switzerland.

Firms eye Thai nuclear power development

State-run Electricity Generating Authority of Thailand (EGAT) said at least four firms expressed interest in building nuclear power plants in Thailand. French state-owned AREVA, General Electric Co., Mitsubishi Corp. and Toshiba Corp. have made presentations to executives and the nuclear power committee, a senior EGAT official told Reuters.

Thailand expects to build four nuclear plants, each with a capacity of 1,000 MW, as part of a 15-year power development plan to add nearly 40,000 MW of capacity by 2021.

Canada hopes for a piece of Britain's nuclear action

Britain in January gave the go-ahead for the construction of new nuclear power plants, a move that could benefit Canada's atomic energy industry.

Last July, the British nuclear agency ruled that a new generation of Atomic Energy of Canada Ltd.'s heavy-water Candu reactor is one of four technologies being considered.

The British agency will pare the list to three in the next few months. If AECL is still in the running, it will discuss its technology with the private firms considering new reactor projects.

Duncan Hawthorne, chief executive officer at Ontario electricity generator Bruce Power, and a veteran of the British power business, was quoted as saying it will be

tough for AECL to get a contract because Britain has not been enthusiastic about heavy water plants in the past. It will all depend on how the private sector consortia form, he said, but just being on the short list means they have a shot.

Even if AECL is not chosen, Canada's nuclear industry could benefit from the building in Britain, Murray Elston, CEO of the Canadian Nuclear Association was quoted as saying.

Many Canadian companies supply services and products to international nuclear developers, so new business will be generated no matter who gets the contracts in Britain, he said. "At the end of the day, it is positive all the way around."

EDF signs deals with Gulf States

French utility EDF recently signed $2 billion worth of contracts with the Government of Qatar to develop nuclear power stations. As part of the deal, French companies would build civilian nuclear power plants in oil rich Gulf States, including Saudi Arabia, Qatar and the UAE.

With increasing electricity demand and high oil prices in the region, Gulf States is looking to build alternative energy sources to fuel refineries and construction with the intention of freeing up its own oil for export.

Nuclear power is also expected to provide a low-cost way of meeting the region's demand for desalinated water and electricity that has risen as a result of growing economies.

Russia to build $6 billion nuclear station in Bulgaria

Russia's state-owned nuclear equipment monopoly Atomstroyexport signed a €3.9 billion ($5.9 billion) contract in Bulgaria to build a nuclear power plant in the north of the Balkan state. The deal with Bulgaria's National Electric Co. was signed during a visit to Bulgaria by Russian President Vladimir Putin.

Atomstroyexport, which won a tender for the project in 2006, is to build two 1,000 MW reactors in Belene, with the first expected to be commissioned in late 2013 and the second in 2014. The planned nuclear power plant at Belene will be Bulgaria's second.

President Putin said Russia was ready to grant Bulgaria a €3.8 billion ($5.6 billion) loan for the construction of the Belene nuclear power plant.

"A total of €3.8 billion is envisioned in the Russian budget to implement plans to build the nuclear power plant. If necessary, we are ready to provide a loan to Bulgaria," Putin said.

The head of the Russian Federal Agency for Nuclear Power said the number of power units at the nuclear power plant could be increased to four.

"We understand that it is unreasonable to have the Belene nuclear power plant construction confined only to two power generating units. This will be the first stage (of construction), which, if successful, will be followed by the third and the fourth units," Sergei Kiriyenko told journalists in Sofia.

South Africa invites nuclear power bids

South African electricity company Eskom invited AREVA and Westinghouse to submit bids to build the South Africa's next nuclear power station.

The new plant would be the first of six more nuclear plants that Eskom is planning to build. An Eskom spokesperson said the company wants to receive and evaluate bids in the first quarter of this year and report back to its board at the end of March. Eskom hopes construction will start by 2010 and that the new plant will be online by 2016.

Westinghouse also submitted a second response to provide up to 20,000 MW of nuclear power generation in South Africa by 2025.

The Westinghouse responses were submitted in cooperation with Shaw Group Inc. of the United States and Murray & Roberts Ltd. of South Africa, a construction company. Westinghouse, Shaw and Murray & Roberts will team together under the brand N-Powerment, which is being formed to implement the project and facilitate a localization and technology transfer program for South Africa.

NEWS

UniStar may take a stake in proposed Idaho plant

Alternate Energy Holdings Inc. (AEHI) signed a memorandum of understanding with UniStar Nuclear Energy (UNE) to discuss the possibility of UNE acquiring a "significant" ownership interest in a potential nuclear power plant in Idaho in the United States. In addition, the companies will discuss the potential for UNE to operate the proposed plant.

In July 2007, AEHI reported that it had chosen the USEPR technology for its proposed new nuclear power plant in Idaho and that it had agreed for UniStar to assist it "in seeking regulatory approval and in subsequent plant construction." UNE is a joint venture between U.S. utility Constellation and Electricite de France (EdF) to own and operate a fleet of USEPR plants in the United States and Canada.

Uranium output rose in Kazakhstan and Australia during 2007

Kazakhstan and Australia both reported double-digit increases in uranium production during 2007. Kazakh output increased more than 25 percent while Australian output grew 13 percent. The countries are the world's second and third biggest uranium suppliers, after Canada.

KazAtomProm said that Kazakhstan's uranium production increased 25.7 percent in 2007, to 6,637 tonnes (7,827 tonnes U3O8). That compared with output of 5,281 tonnes (6,228 tonnes U3O8) in 2006. Production in 2007 was 1,000 tonnes less than planned due to a shortage of sulfuric acid in Kazakhstan following a fire at a production plant and the delayed start-up of some new facilities. Sulfuric acid is the main chemical component during production of uranium using the in-situ leach (ISL) method.

Uranium production in 2008 is planned to be 9,600 tonnes (11,320 tonnes U3O8). Kazakhstan plans to increase uranium output to over 15,000 tonnes (17,690 tonnes U3O8) by 2010. That would make the country the world's largest producer of uranium, ahead of Canada and Australia. Kazakhstan has a uranium production target of 30,000 tonnes (23,380 tonnes U3O8) a year by 2018, the increase being due to a perceived shortfall being likely about 2014.

In Australia, production in 2007 from the country's three uranium mines totaled 8,603 tonnes (10,145 tonnes U3O8). This was 13 percent higher than in 2006, but slightly below output in both 2004 and 2005.

Energy Resources Australia (ERA) reported that output at its Ranger mine increased 14 percent in 2007 to 4,589 tonnes (5,412 tonnes U3O8). This was despite mining operations at Ranger having to be temporarily suspended in early 2007 due to flooding from heavy rainfall. Uranium production at BHP Billiton's Olympic Dam operation in 2007 totaled 3,379 tonnes (3,985 tonnes U3O8). Output at Heathgate Resource's Beverley in-situ leach (ISL) mine totalled 634 tonnes (748 tonnes U3O8).

EDF favors nuclear power in four countries

French power group EDF hopes to share its nuclear expertise with China, South Africa, Britain and the United States, the company's chief executive said, according to Reuters.

"I am convinced that nuclear will develop in some countries, not in every country," said Pierre Gadonneix, EDF's chariman and CEO. EDF is the world's largest nuclear power company, operating 58 nuclear reactors in France.

"We have chosen to invest first in countries which already have a nuclear experience. The countries we have identified are China, South Africa, Britain and the United States. We think these are the countries were there are development opportunities in the short term," he said.

In January, Britain gave the go-ahead to a new generation of nuclear power stations, while South African power utility Eskom in recent months invited international companies to submit bids to build a new nuclear power station.

Shaw group opens second China office

The nuclear division of the Shaw Power Group has opened a new office in Shanghai to support the rapidly growing Chinese nuclear power market. The company already has an office in Beijing.

The new Shanghai office will accommodate the Shaw project management team already working on four AP1000 nuclear reactors at plants in Sanmen and Haiyang. Shaw and Westinghouse, its AP1000 consortium partner, signed contracts in July 2007 to provide services and equipment for two AP1000 units in Sanmen and two at Haiyang. China has indicated plans to construct up to 30 new nuclear power reactors by 2020.

Gulf nuclear plant doubtful before 2020

Plans for nuclear power stations in the Persian Gulf face a lack of infrastructure that the region's cash-rich states will take time to overcome, Hans-Holger Rogner, head of planning and economic studies at the International Atomic Energy Agency (IAEA), told Reuters.

Analysts say they could buy the technology they need and push through the planning, financing and licensing much more quickly than would be the case in more democratic countries.

Even so, Rogner said he doubted a nuclear power plant would be up and running in the Persian Gulf region before 2020.

Sellers of nuclear technology might be eager for the business, but they also would be reluctant to see their product used without a fully developed industry framework in place. "Vendors would also be concerned," said Rogner. "They don't want their technology to be associated with any of the risks. (Gulf countries) will have to regulate and oversee a plant even if it is operated by an international operator."

For that, nations need nuclear engineers. But no universities in the region teach nuclear engineering at present, Rogner said.

The IAEA is working with the Gulf Cooperation Council (GCC) on the basic

requirements for nuclear power, Rogner said. It is also working with the individual GCC member countries.

The IAEA believes the best way forward is with a GCC-wide agreement, rather than for individual countries to go their own way. Rogner said such an approach would encourage transparency and mutual trust between the region's states.

If the countries move ahead on their own, the UAE probably has the edge over the rest of the Gulf Arab states after signing a nuclear cooperation deal with the French government in January. French companies Total, Suez and AREVA said earlier this year they would join forces to develop plans for two nuclear reactors in the UAE, with a possible start-up date of 2016.

AREVA and Bechtel advance U.S. EPR design engineering

UniStar Nuclear Energy, a strategic joint venture between Constellation Energy and EDF Group, officially began detailed engineering design for the Calvert Cliffs Unit 3 nuclear power plant in Maryland by awarding a contract to the AREVA and Bechtel Power Corp. consortium.

Detailed design engineering is a major milestone toward deploying a new plant. It generates the tangible construction drawings and detailed specifications necessary to buy equipment and build the plant

The NRC recently accepted AREVA's design certification (DC) application for the U.S. Evolutionary Power Reactor (EPR) for technical review ahead of schedule. The NRC staff determined that the content of the DC application met the acceptance criteria for the safety review to begin. This early acceptance demonstrates progress toward the completion of the first EPR in the United States by 2015.

As they enter the engineering design phase, the AREVA-Bechtel team will benefit from the advanced design of two separate EPRs currently under construction in Finland and France. In addition, independent COLA projects are underway in parallel for the deployment of the EPR at other U.S. locations. AREVA hired more than 200 engineers and technical experts last year to support the DC applicatoin and detailed design activities and will hire even more this year in preparation for the expected new build plans in the United States.

Russia to build 10 new nuclear generating units

Russia wants to put in operation "two gigawatts of nuclear power generation capacity a year" starting from 2012, Peter Shchedrovitskiy, deputy director of the Nuclear Energy Complex, said during a recent science conference, Itar-Tass reported.

"Such a pace will allow us to put in operation up to four generating units with the capacity of over 1.1 GW each in 2015-2020 and to increase the share of the nuclear power sector in the (country's) electricity generation to 22 percent to 25 percent by 2030," he said.

At the same time, the Nuclear Energy Complex is planning to actively build nuclear power plants abroad.

