

COGNIZANT

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The operator

Bruce Power's Mike Rencheck
isn't going it alone

The supplier: BWXT Canada gathers steam
The board: COG directors on CANDU's promise



A message from CANDU Owners Group President Fred Dermarkar

Purpose and Promise

There is a buzz like active worker bees in a productive hive across the CANDU industry today. Between continued operation and extended life at some plants; refurbishment and life extension projects in full swing at others; and more than \$65 million in shared research at COG, a new collaboration culture is helping CANDU plants get closer to their own nuclear promise.

In this issue of COGnizant we took the pulse of the nuclear industry as seen through the eyes of a CANDU operator, a supplier and the four COG board directors. We found it beating hard.

Mike Rencheck joined Bruce Power as its president last summer and since then he has made the rounds with different organizations, including member and supplier participants at the COG December General Business Meeting.

The Purpose

When people talk about the nuclear industry, they often refer to the sense of community and common purpose that ties us together regardless of whether we are operating in Canada, Latin America, Asia or Europe. Our common commitment to safety, and our belief in nuclear power as a way to power people's lives through clean, reliable electricity, is a bond.

Mike knows a lot about the nuclear community. He's spent his entire career in it, as an operator and as a supplier. He understands the symbiotic roles both must play for us to succeed together.

He's been quick to walk the talk, building partnerships with Ontario Power Generation's (OPG) CEO Jeff Lyash and with the supplier community, which he says will be essential to the success of the Bruce Power major component replacement project and life extension. And, he is just as determined to build a strong support network in Bruce County to sustain the necessary infrastructure for decades of operation to come.

John MacQuarrie has spent his career on the supplier end, mostly with BWXT Canada Ltd. and its predecessor Babcock & Wilcox. Since he took over as president in 2013, he has helped evolve the role of suppliers in the industry. John has been a strong leader within COG and particularly in his support of the supplier participant program as a means to build the knowledge suppliers will need to fully support the Darlington and Bruce Power mid-life projects and continued operations. In the fall, COG members took a tour of the BWXT Cambridge plant and in COGnizant we talk with John about the role of BWXT and the supplier community in nuclear excellence.

At COG, we have always been fortunate to have incredible technical leaders serve on our board. With the retirement of OPG's Paul Spekkens and that of Canadian Nuclear Laboratories' (CNL) Bill Pilkington, COG is fortunate to have OPG's Steve Woods and CNL's David Cox come on board. Equally, we welcome the experience

and knowledge that comes to the board chair in Bruce Power's Gary Newman. Rounding out this team is long-time COG board member Paul Thompson whose deep industry knowledge is welcomed in all quarters thanks to his equally collegial demeanor. In this issue we asked the board to take stock of the industry today. What they had to say reflects an industry that is maturing in its understanding of the role technology can play and the role that can only be served by good people.

The Promise

As you go through these stories, what might strike you, as struck me, is the frenetic level of activity in the industry. United States operators are looking to find new economies and efficiencies through the *nuclear promise*. The CANDU community is looking for lessons from the US experience to apply here. Currently, the potential for innovation in operations, digital technology, obsolescence management, life extension and enhanced human performance, among others, combined with the nuclear projects at Darlington and Bruce, seems to have CANDU industry activity at an all-time high in Canada.

And it's not alone. In Argentina they are currently celebrating a significant refurbishment milestone with a series of calandria tube removals in record speed – 30 CTs in a 24-hour period, 16 of which were removed in 12 hours. The World Association of Nuclear Operators (WANO) recently recognized SNN-Romania for performance excellence. And COG's C6 Fleet Steering Committee is creating new ways to improve obsolescence management and achieve economies of scale – lessons that are sure to be useful to all COG members.

COG is a reflection of the industry it serves. Annually, COG does more than \$65 million in joint projects and R&D. According to the European Commission Joint Research Centre's annual global ranking, this is equal to the R&D investment of a Top 15 Canadian private company. Together, through COG, we are punching above our band weight. I was pleased to report this in November when I appeared before the Canadian House of Commons Standing Committee on Natural Resources.

COG's vision is excellence through collaboration and in this issue there are plenty of examples of it. As Paul Thompson says, "This is a really exciting time again."



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Photo courtesy of BWXT Canada Ltd.

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For more information, visit us at CANDU.org

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CANDU Owners Group

at the Standing Committee for the Future of Canada's Oil and Gas, Mining and Nuclear Sectors: Innovation, Sustainable Solutions and Economic Opportunities

What he said:

Highlights from Fred Dermarkar's testimony to the Standing Committee speaking about COG and the CANDU Industry

On Nov. 29, 2016, CANDU Owners Group President Fred Dermarkar spoke to the Standing Committee on Natural Resources as part of the federal committee's study on the Future of Canada's oil, gas, mining and nuclear sectors.

In 2016, the committee heard from 133 witnesses including several leaders from Canada's nuclear industry. Since that date, the committee has released two reports: one on the state of oil and gas and another on the state of mining.

[Click here](#) to access recordings of all witnesses, briefing notes and reports released to date.

[Click here](#) to read a transcript of Dermarkar's remarks.

“COG's activities result in an investment of more than \$65-million annually in research and development. According to the European Commission -- Joint Research Centre's -- annual global ranking, this is equal to the R&D investment of a Top 15 Canadian private company.”

Research and Innovation

Research to validate **SAFETY MARGINS** on operating equipment improves safety and increases revenue reducing the cost of electricity on a per megawatt basis for consumers

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ONE OF THE MOST COMPREHENSIVE AND CONSISTENT **POST-FUKUSHIMA RESPONSES** WORLDWIDE ENSURES CANDU STATIONS CAN RESPOND TO EVEN HIGHLY-IMPROBABLE EVENTS.

Achieving excellence through collaboration

More than **14-million** Canadians in Ontario and New Brunswick get much of their power from CANDU stations

1984 COG is formed by the Canadian nuclear operators, operating plants with the made-in-Canada CANDU technology. Two years later, international members join creating strength in numbers and diversity.

97.3% Pickering Unit 4

Capability factor in 2015 of the 46-year old unit in part thanks to collaborative research through COG. Bruce Power's 40-year old refurbished Units 2 and 4 reactors sustained a 99.5 and an 88.4 capability the same year.

OPG's DARLINGTON REFURBISHMENT UPDATE

Milestone 1, removal of fuel from the Unit 2 reactor core, was completed safely and ahead of schedule, January 11, through operator and supplier partnership

The first major milestone of Canada's largest clean energy project has been safely completed almost one month earlier than anticipated with the safe removal of fuel from the reactor core on Unit 2.

The Darlington refurbishment project began on Oct. 15, 2016 when Unit 2 was disconnected from Ontario's power grid. Over 87 days, 6,240 fuel bundles were removed from 480 fuel channels and safely discharged and stored. This was done safely and with quality ensuring the highest standards of nuclear safety.

This success was a direct result of years of detailed planning and preparation, and the dedication of employees and project partners such as BWXT Nuclear Energy Canada (formerly GE-Hitachi) putting safety and quality first. BWXT's work included engineering and manufacturing components used in defuelling, as well as software changes.



Workers, like the one above, practise their skills at Darlington's training centre before undertaking the same activities in the reactor building. In addition to the defuel milestone, the project team has also completed other activities including the bulk drain of the Primary Heat Transport System and installation of the mechanical portion of the breathing air system enhancements.

The next phase of the project will be to "island" the reactor, which will involve isolating the defuelled Unit 2 from the three operating units by installing physical safety barriers.

~ Story files and photo provided by Ontario Power Generation

To learn more, visit the OPG Darlington Refurbishment website

<http://www.opg.com/generating-power/nuclear/stations/darlington-nuclear/darlington-refurbishment/Pages/default.aspx>

To read about BWXT's project involvement, go to

http://www.opg.com/news-and-media/our-stories/Documents/20170112_BWXTDarlingtonDefuel.pdf

New handbook provides a guide for irradiated fuel bay tool inspection

REPORT FROM THE FIELD with **GORDON RIFE**
COG project manager

The presence of fuel defects, both as small excursions and more persistent issues, have previously hampered operations, maintenance, and engineering activities. Fuel inspection equipment is required to be responsive to these changing conditions as well as routine inspection needs. However, fuel inspection can be hampered by ageing equipment in the Irradiated Fuel Bay (IFB), erosion of knowledge, inadequate procedures, and configuration management challenges.