By 2015, the end of the federal targeted program on the Development of Russia's Nuclear Energy Complex, "it is planned to put in operation 10 new power generating units with the total capacity of 11 GW," and 10 more units will be in various phases of construction.

The total operational capacity of nuclear power plants by 2015 should exceed 33 GW, Shchedrovitskiy said.

NRC approves GE Hitachi engineering program

The NRC approved earlier this year an engineering program submitted by GE Hitachi Nuclear Energy on behalf of customers seeking to enhance their reactors' performance.

NEWS

The NRC completed and issued a Safety Evaluation (SE) approving GE Hitachi's Maximum Extended Load Line Limit Analysis Plus (MELLLA+) Licensing Topical Report (LTR). The independent Advisory Committee on Reactor Safeguards reviewed the LTR and concurred with the NRC staff's conclusions.

MELLLA+ is an engineering analysis that offers BWR utilities greater flexibility and ease to safely operate their units at maximum power for longer periods. MELLLA+ provides for a more efficient reactor startup, maximizes fuel utilization and improves fuel cycle economics.

The NRC issuance of its SE represents the completion of a major regulatory milestone, allowing GE Hitachi to commercially introduce its MELLLA+ offering and to allow its customers to submit plant-specific license requests.

There are at least nine utilities with 14 BWRs in North America that plan to apply the MELLLA+ option, particularly those that have implemented, or intend to implement, an extended power uprate. GE Hitachi is already working with its customers to submit MELLLA+ plant-specific applications in 2008.

Mitsubishi wins second China steam turbine deal

Mitsubishi Heavy Industries received an order from Shandong Nuclear Power in China for two packages of a steam turbine generator (STG) for the Haiyang Nuclear Power Plant to be built in Haiyang, Shandong Province.

The STG packages, proposed by Mitsubishi jointly with Harbin Power Equipment, will be used as turbine generator systems for two 1,200 MW nuclear reactors. This is the second order from China for STGs for nuclear power plant use, following an order for two units for the Sanmen nuclear plant signed in September 2007.

The Haiyang plant will be built in the city of Haiyang on the southern tip of Jiaodong Peninsula, facing the Yellow Sea. The two power configurations are slated to go on-stream in 2014 and 2015, respectively.

AREVA orders reached "record level" in 2007

France's AREVA Group reported that at the end of 2007 it had orders worth €39.834 billion ($58.9 billion), up 55 percent from the level of orders at the end of 2006. For 2007, the AREVA Group reported total sales revenue of €11.923 billion ($17.7 billion), an increase of 9.8 percent compared with 2006.

Most of the Group's orders are for nuclear equipment and services provided by its nuclear division, representing €34.927 billion ($51.7 billion). This was a 58

[CONTINUED ON PG. 13]

Fault lines examined at Kashiwazaki Kariwa

An International Atomic Energy Agency (IAEA) follow up fact finding mission to the Kashiwazaki Kariwa nuclear power plant in Japan has concluded from the examination of the plant's key safety areas that there was no significant damage to safety equipment from a strong earthquake last year.

"The first objective of the team has been to confirm that there appears to be no significant damage to the integrity of the plant," said Phillipe Jamet, whose team was able to view key internal components in the plant inaccessible during their first visit in August last year.

Last year's earthquake significantly exceeded the level of seismic activity for which the Kashiwazaki Kariwa plant, in the coastal prefecture of Niigata, northwest of Tokyo, was designed.

The earthquake caused fractures on the surface of the site. Before the reactors at the Tokyo Electric Power Co. (TEPCO) owned plant started up, between 1985 and 1997, it was acknowledged that geological faults ran deep beneath the site but were considered stable, the team said.

Geologists are investigating if surface fractures caused by the earthquake correspond to deeper faults. The team observed one fault during its site visit and was able to conclude that it was stable. Confirmation of the stability of others is underway.

The IAEA team's site visit followed three days of discussions with Japanese regulatory officials, the plant's operators and other experts.

The mission concluded that significant data about the earthquake has been gathered and efforts to obtain remaining information are underway. Overall interpretation of all the data will still be necessary to reach a full understanding of the July 16, 2007 earthquake and to assess the possibility of future ones.

The seven-unit Kashiwazaki Kariwa station in Japan.

The team also indicated that there had been significant improvement in the level of fire safety at the plant since last year.

The seven-unit plant, the world's largest, shut down safely during the earthquake and remains shut down. A small radioactive release at the time of the earthquake was said to be below public health and environmental limits.

[CONTINUED FROM PG. 12]

percent increase compared with such orders at the end of 2006, primarily attributable to a series of deals with Chinese utility China Guangdong Nuclear Power Corp. (CGNPC).

The series of agreements provide among other things for the construction of two Evolutionary Pressurized Water Reactor (EPR) nuclear islands and the supply of all the materials and services needed for their operation through 2027. CGNPC also bought 35 percent of the production of UraMin, a mining company acquired by AREVA in August 2007. In addition, AREVA signed several long-term contracts, in particular with Korea Hydro & Nuclear Power (KHNP) of South Korea, Electricité de France (EdF) and Japanese utilities.

Sales revenue from AREVA's reactors and services division were up 17.5 percent in 2007, mainly due to a recovery in the reactor services business. This recovery was as a result of "progress" on construction of the Olkiluoto 3 EPR in Finland and the start of construction of EdF's Flamanville 3 EPR.

AREVA signed four major commercial nuclear fuel contracts in the United States in late December 2007. Under a contract with Tennessee Valley Authority (TVA), AREVA will supply Browns Ferry Unit 1 with reload batches of blended low enriched uranium (BLEU) fuel beginning in 2010. In addition, AREVA agreed to supply reload batches of fuel for Constellation Energy's two-unit Calvert Cliffs nuclear power plant in Maryland. Meanwhile, PPL Susquehanna has extended its contract with AREVA for the supply of reload batches for the Susquehanna nuclear power plant, with additional deliveries to begin in 2011. Also under a contract extension, AREVA will supply fuel for AmerGen's Three Mile Island Unit 1, with deliveries of reload batches commencing in 2009.

Westinghouse, Emerson in automation deal

Westinghouse Electric and Emerson Process Management announced a 10-year extension to an existing agreement in which Emerson will provide key automation technology for Westinghouse AP1000 design plants. The agreement also selects Emerson for modernization of existing facilities.

Westinghouse will use Emerson's Ovation expert control and information system. The Ovation system will control power generation processes, provide operations and maintenance interface and collect and distribute plant-wide information for process and power generation management.

Four Westinghouse AP1000 design plants have been contracted for construction in China. The AP1000 design has been selected as the basis for 12 advanced nuclear plants that could be built in the United States over the next 10 to 12 years.

New U.S. import rules for Russian uranium

The United States will import Russian commercial uranium products beginning in 2011 under new legislation. The new rules will ultimately see an end to measures meant to stop Russia dumping cheap uranium on U.S. markets.

U.S. Secretary of Commerce Carlos Gutierrez met Sergei Kiriyenko, head of Russia's Federal Atomic Energy Agency (Rosatom), at Washington's Dulles Airport on February 1 to sign a new long-term suspension agreement. It allows Russian companies to sell low-enriched uranium (LEU) to U.S. nuclear generators. This sidesteps the uranium enrichment step in the nuclear fuel cycle, over which there have been legal arguments for some years.

Russia will be able to supply limited amounts of nuclear fuel for reactor reloads, while the supply of initial fuel loads for new reactors would be unlimited. All limits are to be phased out by 2021.

In 1991, the U.S. Department of Commerce began investigating uranium exports from the Soviet Union when that country's excess of enrichment capability meant the United States was flooded with low-cost uranium. The Commerce study concluded that this had harmed American enrichers. In 1992 the break-up of the Soviet Union and the need to find an avenue to import uranium from downblended Russian nuclear weapons led the U.S. government to suspend the investigation and place a duty of 115 percent on enriched uranium products.

This continued until a separate case between the Department of Commerce and a French enricher saw uranium enrichment classified as a service, not a product. The Suspension Agreement was then certain to be revised, as trade embargoes cannot be set against services.

The new legislation also addresses an upcoming uranium supply problem. U.S. nuclear utilities currently get about half of their uranium from dismantled Russian nuclear weapons under the 'Megatons to Megawatts' program, which is to end in 2013.

The Department of Commerce said the new agreement would "help to ensure that U.S. utilities have an adequate source of enriched uranium" while also minimizing the threat to U.S. uranium enrichers. Limits on imports from Russia increase from 16,559 kg of uranium in 2011 to 41,398 kg in 2013. The limit rises to 485,279 kg of uranium when Megatons to Megawatts supply stops in 2014; then 514,754 kg in 2020. These figures represent the maximum amount of LEU to be traded between the countries, subject to each contract gaining approval from the U.S. government. All limits are lifted after 2021.

Currently, three plans exist to increase U.S. uranium enrichment capacity:

- USEC is building its American Centrifuge plant, hoping to operate at full capacity from 2012.
- Louisiana Energy Services is constructing the National Enrichment Facility, using Urenco technology owned by France, Germany, the Netherlands and the UK. That could reach full capacity by 2013.
- France's AREVA is also preparing plans for a U.S. enrichment plant to reach full capacity in 2017. That also uses Urenco technology under license.

NEWS

Turkey selects site for 600 MWe plant

The Turkish government has decided to build its first nuclear power plant at Akkuyu, on the Mediterranean coast. This sets aside a decision two years ago to locate it at Sinop, on the Black Sea coast.

Akkuyu has been under consideration since the 1970s and has the advantage of already being licensed.

Sinop would have had the advantage of cooling water temperatures about 5 C below those at Akkuyu, allowing about 1 percent greater power output. The announcement of the site selection said that preparatory work is also under way to build a second nuclear plant there. In addition, Akkuyu is to be the site for a €1.7 billion ($2.5 billion) nuclear technology center.

In May 2007, a new bill concerning construction and operation of nuclear power plants and the sale of their electricity was passed by parliament. This was confirmed in November and approved by the president. It allows for the private sector to build the plants and the state utility to buy all the electricity for 15 years.

The Turkish Atomic Energy Authority (TAEK) has issued specifications, allowing for PWR, BWR or PHWR types of at least 600 MWe and with a 40-year service life. A government decision on plant type and construction arrangements is expected later in the year.

Argentina and Brazil in nuclear joint venture

Argentina and Brazil have agreed to jointly build a nuclear reactor. The plan was agreed to at a meeting between Argentinian President Cristina Fernández and her Brazilian counterpart Luiz Inacio Lula da Silva in Buenos Aires.

Argentina currently has two nuclear power plants and is building a third. Brazil, which owns large stocks of uranium, also operates two plants and wants to expand its nuclear energy program.

Bruce and CME prep for new investments

Bruce Power has joined forces with Canadian Manufacturers & Exports (CME) to help prepare for up to $40 billion of new nuclear investment in Ontario over the next 15 years. Nuclear energy plays a significant role in Ontario's energy plan announced last year.

CME and Bruce Power, operator of the Bruce A and B nuclear power plants in Ontario, will initially establish a working group of Canadian companies that could be affected by nuclear new-build and further refurbishment of existing plants. The group will consider strategies to deal with potential supply chain issues presented by a resurgent nuclear industry.

"We're considering multi-billion dollar investments in the next generation of nuclear assets, so the more planning we can do at the outset will help the manufacturing sector benefit from this," said Duncan Hawthorne, Bruce Power's president and CEO. "We have already committed more than $5 billion towards our restart and refurbishment project, which is demonstrating real and positive economic impacts on the province's economy."

Bruce Power has also conducted studies into a possible Bruce C plant, which could host four new 1,000 MWe reactors. An application for a licence to prepare the site for a new plant was submitted to regulators in August 2006. If plans materialize, the reactors could start up in 2014.

Currently, 16 operating nuclear power plants provide up to 12,595 MWe in Ontario. They are all AECL Candu units, which require refurbishment after about 25 years of operation. Two units at Pickering A have undergone that work already and their working lives have been extended out to 2018 and 2022; two at Bruce A are being refurbished now.

Ontario's energy plan was announced in August 2007. The plan sees nuclear power plants providing the bulk of baseload electricity after maximum use of conservation and renewables. Some $26 billion would be spent on nuclear generation by 2027.

Aerial photo of Bruce Power nuclear power plants in Ontario.

The integrated proposal, put together over two years by Ontario Power Authority (OPA), is the province's first "comprehensive electricity supply plan" in 15 years. It addresses the government's intention to phase out 6,434 MWe of coal-fired generation "in the earliest practicable timeframe," and the complication that nuclear plants are growing older and most could shut down by 2030.

Nuclear's role would be to provide up to 14,000 MWe of baseload capacity, which would operate on full power almost all of the time and provide the bulk of electricity. OPA's plan foresees 10,249 MWe coming from a combination of new plants and refurbishments of existing units to extend their operating lives. OPA said that 2018 could see the start of operation of 1,400 to 3,400 MWe of new nuclear capacity, depending on the mix of new-build to refurbishment.

EUCG releases 2007 nuclear plant cost data

By David Wagman, *Power Engineering* magazine

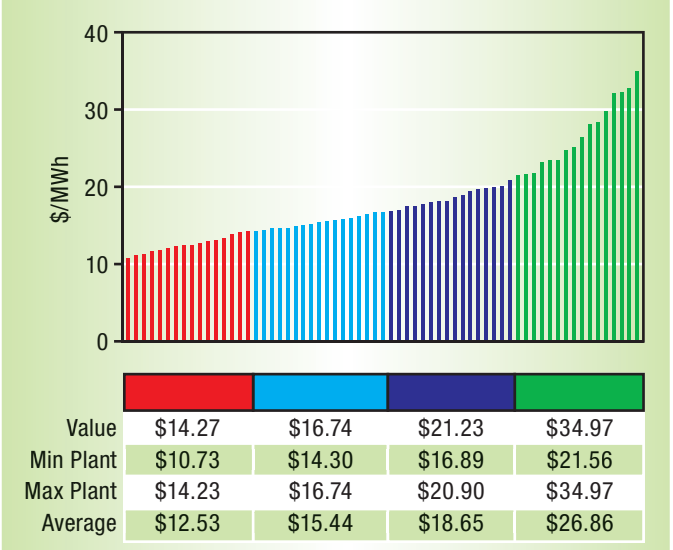
The Electric Utility Cost Group EUCG (www.eucg.org), a global association of utility professionals and member companies which gathers electric energy industry performance and cost information, released its 2007 overview of U.S. nuclear power plant operating and generating costs.

The data covers 100 percent of the nuclear commercial operating units in the 65 U.S. plants and present both 2007 statistics and three-year averages for the period 2005-2007. To protect data confidentiality, plant and unit names are not revealed.

EUCG presented three cost metrics in their data release: the first is called "operating costs." These are calculated as the sum of plant, support and other costs. The second—referred to as "total operating costs"—added fuel costs. The third cost metric, "total generating costs" adds capital costs to total operating costs.

Operating costs during 2007 ranged from a low of $10.73/MWh to a high of $34.97/MWh, according to the EUCG data. First quartile performers, as the graph shows, had an average operating cost of $12.53/MWh. Fourth quartile performers had average operating costs more than double that, $26.86/MWh.

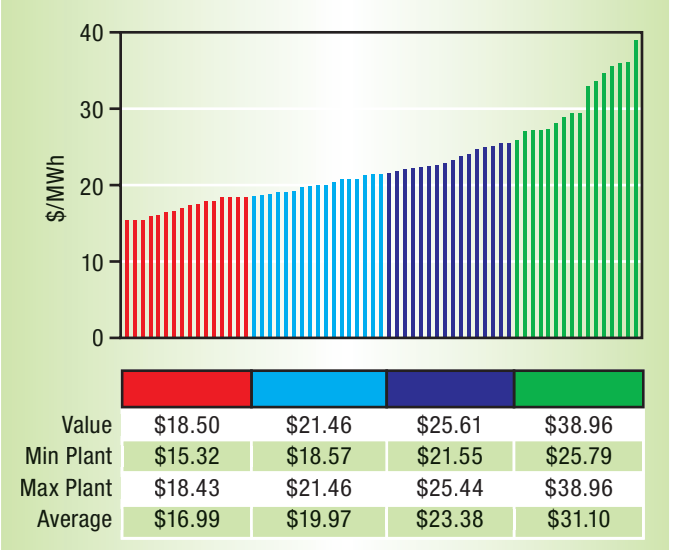
Figure 1 OPERATING COSTS 2007



Value	$14.27	$16.74	$21.23	$34.97
Min Plant	$10.73	$14.30	$16.89	$21.56
Max Plant	$14.23	$16.74	$20.90	$34.97
Average	$12.53	$15.44	$18.65	$26.86

Source: EUCG Data as of 2/4/2008

Figure 2 TOTAL OPERATING COSTS 2007



Value	$18.50	$21.46	$25.61	$38.96
Min Plant	$15.32	$18.57	$21.55	$25.79
Max Plant	$18.43	$21.46	$25.44	$38.96
Average	$16.99	$19.97	$23.38	$31.10

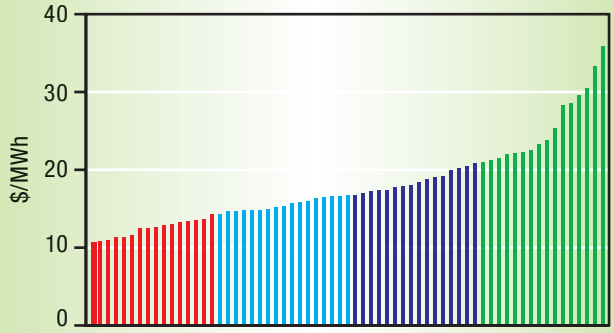
Source: EUCG Data as of 2/4/2008

Total operating costs during 2007 ranged from a low of $15.32/MWh to a high of $38.96/MWh. The average first quartile-ranked plant had a total operating cost of $16.99/MWh. The average fourth quartile-ranked plant had a total operating cost of $31.10/MWh.

When calculated over a three-year period, both operating costs and total operating costs were somewhat lower. Operating costs between 2005 and 2007 ranged from $10.71/MWh to $35.88/MWh. Total operating cost (which, again, included fuel) over the three-year period ranged from $16.64/MWh to $38.44/MWh.

NEWS

Figure 3 OPERATING COSTS 3-YEAR AVERAGE — 2005–2007

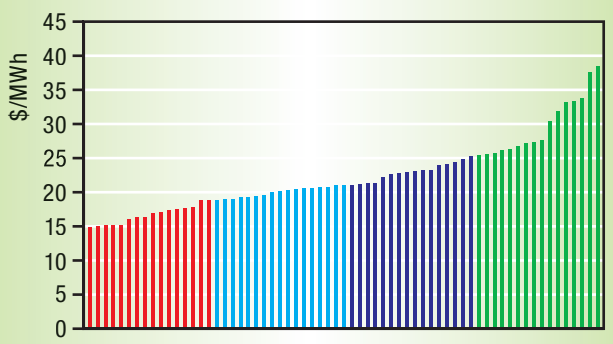


Value	$14.30	$16.77	$20.91	$35.88
Min Plant	$10.71	$14.35	$16.78	$20.96
Max Plant	$14.26	$16.77	$20.86	$35.88
Average	$12.40	$15.52	$18.51	$25.72

Source: EUCG Data as of 2/5/2008

The EUCG data also looked at total generating costs for 2007 and for the period 2005-2007. Total generating costs factored in capital costs in addition to plant, support, fuel and other costs.

Figure 4 TOTAL OPERATING COSTS 3-YEAR AVERAGE — 2005–2007

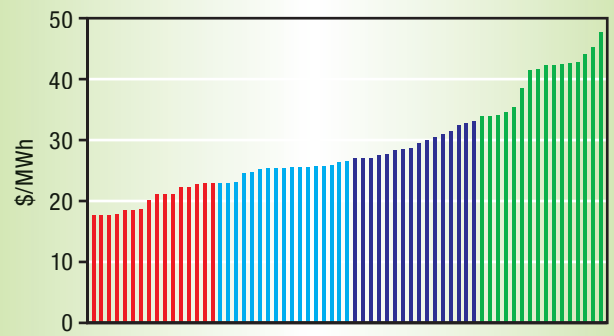


Value	$18.83	$21.03	$25.30	$38.44
Min Plant	$14.86	$18.84	$21.07	$25.38
Max Plant	$18.81	$21.03	$25.22	$38.44
Average	$16.62	$19.98	$22.96	$29.78

Source: EUCG Data as of 2/5/2008

During 2007, total generating costs ranged from $17.58/MWh to $47.67/MWh. First quartile plants had a total generating cost below $20.16/MWh. Those plants in the fourth quartile had a total generating cost higher than $40.17/MWh.

Figure 5 TOTAL GENERATING COSTS 2007



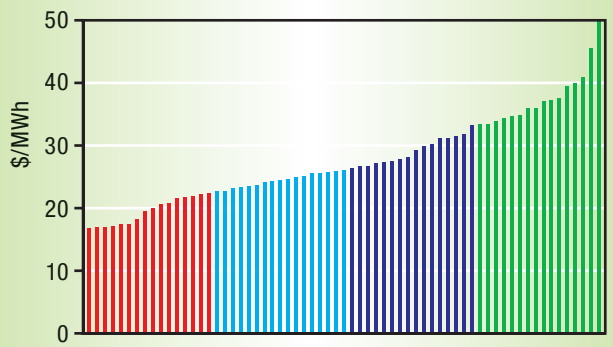
Value	$22.85	$26.47	$33.49	$47.67
Min Plant	$17.58	$22.87	$26.97	$33.88
Max Plant	$22.83	$26.47	$33.09	$47.67
Average	$20.16	$25.03	$29.51	$40.17

Source: EUCG Data as of 2/4/2008

Over the three-year period, total generating costs ranged from a low of $16.86/MWh to a high of $71.31/MWh. Those plants in the first quartile had total generating costs equal to or lower than $19.51/MWh. Fourth quartile plants had total generating costs equal to or above $39.11/MWh.

Many nuclear utilities from the United States and around the globe will meet in San Antonio in April and San Francisco this

Figure 6 TOTAL GENERATING COSTS 3-YEAR AVERAGE — 2005–2007



Value	$22.50	$26.11	$33.31	$71.31
Min Plant	$16.86	$22.65	$26.34	$33.37
Max Plant	$22.34	$26.11	$33.25	$71.31
Average	$19.51	$24.46	$29.12	$39.11

Source: EUCG Data as of 2/5/2008

September to discuss business issues, operating issues and various other aspects associated with managing nuclear power plants in the most safe, efficient, and effective manner. These three-day nuclear workshops are part of the EUCG semi-annual meetings and allow direct member interface. More information on EUCG and the EUCG Nuclear Committee can be obtained at the EUCG Web site, www.eucg.org.