There is consensus among utilities that there is a need for standardization of fuel in-bay inspection equipment to bring all fuel bays to a similar level of capability in terms of quality of inspection. The normalization of the way observations are photographed, recorded, and disseminated would allow nuclear stations to share expertise more easily.

In October 2015, Stern Laboratories asked the CANDU Owners Group (COG) to review the need for improved support to utilities on Irradiated Fuel Bay (IFB) / Secondary Fuel Bay (SFB) fuel inspection tooling, practices, and procedures. The COG Fuel Handling Managers Peer Group (FHMG) indicated support for development of an IFB/SFB Inspection Tooling Handbook to address the erosion of experienced resources as well as inconsistent processes and procedures across the CANDU fleet.

A project to create a pocket-sized handbook was initiated in late 2015 and has been in an active status since the spring of 2016. Through the summer of 2016 the handbook was assembled and has been reviewed by experienced industry experts. COG used existing COG and utility documents to construct the guide, which can be used by field personnel as both a training aid and a handy reference. The previously written documents were used with the approval of the utilities involved in the original development. It is now in a final draft form awaiting approval by the Fuel Handling Peer Group, the champions behind the project.

The objectives of the Irradiated Fuel Bay (IFB) / Secondary Fuel Bay (SFB) Inspection Tooling Handbook are to:

- Provide baseline information, requisite knowledge and good practices on fuel inspection tooling and fuel inspection,
- Provide a design basis package for CANDU fuel inspection



Figure 3: Close-up of finger tool on bundle showing latching device.



Figure 4: Latching fingers.

The Inspection Tooling IRB Handbook has a number of illustrations such as the one above, as well as detailed instructions inside the pocket-sized guide.

tooling against which utilities can initiate procurement or improvement initiatives, and

- Provide field staff with a generic tool for easy portability and use in the field.

Seven utilities and two suppliers have shown interest or joined the project. Inquiries from others are welcome. Contact Gordon Rife at gordon.rife@candu.org.

The irradiated fuel bay challenge

The Irradiated Fuel Bays are a hostile environment for equipment. High radiation levels at the bottom of the bays mean that much thought is required when designing fuel inspection equipment.

Equipment that is exposed to this environment must not be comprised of any plastics, electronics, or parts requiring grease. Glass lenses tend to darken over time in this environment, introducing challenges with respect to the viewing of equipment and the fuel. Lighting conditions can be poor at the bottom of the bay. Prolonged exposure to such high radiation fields also makes maintenance of such equipment problematic, as once the equipment is placed at the bottom of the bay it ought to preferably remain there.

Remote maintenance from above, although possible, is very difficult. In cases where materials must be removed from the bays, station guidelines with respect to radiation control enforce strict controls with respect to contamination spread, and the implementation of rubber areas is required. Humidity and temperature also have adverse effects on equipment. These characteristics can also make the bays a challenging environment for working personnel, especially given the personal protective equipment requirements.

The solution

A regular fuel inspection program is required to confirm the condition of spent fuel, provide an indication of potential issues in fuel channels or the heat transport system, and to assess the condition of the fuel following an unplanned event. The inspections provide information on the condition of the bundles during in-core service, which lends itself to several purposes:

- Confirmation that fuel operating conditions are within the design limits.
- Provision of indirect information on the condition of the heat transport system, fuel channels, and fuel handling system.
- Provision of a statistical measure of the condition of fuel in the core to verify that it is within the range assumed by safety analysis at the start of an accident.
- Provision of information to support incident investigations.
- Provision of information to determine the root cause of fuel defects.
- Provision of input for fuel channel selection for pressure tube inspections.

With the Inspection Tooling Handbook, IFB handlers will have an additional tool to maximize efficiency of fuel systems.

Building the Village



Photo courtesy: Bruce Power



The starting gun has sounded on two massive infrastructure projects, more than a decade long each. There are overlapping timetables and resources needed on an unprecedented scale.