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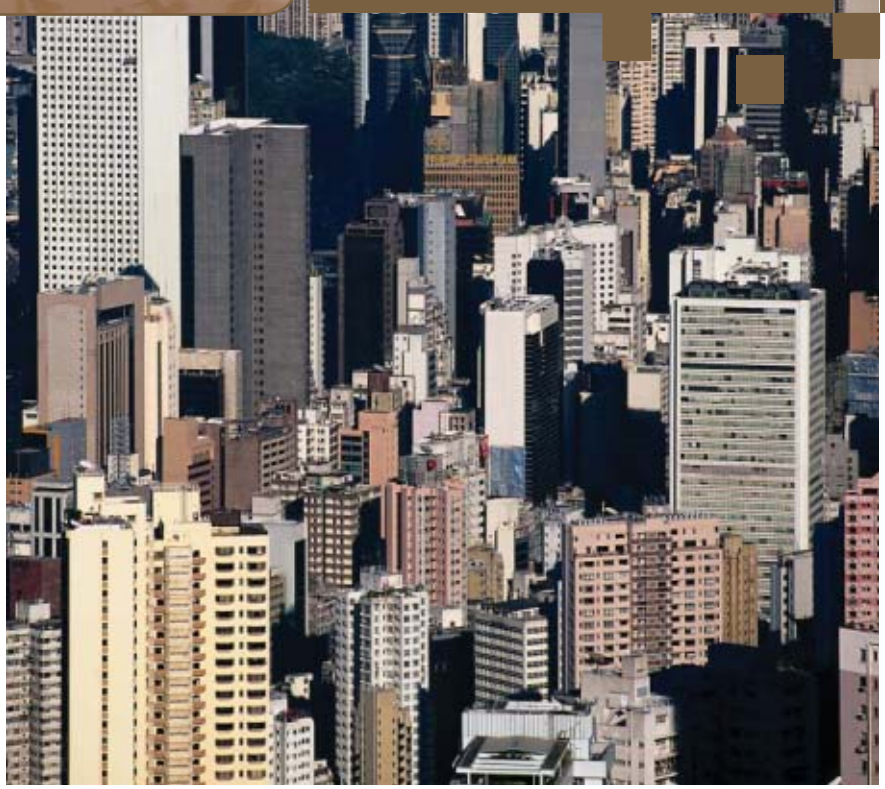

Global Prospects for Nuclear Power

By Ian Hore-Lacy, World Nuclear Association

Several issues frame the question of nuclear energy's revival. After two decades of sound but unspectacular performance in providing one sixth of the world's electricity, we have a coincidence of factors that bring nuclear power to the forefront of political and commercial agendas. In 2008 this is most striking in the United Kingdom.

The first factor is economic growth in many parts of the world and the prospect that those who have previously struggled along without much access to reliable electricity supplies—or any electricity at all—want what readers of this magazine are likely to take for granted.

Rapid growth in electricity demand in a few countries (including the giant of China, but also in India) is now hardly newsworthy, but the implications are huge. The International Energy Agency's *World Energy Outlook 2006* showed that to quench the world's thirst for energy, the Reference Scenario projections would require "a cumulative investment in energy-supply infrastructure of more than $20 trillion in real terms from 2005 to 2030—substantially more than was previously estimated, and half of it in developing countries.

Second, nuclear power is now a mature technology: the scientific and safety uncertainties of earlier years have been largely resolved, the engineering is now third-generation and many existing plants have been brought to a high level of operational efficiency. The costs of nuclear electricity are accordingly competitive in most countries.

Third is the fact that energy security has become a major concern in Europe and North America. The message that galvanized energy policy in France and Japan in the early 1970s can no longer be ignored in any major consumer nation. While oil was the main issue then, now it is natural gas. Most of us depend more than we care to acknowledge on supplies from Siberia, the Middle East and North Africa. Strategic reserves of gas are very hard to store in importing nations, but a few year's supply of uranium would be no problem.

Fourth is the allied question of the cost of fuel. One major disincentive to building nuclear plants is the capital cost. The cost of the raw uranium is minor. Geopolitical considerations are causing great uncertainty about the immediate (let alone the medium-term) price of gas, the capital investment challenge of nuclear power suddenly looks much more manageable. Building gas-fired generating capacity is relatively quick and cheap, but utilities and their customers are then hostages to fortune. After the hassle of financing and building a nuclear plant, it is then plain sailing.

Finally, is the threat of global warming. With increasing world political consensus that CO_2 emissions need to be constrained, and perhaps a 60 percent reduction to be achieved, zero-carbon power generation looks virtuous. In any case, and more tangibly, the likelihood of significant costs on CO_2 emissions is great, and that drives the economics strongly to nuclear and renewables. Building coal-fired plants, which have underwritten much of our western prosperity for decades, is now high-risk when each kilowatt-hour delivers another kilogram of CO_2.

It is hardly surprising then that the International Energy Agency in 2006 was more positive about nuclear power than ever before: "The *Outlook* demonstrates that nuclear power could make a major contribution to reducing dependence on imported gas and curbing CO_2 emissions in a cost-effective way."

So, what about the real or imagined disincentives to more nuclear reliance?

Is there enough uranium to fuel it?

Known economic resources of uranium are currently about 70 times annual usage, and that is simply a statement about knowledge, not geology. Known resource figures have grown over 40 years in line with cumulative exploration expenditure (and there has been little exploration for uranium in the past 20 years). On top of that, there is about 60 times more energy in the raw uranium than is captured with today's technology. This additional energy can be utilized with one well-proven but currently uneconomic technological step—the fast neutron reactor. Only Russia is now operating a commercial-scale reactor of this kind, but future plans internationally focus on such technology. So the industry could scarcely be more comfortable there.

Is it safe enough for people to accept more widely?

There has never been any major public harm from a Western-type reactor and, as with most technologies, plants and operations today have generally much enhanced safety margins compared with decades ago. This includes resistance to terrorism and certainly to adverse local effects arising from it. Nuclear power reactors are robust steel and concrete structures. Materials arising from nuclear power are intrinsically unattractive for "dirty bombs" compared with radioactive materials from other sources.

The nuclear industry has had only one accident causing public harm in more than 12,950 reactor-years of civil experience and that was of little relevance to any reactor licensable in the West. The United States' Three Mile Island accident in 1979 was the one most relevant for ongoing safety and much was learned and applied. Moreover, no one was harmed by it, due to the way the plant (and all plants in the West) was designed and constructed. The Chernobyl disaster in 1986 was largely irrelevant to any nuclear power plant outside the Soviet bloc, because its design was so far from being licensable elsewhere. It tragically underlined the reasons why such plants could never be built outside the former Soviet Union.

There has never been any major public harm from a Western-type reactor and, as with most technologies, plants and operations today have generally much enhanced safety margins compared with decades ago

What about the wastes?

Don't these present great unsolved problems? Waste management and disposal cost is internalized at about one-fortieth of generation cost, so it is met by electricity consumers. Technically, storage and disposal are straightforward and the radioactivity of high-level wastes diminishes to 0.1 percent of the original amount after about 40 years. There have been no significant problems from storage, handling and transport of civil nuclear wastes in the first 50 years of industry experience.

Decommissioning costs are normally met from a levy on current production and in most cases the amount of that has been found more than adequate as experience has caught up with projections. Political problems regarding geological disposal sites for wastes hamper the industry. It is good to see, however, that the United Kingdom—long the main delinquent among Western nations—is finally grappling seriously with this.

Will more nuclear power exacerbate today's problems with nuclear weapons proliferation?

Beyond the knee-jerk reaction, it is hard to see how. Civil nuclear power has not been the cause of or route to nuclear weapons in any country now possessing them, and no uranium traded for electricity production has ever been diverted for military use. There is no chance that the real problem of nuclear weapons proliferation will be solved by turning away from nuclear power or ceasing trade in the tens of thousands of tons needed for it. But further steps in line with non-proliferation treaty principles of international transparency, accountability and interdependence are needed.

It is also relevant to note and be thankful for the fact that a lot of military high-enriched uranium is today coming out of weapon stockpiles and is being used in civil power programs to generate electricity. Almost half of the uranium used in the United States is from Russian nuclear weapons. The first military plutonium is now being used similarly.

Nuclear power plants operate in 30 countries and produce 16 percent of the world's electricity (24 percent of electricity in Organization for Economic Cooperation and Development (OECD) member countries). More nuclear plants are being built or are about to be built in 15 countries. (See page 31) India and China plan to quadruple nuclear capacity by 2020 because it can effectively help meet their rapidly escalating electricity demand while improving air quality.

Among the 30 or more power reactors now being built, are advanced third-generation reactors. These have greater standardization, simpler engineering, expedited approvals in several countries, longer operating life and are one or two orders of magnitude safer than the well-proven second-generation units. While many of these depend on economies of scale and are around 1,500 MWe, others depend on economies of replication and factory construction and are 165 MWe to 200 MWe each.

Beyond these units under construction, about 80 more are planned and another 200 proposed, with some reasonable degree of plausibility. It is an exciting time for the industry. NPI

Standard Tool Allows Plants to Address INPO's Nuclear Safety Culture Expectations

By Teresa Hansen, Editor

The Institute of Nuclear Operations (INPO) is a well-respected guiding influence in the nuclear power industry. It was created by nuclear power plant owners to be a self-policing authority aimed at achieving excellence in reactor safety and performance. All operating nuclear power plants strive to receive the coveted INPO "Excellent" rating on their evaluations; therefore, when the organization released the Principles for a Strong Nuclear Safety Culture in late 2004, nuclear power plant owners took notice.

The United States-based Utilities Services Alliance Inc. (USA) responded to the INPO document and focused on ensuring its member plants operate in a "Strong Nuclear Safety Culture." USA developed the Nuclear Safety Culture Assessment (NSCA) process tool. The tool's purpose is to evaluate an organization's overall safety culture and provide an early warning of areas where that culture could be beginning to erode. The tool is a formal mechanism that judges plant personnel's behaviors to ensure they maintain the appropriate focus on nuclear safety.

USA is a "fleet" of individual nuclear power sites owned by different corporations that have joined together primarily to reduce operating and maintenance costs, help one another improve performance and provide industry leadership where appropriate. USA members are: American Electric Power's Cook Nuclear Plant (Michigan); Ameren's Callaway Station (Missouri), Arizona Public Service's Palo Verde Station (Arizona), Detroit Edison's Fermi 2 Nuclear Plant (Michigan); Energy Northwest's Columbia Generation Station (Washington State); Luminant's Comanche Peak Nuclear Plant (Texas); Nebraska Public Power District's Cooper Nuclear Station (Nebraska); Omaha Public Power District's Fort Calhoun Station (Nebraska); Pacific Gas & Electric's Diablo Canyon Station (California); PPL's Susquehanna Nuclear Plant (Pennsylvania); PSEG Nuclear's Salem and Hope Creek Stations (New Jersey); Southern California Edison's San Onofre Nuclear Generating Station (California); STP Nuclear Operating Co.'s South Texas Project (Texas); and Wolf Creek Nuclear Operating Co.'s Wolf Creek Generating Station (Kansas).

RATING	ATTR	PRINCIPLE 1 EVERYONE IS PERSONALLY RESPONSIBLE FOR NUCLEAR SAFETY
	P1a N10-2	Are the reporting relationships, lines of authourity and responsibility for nuclear safety sufficiently defined and communicated in your area?
	P1b N13-1 N13-2	Is there a vision/mission statement/policy or procedure that addresses nuclear safety? Where is that statement/policy located? What goals does that statement/policy specify?
	P1b N13-2	Is there a separate policy on nuclear safety culture? What do you think is most important aspect of this policy? Why?
	P1b N9-1 N9-5 N13-2	Is there a separate policy on safety conscious work environment (including but not limited to detecting and preventing retaliation)? How does management communicate these policies to the staff?
	1A N10-3	Do you have responsibilities for nuclear safety in your job? Please describe them. Are any of these responsiblities evaluated in your annual job performance reviews by your management?

INPO'S GUIDING PRINCIPLES

Problems related to nuclear safety culture have been primary contributors to plant level operational problems and in some cases have resulted in extended shutdowns. When a deep corrosion-caused hole was discovered in the reactor vessel head at First Energy's Davis Besse plant in Ohio, INPO took notice. Davis Besse was rated as an "Excellent" or "Good" facility for years and was highly regarded by the Nuclear Regulatory Commission (NRC). It had been regularly audited both internally and externally by INPO and the NRC,

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yet the plant still had a near-catastrophic safety system failure. This incident illustrated that more than plant operation, maintenance and engineering processes and performance needed to be evaluated to ensure an adequate safety culture. Even though the corrosion did not result in an accident at the plant, Davis Bessie was shut down for almost two years for repairs and additional inspections. The discovery also led to a nationwide review of all similar plants to ensure the same conditions were not present.

The NRC and INPO conducted many studies and reviews pertaining to the Davis Bessie discovery and the plant's operations and safety culture. The discovery prompted INPO to issue Significant Operating Experience Report (SOER) 02-4 Revision 1, "Reactor Pressure Vessel Head Degradation at Davis-Besse Nuclear Power Station," and ultimately mandate its Principles for a Strong Nuclear Safety Culture.

"INPO developed an expectation that plants assess their nuclear safety culture to make sure production priorities weren't overriding safety cultures," said Willis Frick, Nuclear Safety Concerns Program Manager at San Onofre Nuclear Generating Station and USA's NSCA Program Manager.

INPO defines safety culture as "an organization's values and behaviors—modeled by its leaders and internalized by its members—that serve to make nuclear safety the overriding priority." Its Principles for a Strong Nuclear Safety Culture describes "the essential attributes of a healthy nuclear safety culture, with the goal of creating a framework for open discussion and continuing evolution of safety culture throughout the commercial nuclear electric generating industry." The principles and associated attributes have a strong basis in plant events.

USA'S ASSESSMENT PROGRAM

In response to INPO's SOER 02-4 Revision 1, USA member plants collaborated to develop the USA NSCA. They formed a team to develop the self-assessment program. The team developed Phase I of the NSCA based on studies of the INPO documents related to Davis Bessie along with other INPO documents including SOER 02-4, as well as NRC issuances. The team determined that a true safety culture assessment must be more than just audits and inspections aimed at determining if processes and programs are in place and are being followed; the assessment also must look at the staff's attitude. Therefore, USA's safety assessment process looks for opinions, perceptions, thoughts and feelings. The process evaluates the health of each member plant's safety culture, identifies strengths and weaknesses and provides recommendations to plant management to improve or sustain this health.

The development tool for USA' NSCA Phase I is a self-assessment of the member plants' safety culture. It includes approximately 90 discrete behavioral attributes that should be present in a culture that has an appropriate focus on nuclear safety.

In Phase I, a team visited 10 of USA's 11 member plants, as well as other nonmember plants. The team members asked plant personnel from various departments (such as security, engineering and operations) a set of questions, said Rick Burnside, Employee Concerns Program Manager at Diablo Canyon Generating Station and USA's Assistant Program Manager. The team then used a systematic method to analyze the responses and draw a conclusion about each of the plants' safety culture.

When INPO decided that the need to conduct a Safety Culture Assessment to meet the requirements of SOER 02-4 Revision 1 Recommendation 2 would be a permanent, periodic requirement and the NRC revised the Reactor Oversight Process to include a strong recommendation to conduct Safety Culture Assessments periodically, USA decided it needed to continue and expand its NSCA program. Thus began Phase II. Phase II is currently being implemented by the USA member plants and several utilities have participated in an NSCA and are using the tool at their facilities.

Phase II changed the interview and observation questionnaire and scoring sheets to capture worker perceptions as they relate to the 71 principles and attributes provided in the INPO's Principles for a Strong Nuclear Safety Culture. Phase II also incorporates eight INPO principles:

1. Everyone is personally responsible for nuclear safety
2. Leaders demonstrate commitment to safety
3. Trust permeates the organization
4. Decision-making reflects safety first
5. Nuclear technology is recognized as special and unique
6. A questioning attitude is cultivated
7. Organizational learning is embraced
8. Nuclear safety undergoes constant examination.

The modifications resulted not only in a change to the interview and observation questions but also to the analysis method. The box on page 20 shows the questions asked of middle management, based on the first principle. Figure 1 on the next page is a bar graph that illustrates a plant's interview results based on all eight INPO principles.

The primary goal of the NSCA Phase II process is to assess the site's overall safety culture, increase management's awareness of its culture and leave each assessed site with a list of observations that the plant leadership team can use to improve performance.

In Phase II, the assessment team is made up of a mixture of personnel from USA member plants and from the plant being assessed. The individuals interviewed are from a cross-section of plant departments, such as security, engineering, operations and management. They are asked a series of questions that are the same among like groups, but vary somewhat between the different groups. In this way, engineers from, say, Fermi 2 are asked the same

questions as engineers from Cooper. Their questions, however, are slightly different than the operators' questions, Frick said.

The assessment process is the same at each plant. The assessment team is composed of independent and objective subject matter experts who evaluate organizational dynamics using a comprehensive set of attributes. Each assessment is intended to be an "outsider's" look at how the organization perceives nuclear safety.

The team conducts about 80 interviews from Monday through Thursday. For interviewing, the team is split into pairs (one team member from the plant and one from outside the plant). These pairs ask questions and then evaluate the answers. Each questioner assigns a plus, minus or neutral rating for each answer. These ratings are then analyzed by the entire team. Any attribute with a significant number of negative ratings is tagged for evaluation and discussion by the team, Burnside said.

Although the bulk of the information used to form an assessment comes from the interviews and an optional pre-assessment survey, data review and observations are also included in the process.

The optional survey is an electronic nuclear safety culture survey sent to approximately 10 percent to 20 percent of plant workers. Data from this survey help the assessment team understand which areas should receive additional focus during the site assessment interviews and observations. The survey data also help the team members understand interview responses and observations. Observations made by team members during the interview are included in the process, as are observations made during meetings or other events.

The data/documentation review includes pre-screening recent plant history and provides focus areas for the team during assessment week.

The information collected during the week's assessment is compiled and the team then develops preliminary results and recommendations, which it shares with management. The top issues needing attention are presented because they represent the areas where the plant will gain the most value.

The team leader and host peer provide a final assessment report approximately four weeks after the on-site assessment. The entire assessment team concurs with the final assessment report. The report is fully documented in accordance with the site's self-assessment process and is usually entered into the plant's corrective action program.

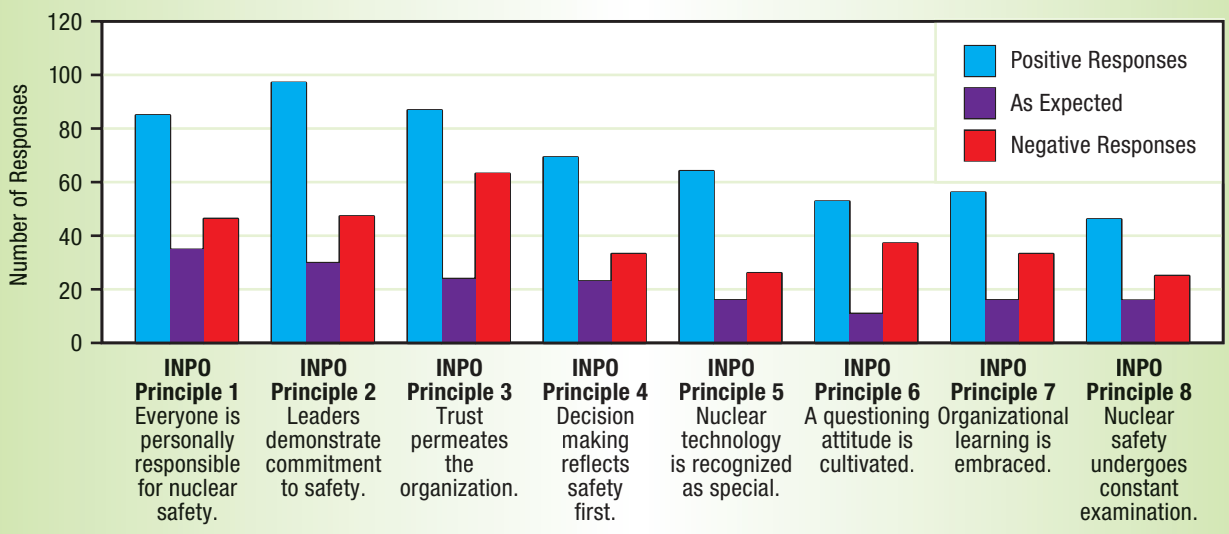
The final assessment report includes at a minimum:

- An overall assessment summary with a rollup scoring chart of INPO's eight principles
- Assessment results categorized by the eight principles
- Assessment methodology
- Assessment results by principle
- Follow-up of weaknesses from previous nuclear safety culture assessment
- Positive organizational traits noted during the assessment
- Summary of recommendations.

Individual plants may ask for the team to look at related matters such as industrial safety, but these issues are addressed separately.

[CONTINUED ON PG. 27]

Figure 1 **NUCLEAR SAFETY CULTURE ASSESSMENT**
INPO'S EIGHT ATTRIBUTES OF A STRONG NUCLEAR SAFETY CULTURE



NUCLEUS

Teresa Hansen, *Nuclear Power International* magazine's editor, speaks with Ron Pitts, senior vice president of Fluor's Nuclear Power business, about how Fluor is preparing for the STP project and some of the challenges the nuclear industry faces with regard to new plant build-outs.

New Build Challenges from an EPC Perspective

An EPC company executive voices his opinions about new plant build-out challenges

Fluor Corp., a global engineering, procurement, construction (EPC) and maintenance company, in August 2007 was awarded the EPC contract from Toshiba to support the construction of South Texas Project's (STP's) Units 3 and 4. Many in the nuclear power industry believe these units will be the first next generation nuclear plants built in the United States.

Teresa Hansen, *Nuclear Power International* magazine's editor, recently spoke with Ron Pitts, senior vice president of Fluor's Nuclear Power business, to discuss not only how Fluor is preparing for the STP project, but also to get his views on some of the challenges the nuclear industry faces with regard to new plant build-outs.

NPI: Why did Fluor decide to get back into the nuclear power business and what is the company doing to prepare for upcoming projects?

Pitts: The company never got out of the nuclear industry, but construction companies go where the construction projects are. After constructing or helping to construct 20 plants in the United States during the 1970s and 1980s, Fluor provided engineering, construction, operations and maintenance services to 90 U.S. nuclear plants.

As the new construction market went away, we shifted to the new nuclear decommissioning markets forming in the United States, the United Kingdom and Russia. During this time, we also designed and built dozens of non-reactor nuclear facilities for the U.S. government and won the contract to design and build United States Enrichment Corp.'s new uranium enrichment facility—work that is ongoing. Now we are focusing on the construction opportunities presented by the resurgence of new nuclear power plants being planned.

Beginning in 2006, Fluor studied the nuclear power new generation market to see if the much talked about "renaissance" was truly viable. I was one of several people appointed to perform the study. We talked to a lot of people and clients and in late 2006 concluded that global nuclear new-build did represent a potentially good market opportunity.

We officially formed Fluor's nuclear power group in January 2007 to focus on nuclear power new-build and construction opportunities. We were fortunate to be awarded the STP effort with our partner Toshiba about seven months later.

One of Fluor's first items of business was to regain our N-stamps from ASME for commercial nuclear power plant construction. We subsequently applied for and received:

- The N stamp, which allows Fluor to perform engineering work for nuclear power plants,
- The NA stamp, which allows Fluor to construct nuclear power plants,
- The NPT stamp, which allows Fluor to build components and sub-assemblies, and
- The NS stamp, which allows Fluor to install nuclear supports, such as pipe hangers.

NPI: Many people have said the EPC's role in new plant construction this time around will be much different than when the current fleet of nuclear plants was built. Do you think the role will be different, and if so, how?

Pitts: The entire engineering and construction process will be significantly different this time around in the United States, as well as globally. In the United States, the NRC has done an excellent job of improving the licensing process used in the past—the process whereby a construction license was issued long before the operating license. During the first construction phase, expensive design changes often occurred after the construction process began, resulting in large cost overruns and extended schedules, which threatened project completion.

Today, the NRC has streamlined the process with a combined operating and licensing application (COLA) process with a commitment to issue the construction and operation license within 42 months from the time it receives the application. Once it issues the COL, frequent and expensive design changes will most likely not be mandated by the NRC as happened in the previous cycle of new nuclear plants.

Also, right now, there will likely be five standard plant designs—GE-Hitachi's ESBWR, Westinghouse's AP1000, AREVA's EPR , Mitsubishi's APWR and the ABWR developed by Toshiba, GE and Hitachi. Each of these designs will likely be approved by the NRC, so each new licensee won't have to start from scratch when preparing the COLA.

While site specific items will have to be addressed at each site, much of the construction and operation will be the same from site to site. As long as the owners and EPCs adhere to the NRC-certified plant design, there should be fewer delays and cost overruns due to major design changes.

Another significant difference is that most new designs use modular construction, which can significantly shorten construction schedules and lessen on-site craft labor needs, versus the old "stick built" method of construction. Fluor has performed modular construction across many industries and we see modular construction of new nuclear reactors as a significant improvement over what happened in the 1970s and 1980s.

NPI: I've heard several owners say they expect the EPC to share in the risks on future projects. What are your thought on this?

Pitts: I don't believe any EPC will be willing to share huge amounts of risk associated with the nuclear island on the first plants. It isn't that EPCs are totally risk averse, but there are so many unknowns associated with the first plants that it is unlikely any EPC firm's board of directors and shareholders will agree to take on potentially several billion dollars worth of risk.

The biggest question with the nuclear island is labor. An EPC can price equipment and materials, but it is difficult to know today how much labor productivity can be obtained on the first nuclear islands, how quickly craftsmen can be trained to perform work to nuclear standards, how quickly craftsmen in the field will be able to construct the nuclear island, how many welds will pass inspection the first time, and how consistent the NRC inspectors are going to be in their requirements.

As more and more plants are built and the EPCs begin to better understand schedule, labor activities, productivity and such, then they may be willing to accept some more risk. But on the first plants, I do not think it will happen.

Also, I don't believe the financial market will require EPCs to put large amounts at risk on the first plants. I think that today utilities understand the uncertainties regarding labor availability, pricing and productivity that EPCs currently face in building $2 billion coal plants; they accept that owners must assume some of these risks and they are able to get these projects financed. These are not even first-of-a-kind plants as the first nuclear plants will be.

EPCs will likely, however, be willing to accept risk for certain systems and components on new plants. For example, EPCs are experienced in constructing intake structures, installing turbine islands, installing underground piping and performing earth work, and they may be willing to quote this type of work on a fixed-price basis.

NPI: Supply constraints for nuclear components are expected when new build-out begins. Do you believe the industry is prepared for this?

Pitts: The industry is somewhat prepared. No manufacturing facilities capable of forging major reactor components exist in the United States. All the large components initially will come from Japan and/or Korea. I am comfortable that the nuclear plant designers/OEMs will be able to supply these major components for the first wave, as they are already taking actions to reserve production of their components. If, however, new-build really takes off, I would hope and expect to see domestic capability be developed, as this could otherwise become a major pinch point.

I am more concerned about the supply of the smaller components such as pumps, valves and piping. Manufacturers of these items do exist in the United States. They have been supplying replacement and upgraded components to the country's existing 104 nuclear plants since the 1970s. Currently, however, these manufacturers could not produce the number of components that would be required once new build-out begins. These manufacturers will need to increase their manufacturing capabilities and new manufacturers will need to enter the market to supply the component quantities that will be needed.

For manufacturers to commit to supporting the nuclear industry, a sustained market for the manufactured components must exist. Some initiatives are underway to try to increase manufacturing. The Nuclear Energy Institute (NEI) is doing a lot in this area. For example, it is holding meetings with manufacturers in South Carolina, which has a large manufacturing sector. It will be discussing the market outlook, projections and timing, what codes and standards manufacturers will be required to adhere to, the regulatory environment and what it means to be a supplier, as well as what State organizations can do to help manufacturers get up-to-speed on the coming nuclear component demands.

Fluor is working closely with NEI and utilities on supply chain initiatives and we are also auditing and qualifying

existing manufacturers that currently supply nuclear components. However, there is still a lot of work to be done in the manufacturing area.

NPI: Like component supply constraint, a tight skilled workforce supply is also expected. Do you believe the industry is prepared for this?

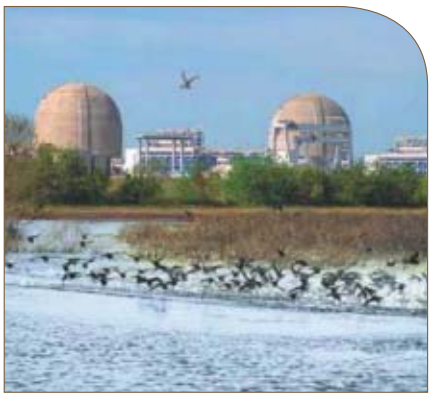
Pitts: No. There has been a lot of rhetoric and talk about the labor demand and short supply in the United States, but very little has really been done about it. Many people are simply talking and are not doing much about the skilled labor shortage. Currently, Fluor is seeking numerous skilled construction workers for our ongoing projects. In other words, we cannot hire skilled labor fast enough, although we are actively working to obtain, educate and retain skilled labor. The labor shortage—meaning the lack of qualified, skilled laborers—is real.

Fluor is already beginning to educate and train craftsmen for the STP project, many from the local area. We plan to train these individuals now so they can go to work on other jobs once they complete their training. Some may stay around the area in Texas, while others may find jobs in other parts of the country. Our hope and belief is that once construction begins on STP Units 3 and 4, these trained craft workers not only will have improved their skills through work experience, but will also want to return to south Texas to work on STP.

Wharton County Junior College in Bay City, Texas, is helping Fluor with this endeavor. The college renovated a large commercial building, turning it into a training facility. The college and Fluor will work together to recruit individuals and provide them with training in various crafts. These individuals will then be ready to enter the workforce as "sub-journeymen."

Fluor plans to hire many of these individuals; we have been working with Bechtel and they have also agreed to hire some, as have other companies in the area. Those who go to work for Fluor and Bechtel will have the opportunity to enhance their careers, as both companies offer additional training in the evenings for skilled craft employees.

We believe that many of the craft workers who come back to the area to work on construction of STP Units 3 and 4 will potentially have the opportunity to stay at STP and move into the maintenance workforce once the plant is operational.



South Texas Project Units 1 and 2.

NPI: Projected costs of new plants continue to escalate due to rising materials costs, labor costs, etc. What are your thoughts on this trend?

Pitts: The rising cost of construction materials is a concern. Steel prices are still escalating. Concrete has slowed a bit with the slowdown in housing construction, but it's likely to be on the rise again by 2010 to 2011, about the time we plan to start construction on STP Units 3 and 4.

These rising costs are not unique to the nuclear power industry, as all construction projects must deal with escalating materials costs. I'm afraid that material costs will probably continue to rise, but we simply do not have much control over it. This factor we cannot control is one of the primary reasons EPCs aren't willing to take on a lot of risk when it comes to new plant construction.

Labor is a little different. Labor costs spiked after Hurricane Katrina, but that spike was coming anyway, with or without Katrina. The labor shortage was already underway and wages were on the way up. We aren't likely to see 25 percent to 50 percent increases in craft wages as we've seen in the past few years, but wages probably will continue to increase moderately, more along the line of 4 percent to 6 percent a year—similar to other wage earners' increases.

While labor costs are a concern, Fluor and other EPCs have a better understanding and more control over them than we do commodity costs. Our labor strategy for STP is one of the ways we are trying to increase labor resources and control costs.

NPI: How do you see today's technology and tools improving the way new plants are constructed compared to those constructed during the 1970s and 1980s?

Pitts: Today's technology, especially the technology built around computer systems, has eliminated the need for the phenomenal amount of paper that used to be necessary during the first construction phase. For example, design drawings can now be printed right out of the CAD machines. All signoffs from QC and QA can be done on the computer, as soon as the inspections are complete. Bar coding now allows materials to be traced from the time they are ordered until they are installed in the plant.

All of this, plus many other processes streamlined by computer technology, will mitigate the need for huge paper vaults to house documents and drawings, as well as the personnel required to control those documents and drawings. Improved technology also significantly speeds up the time it takes to perform tasks. It increases productivity, effectiveness, efficiency and quality and should be a step change since the last fleet of nuclear

plants in the 1970s and 1980s.

In addition, integrated computer systems will allow information to flow from one system to another, helping to ensure that the most current information is available to procurement personnel, engineers, planning and scheduling personnel and others.

Heavier duty tools like automatic welding machines and computer-operated heavy equipment will also streamline processes and reduce construction time.

Modularization will have a big impact on construction and will be instrumental in helping STP meet its aggressive construction schedule. Different off-site fabrication shops, some as far as 500 miles away from the construction site, will be building modules; not just large component modules, but small modules. For example, valves complete with valve controllers, inlet and outlet piping and all electrical equipment can be assembled off-site.

GE used modularization to get its gas turbines in the field quickly and efficiently and that's what we intend to do with nuclear plant construction. Fluor expects these tools and processes to reduce the on-site workforce to about half of what it typically was during construction of the previous generation of nuclear plants.

NPI: You are currently working on what may be the first new nuclear reactors to be built in the United States in decades; what is next for Fluor's nuclear power business?

We are working hard on STP 3 & 4 with our partner Toshiba, owners NRG Energy and CPS Energy and with Sargent & Lundy, who is playing an important role supporting the project; STP will continue to be our primary focus.

Fluor is an EPC player across the globe though and we are currently observing a phenomenal expansion of interest and intentions to build new nuclear power plants across North and South America, Europe, Africa, Asia and the Middle East. One of the things we will be working hard on in the near future is preparing to be a major nuclear EPC player in many of these other global geographies.

Standard Tool Allows Plants to Address INPO's Nuclear Safety Culture Expectations

[CONTINUED FROM PG. 23]

To ensure consistency and a thorough evaluation from site to site, the NSCA team developed an assessment handbook. The handbook is a one-stop reference tool for preparing for an assessment and conducting the on-site review activities, as well as documenting the assessment findings. It contains pre-established guidance for performing the optional pre-assessment survey; conducting assessments, entrance and exits meetings; specific interview checklists covering various levels of management and disciplines; questionnaire scoring sheets; sample graphs of the score sheet input results; and the final report format.

COST SHARING AND OTHER BENEFITS

By collaborating on the NSCA tool's development, USA members were able to share costs and resources. The plants realized substantial savings by using a fleetwide approach versus each plant developing and implementing its own assessments.

The USA team members estimate the member resources used to develop the NSCA process tool was conservatively 36 weeks. This one time expenditure saved each participating plant the same amount of resource time, which equates to some 300 man-weeks of time saved for each of the 10 active members in the process. The USA membership reported a total savings of $831,000 in 2007 from the development of this process.

Another benefit of collaboration includes continuing improvements and objective evaluations. The product's quality improves continuously through use, feedback and experience. Senior management at all the participating plants agree that these assessments resulted in more objective, critical and meaningful results than those that would have been developed from assessments using only internal personnel.

USA has made the process tool available to other utilities. In addition to the USA member plants, NSCA-style assessments have been conducted at Ontario Power Generation's Pickering A, Pickering B and Darlington plants; at PSE&G's Salem/Hope Creek plant; Arizona Public Service Co.'s Palo Verde Station; Entergy's Grand Gulf plant; and the University of Missouri's Research Reactor. The assessment tool also has been shared with Entergy and Southern Co. In addition, USA has received inquiries from companies in Canada, Great Britain, South Africa, Spain and Slovakia.

Phase III improvements will be started in 2008. One action considered for Phase III is to further develop the tool related to the NRC's 13 nuclear safety culture components.

Editor's Note

In addition to Willis Frick and Rick Burnside (USA program leaders interviewed for this article) I would also like to thank Ed Peterson, Ombudsman at Wolf Creek Generating Station and an active member of the USA NSCA team for his input.

CASE STUDY

Pictured here is the standard Climax Portable Machine Tools BB5000 Boring Machine that was adapted to meet the maintenance project's machining requirements.

The original manway, pictured here, was not sealing properly.

Collaborative Machining Equals Success in Nuclear Plant Repair

By Jim Vandenberg, Babcock and Wilcox Nuclear Services

When service engineers face the common but difficult maintenance challenges necessary to extend the reactor life in nuclear power plants, precision is key. Equally important are partners who share the common goal of accuracy.

Babcock & Wilcox Canada Ltd. (B&W), a global developer and supplier of solutions for global building and repairing of power plants, recently sought a viable machining solution to support its maintenance program for a CANDU 6 nuclear power plant in Asia.

When the company examined the plant during a scheduled maintenance outage it found that the steam generator manway opening seals in an ASME Section III, Class 1 pressure boundary area needed repair. The port's inner cover gasket, which measured 355 mm by 456 mm, was not seating properly. In addition, the stud seals were not leak-tight, causing a pressure differential between the port's inner and outer covers. Integrity was at risk. The solution team at B&W needed to determine how to balance the geometry of the port and redesign the covers' gaskets.

In addition, the steam generator's hemispherical head was developed out of forged steel and the exact properties of the material were unknown. An earlier attempt by B&W to machine the opening with lathe technology was unsuccessful: The material proved more difficult to cut than originally expected and the feed rates of the cutting inserts could not withstand the tough material. Following its evaluation, B&W determined the job required a specialized machine to accomplish the task.

MACHINE DESIGN SPECIFICATIONS

B&W selected Climax Portable Machine Tools to help it engineer and perform the machining solutions. A team comprised of B&W engineers and project managers, and Climax engineering specialists developed a cutting repair solution to quickly and accurately machine the difficult material.

First, the team had to determine the project requirements. They knew the tool had to operate in a tight space and would need to withstand cutting tough material. Second, the solution had to perform a dry cut. Third, the tool needed to be rigid, accurate and quick to set up. Finally, with a tight 24-hour time allotment to complete the machining, the machine also needed to cut speedily.

The tool's mounting requirements were another consideration. The team needed one stationary bracket to mount the tool because it would be in a crowded area where the primary head of the generators was surrounded by process piping and system components. This made access difficult. In addition, to accommodate unforeseen machining adjustments on-site, the tool needed to include several interchangeable cutting heads.

A STANDARD MACHINE REDESIGN PROVIDES THE SOLUTION

Meeting all these machining requirements limited the engineers' tool options. After much assessment and analysis, the team decided to adapt Climax Portable Machine Tools' standard BB5000 Boring Machine. The tool's ability to program precise cutter movements provided the flexibility necessary to perform on-site cutting of material with unknown qualities. The machine also offered precise control of the spindle RPM, allowing feed rates and cutter movements to be fine-tuned by the operator at the repair area.

The boring machine incorporated

CASE STUDY

changeable tooling and cutting technology to provide accurate cuts and inserts. An adjustable mechanical stop and an incremental adjustment process were machined into the tool head and bit. The cutting head was automatically fed axially on a traveling bar using the standard axial feed screw with mechanical stops. The radial feed was manually adjustable using a tapered locking mechanism.

Through re-machining, the crew enlarged the manway opening from 492 mm to 592 mm in an obround shape, pictured here.

It also included a 108 mm-diameter x 1219 mm-long chromed bar, a rotational drive unit and an axial feed unit. In addition, the boring machine featured an electric drive motor, 115 volt 50/60 Hz, with two-speed gearboxes and a 115 volt remote control pendant with variable speed and stop start.

To meet the job's difficult attachment concerns, a special bearing mount was developed into a slide mechanism and attached to a modified version of the hydraulic chuck supplied by B&W. The modified chuck incorporated a slide, which held the bearing and allowed it to move from one side of the bore to the other. The chuck was mounted using stops and screws at either end of the slide. A passage bore cut into the chuck enabled the hydraulic line to connect and move to either side of the bore.

B&W engineers supplied Climax with a three-meter hydraulic hose with a quick connect for attaching to a hydraulic pump for activating the chucking system. A B&W manifold attached to the top of the slide mechanisms and the lines were routed away from the bar using hose brackets and looms to provide stability to the machine once it was mounted on-site.

A special standoff bracket supported the bar's other end and used the manway pivot block as the primary mount. The fixture was anchored against the wall of the steam generator and the plant's structural steel. Adjustable legs with jacking feet were expandable to secure the fixture in place. The team designed a slide mechanism into the standoff bracket for positioning the bar on both ends.

Once the new boring tool was completed, B&W's operational staff traveled to Climax Portable Machine Tools' Training Center in Newberg, Ore., for training on its capabilities. Machinists tested the boring tool by simulating the repair on a replica of the repair site. This testing and training process provided B&W with a level of confidence that the tool could complete the work to specification within the allotted time. Having the opportunity to learn how to use the machine before on-site work began also helped reduce any on-site guesswork by machinists.

APPROVAL CYCLES

Before deploying the tool, Climax proved the boring machine's capabilities to a validation committee comprised of B&W and nuclear plant personnel. The acceptance criteria were based on set-up times, cutting rates and reliability of operation over what was required at the site. This was deemed necessary to ensure that the equipment could complete the machining functions successfully, considering the uncertainties of the vessel material properties.

The final solution met expectations and passed a test plan before any work was completed.

THE REPAIR

On-site, B&W machinists mounted the customized boring bar to re-machine the outer seal of the existing port. The crew enlarged the opening from 492 mm to 592 mm in an obround shape to provide a footprint of the opening size for counter-boring. Machinists removed approximately three inches radially into the primary head of the material during this first machining step and five-eighths of an inch in the width.

The machinist's second step in the job was to counter-bore off a considerable amount of material to form an obround opening from a round opening. For the major shape to match the outer seal's opening, they completed cutting the opening from 193 mm to 211 mm.

Once the operators made the cuts, they completed the repair by using a B&W developed computer numerically controlled (CNC) machine to achieve the necessary gasket face location and size. This machine also accurately produced the desired smooth finish of the obround shape.

RESULTS

The final repair results met all of the plant mangers' expectations. Together, the teams exceeded the exacting cutting requirements and beat the time requirements.

By working together, B&W and Climax efficiently and collaboratively defined the requirements and customized the tool according to specifications including space and location criteria. Additionally, they shortened the development process and accounted for all potential problems during the machining process. As a result, Climax completed the machine from quote to finished job in 12 weeks—well within the targeted outage time.

Author

Jim Vandenberg is a senior project manager for Babcock & Wilcox Nuclear Services. He is responsible for international service work, primarily involving CANDU nuclear steam generators and critical heat exchangers.

PRODUCTS

Portable Laser Tracker

Leica Geosystems, a Hexagon company, has introduced a new laser tracker—the Leica Absolute Tracker, which is the company's most advanced portable metrology technology. It offers scaled-up features in a scaled-down, sleek housing for ultimate portability and ease of handling. The Leica Absolute Tracker's compact size, at only two feet tall and 48 lbs., enables the sensor and the stand to be safely operated and maneuvered by one person. It combines the strengths of both measurement principles of the absolute distance meter (ADM) and an interferometer (IFM). Its Absolute Interferometer (AIFM) technology ensures high-accuracy measurements in all operating conditions, with multiple built-in redundancies that guarantee accuracies throughout the measurement volume. The new Absolute Interferometer is 15 times faster than the previous model, with integration time down to 0.2 seconds. Another time-saving benefit of the Leica Absolute Tracker is its ultra-fast typical warm-up time of six minutes from a cold start, and only a three minute warm-up time from a warm start.

Lecia Geosystems
Info. http://powereng.hotims.com

Modeling and Optimization Software

VTT Technical Research Centre of Finland has released version 5.08 of APROS (Advanced Process

Simulation Software) that is widely used for process modeling and optimization of nuclear power plants. APROS version 5.08 brings several new features for the end-users, allowing the most difficult process failures to be simulated. APROS steam tables have been extended to the supercritical region of interest in the design of new and more efficient power plants. Provisions are made for calculation of typical Gen4 coolants such as helium, sodium, lead and salts. fuel It provides for elementary model building blocks, enabling the user to graphically specify more extensive process component models in detail. Elementary blocks for the calculation of heat accumulation and diffusion in structures cover both plate, cylindrical and spherical geometries. Model specifications can be written to ASCII-files using the model specification language of APROS and easily transported to new software versions, computer hardware or operation systems. The specification language enables interconnection of APROS to other design tools and especially to new semantic design databases of both processes and control systems. APROS simulation software is used in 20 countries. APROS is also used in training on how the processes operate.

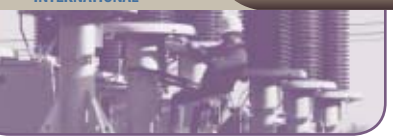
VTT Technical
Research Centre of Finland
Info. http://powereng.hotims.com

Floating Visual Inspection Tool

GE Hitachi has introduced a new addition to its Bridge-Free Tooling portfolio—the Floating Platform Visual Inspection Tool, also known as the "Lily Pad." This new technology offering boasts a floating platform to eliminate the use of the refueling bridge or work platform when performing steam dryer outer diameter inspections. This new offering reduces

radiation exposure to technicians performing visual inspections of the steam dryer from the refueling floor, as opposed to the bridge or work platform. The patented method by which the Lily Pad's robotic arm positions and manipulates the camera keeps the bridge free for parallel fuel moves during BWR 6 inspections. (Future configurations will allow use in BWR 3, 4, and 5 inspections.) The tool features a pan/tilt/zoom (PTZ) equipped color camera with 25X zoom capabilities and exceptionally high quality resolutions capable of Enhanced Visual Technique-1 (EVT-1) through Visual Technique-3 (VT-3) level exams.

GE-Hitachi
Info. http://powereng.hotims.com



DATA POINTS

Nuclear Power Across Europe

BRITAIN: Approved in January the construction of a new generation of nuclear power plants.

FRANCE: A world leader in nuclear power: 59 reactors provide more than 70 percent of the country's electricity. President Nicolas Sarkozy has campaigned for more countries to adopt nuclear power to combat global warming.

GERMANY: Chancellor Angela Merkel has agreed to abide by a previous government's decision to close all the country's 17 nuclear reactors by 2021.

THE NETHERLANDS: One nuclear plant still in operation. Was to have been shut down in 2013, but in 2006 the government won a fight to extend its life to 2033.

ITALY: Banned nuclear power after a 1987 referendum; the government opposes its reintroduction.

SPAIN: Has six nuclear power plants, but there is a 23-year-old moratorium on building new ones.

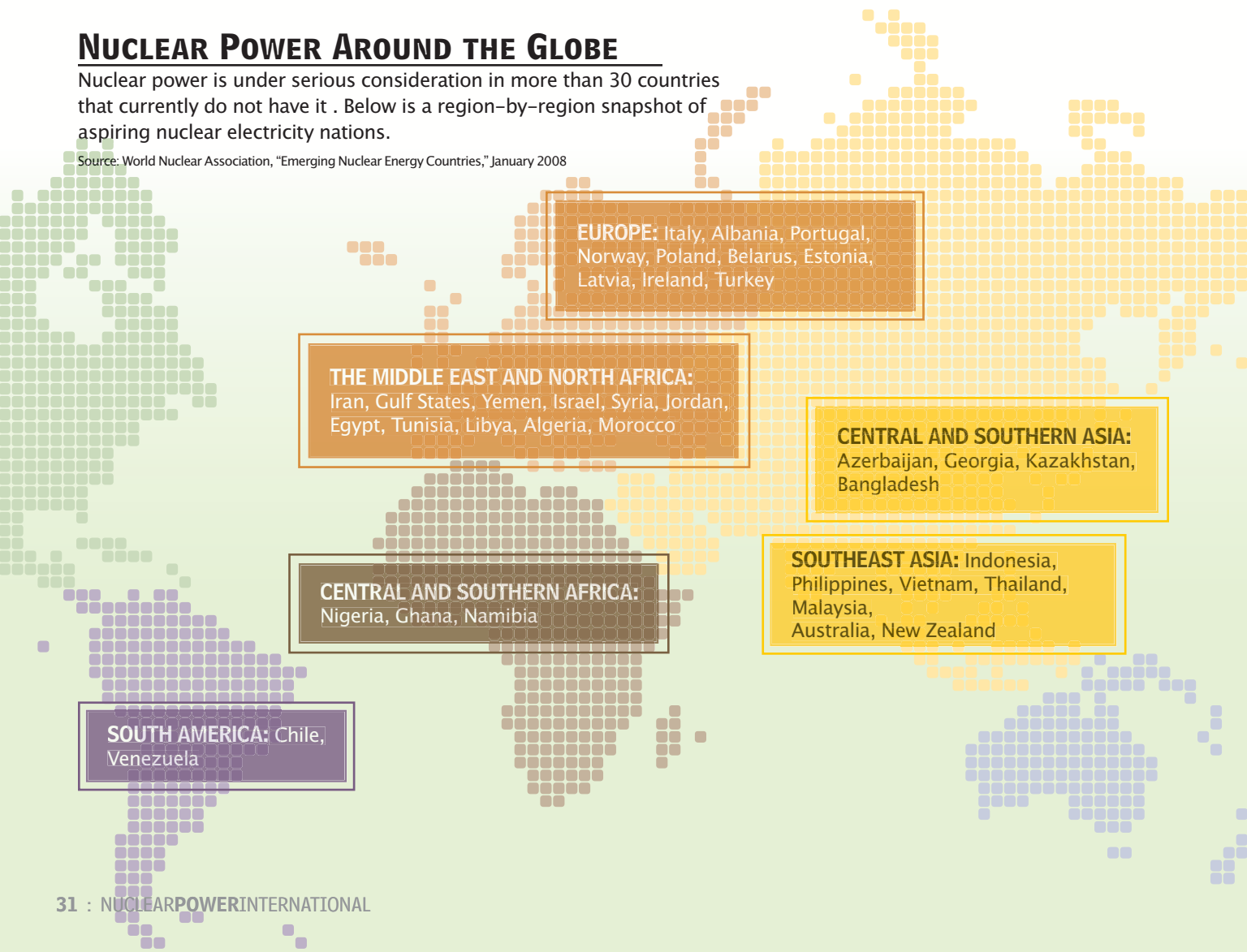
SWEDEN: Decided in 1997 to phase out nuclear power, which accounts for about half of electricity production. So far two of the country's 12 reactors have been closed and the country is struggling to find alternatives.

FINLAND: Four nuclear reactors provide about one-quarter of the country's electricity; currently constructing a fifth.

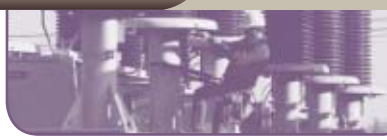
Nuclear Power Around the Globe

Nuclear power is under serious consideration in more than 30 countries that currently do not have it . Below is a region-by-region snapshot of aspiring nuclear electricity nations.

Source: World Nuclear Association, "Emerging Nuclear Energy Countries," January 2008



DATA POINTS



	NUCLEAR ELECTRICITY GENERATION 2006		REACTORS OPERABLE January 2008		REACTORS UNDER CONSTRUCTION January 2008		REACTORS PLANNED January 2008		REACTORS PROPOSED January 2008		URANIUM REQUIRED 2008
	billion kWh	% e	No.	MWe	No.	MWe	No.	MWe	No.	MWe	tonnes U
Argentina	7.2	6.9	2	935	1	692	1	740	1	740	123
Armenia	2.4	42	1	376	0	0	0	0	1	1000	51
Bangladesh	0	0	0	0	0	0	0	0	2	2000	0
Belarus	0	0	0	0	0	0	2	2000	0	0	0
Belgium	44.3	54	7	5728	0	0	0	0	0	0	1011
Brazil	13	3.3	2	1901	0	0	1	1245	4	4000	303
Bulgaria	18.1	44	2	1906	0	0	2	1900	0	0	261
Canada*	92.4	16	18	12652	2	1540	4	4000	2	2200	1665
China	51.8	1.9	11	8587	5	4540	30	32000	86	68000	1396
Czech Republic	24.5	31	6	3472	0	0	0	0	2	1900	619
Egypt	0	0	0	0	0	0	0	0	1	1000	0
Finland	22	28	4	2696	1	1600	0	0	1	1000	1051
France	428.7	78	59	63473	1	1630	0	0	1	1600	10527
Germany	158.7	32	17	20339	0	0	0	0	0	0	3332
Hungary	12.5	38	4	1826	0	0	0	0	2	2000	271
India	15.6	2.6	17	3779	6	2976	10	8560	9	4800	978
Indonesia	0	0	0	0	0	0	2	2000	0	0	0
Iran	0	0	0	0	1	915	2	1900	1	300	143
Israel	0	0	0	0	0	0	0	0	1	1200	0
Japan	291.5	30	55	47577	2	2285	11	14945	1	1100	7569
Kazakhstan	0	0	0	0	0	0	0	0	1	300	0
Korea DPR (North)	0	0	0	0	0	0	1	950	0	0	0
Korea RO (South)	141.2	39	20	17533	2	2000	6	7600	0	0	3109
Lithuania	8	69	1	1185	0	0	0	0	2	3200	225
Mexico	10.4	4.9	2	1310	0	0	0	0	2	2000	246
Netherlands	3.3	3.5	1	485	0	0	0	0	0	0	98
Pakistan	2.6	2.7	2	400	1	300	2	600	2	2000	65
Romania	5.2	9	2	1310	0	0	2	1310	1	655	174
Russia	144.3	16	31	21743	7	4920	8	9600	20	18200	3365
Slovakia	16.6	57	5	2064	2	840	0	0	0	0	313
Slovenia	5.3	40	1	696	0	0	0	0	1	1000	141
South Africa	10.1	4.4	2	1842	0	0	1	165	24	4000	303
Spain	57.4	20	8	7442	0	0	0	0	0	0	1398
Sweden	65.1	48	10	9086	0	0	0	0	0	0	1418
Switzerland	26.4	37	5	3220	0	0	0	0	1	1000	537
Thailand	0	0	0	0	0	0	0	0	4	4000	0
Turkey	0	0	0	0	0	0	0	0	3	4500	0
Ukraine	84.8	48	15	13168	0	0	2	1900	20	27000	1974
United Kingdom	69.2	18	19	11035	0	0	0	0	0	0	2199
USA	787.2	19	104	99049	0	0	7	10180	25	32000	18918
Vietnam	0	0	0	0	0	0	0	0	2	2000	0
WORLD**	2658	16	439	372,059	34	27,798	93		222	193,095	64,615
	billion kWh	% e	No.	MWe	No.	MWe	No.	MWe	No.	MWe	tonnes U
	NUCLEAR ELECTRICITY GENERATION 2006		REACTORS OPERABLE January 2008		REACTORS UNDER CONSTRUCTION		REACTORS PLANNED January 2008		REACTORS PROPOSED January 2008		URANIUM REQUIRED

Sources:
Reactor data: World Nuclear Association (WNA) to 1/14/08.
IAEA- for nuclear electricity production & percentage of electricity (% e) 5/07.
WNA: Global Nuclear Fuel Market (reference scenario) - for U.
Operating = Connected to the grid;
Building/Construction = first concrete for reactor poured, or major refurbishment under way;
Planned = Approvals, funding or major commitment in place, mostly expected in operation within 8 years, or construction well advanced but suspended indefinitely;
Proposed = clear intention or proposal but still without firm commitment. Planned and Proposed are generally gross MWe;
TWh = Terawatt-hours (billion kilowatt-hours), MWe = Megawatt net (electrical as distinct from thermal), kWh = kilowatt-hour.
64,615 tU = 76,200 t U3O8
* In Canada, 'construction' figure is 2 laid-up Bruce A reactors.
** The world total includes 6 reactors operating on Taiwan with a combined capacity of 4884 MWe, which generated a total of 38.3 billion kWh in 2006 (accounting for 20% of Taiwan's total electricity generation). Taiwan has two reactors under construction with a combined capacity of 2600 MWe.