To succeed will require an era of collaboration beyond anything that has come before. There is challenge but also opportunity. Great opportunity.

“All we have to do is execute,”
says Bruce Power’s president and CEO Mike Rencheck.

Spotlight on operators: Mike Rencheck, President and CEO, Bruce Power

Last summer, when Bruce Power's new president and CEO arrived in Bruce County, he came with life experience likely to resonate with his team and neighbours.

The son of a steel worker from a small town just outside of Pittsburgh, Mike Rencheck saw the community of his youth devastated by steel plant closures much in the same way Bruce County was affected by the nuclear unit shutdowns in the 1990s before Bruce Power literally gave the region a new lease on life.

It's the kind of history that serves as shorthand between those who share it. It may also explain Rencheck's commitment to organizations like Habitat for Humanity and the United Way, which are committed to helping build communities and lifting people out of challenging circumstances.

An innate understanding of the linkage between sustainability of a business and its community is likely a driving factor in Rencheck's determination to not just run and extend the life of a nuclear plant during his time at Bruce Power but also to grow and strengthen the infrastructure of the region surrounding it.

In December, at a CANDU Owners Group (COG) General Business Meeting, Rencheck talked about that symbiotic relationship. And he outlined his vision to put the infrastructure in place that will sustain Bruce Power decades after he passes the baton to the next generation of workers.

"We have to do some work in rebuilding the community and economic development in the area," he told the GBM audience of international leaders from operators, suppliers and industry associations across the CANDU industry.

"When the plants were deemed to be shutdown years ago, much of the infrastructure collapsed. That affects the hospital systems, the school systems and that affects the services. The only way we're going to have sustainability is if we can rebuild the infrastructure so all these young folks will have schools and proper healthcare."

The life extension deal between the Province and Bruce Power could see the plant operate until 2064. The extension work plan includes equipment optimization including work with COG on fuel channel life extension. It also includes a hefty amount of asset-management sustaining capital work, which began in January 2016 with \$400 million of investment last year. That investment will be repeated each year over the next three years leading into the Major Component Replacement (MCR) project starting in 2020.

"After one year we're on time, on budget. We need to build a track record going into our MCR, which is the third piece," says Rencheck. "We have a lot of work going on. Doing those things on time and on budget keep that deal intact."

Other work currently being done includes detailed schedule and cost estimates for each phase.

"We have to demonstrate both at Darlington and at Bruce that we can do these and do these well; and to establish a track record at both such that they (the IESO) have no reason to say 'no'. If we do all of that well, we'll be sitting in this room some years from now talking about new nuclear."

Resilience through community

When one considers that the life extension work doesn't really end until into the mid-2050s, it becomes apparent why sustainability is high on Rencheck's priority list. Unlike his predecessors though, his business model does not afford him the luxury to do it alone.

Today's nuclear industry runs on a different business model from the one that existed when the Bruce County site was developed. The early model of "Mother Hydro" as sole provider -- and beneficiary -- of the work no longer exists. In its place is a community of stakeholders including suppliers and unions, all with a vested interest in the plant's success.

This shift is reflected in the changing composition of COG as well. COG was formed in 1984 as a not-for-profit vehicle for collaboration on research and development, joint projects and sharing of operating experience amongst CANDU operators.

Today, with almost 20 supplier participants, it has ramped up its information sharing and training programs for suppliers working on the Ontario Power Generation (OPG) Darlington refurbishment and Bruce's life extension. The group also collaborates on other supply chain-related issues like prevention of counterfeit parts and obsolescence management in supply chain. One of the program's greatest strengths is the interaction between suppliers

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Since joining Bruce Power in 2016, Mike Rencheck has been connecting with stakeholders across the province. He's met with elected officials such as Parliamentary Secretary to the Minister of Natural Resources Kim Rudd (above), employees at town halls at both OPG and Bruce Power (cover page bottom) as well as organizations like CANDU Owners Group (cover top right), where he attended the December 2016 General Business Meeting.

Photo courtesy: Bruce Power

and operators say its champions, and there are many.

COG also has a partnership agreement in place with the Organization of Canadian Nuclear Industries (OCNI), which represents industry suppliers. With the change in the industry's business model and the significant project work now underway, OCNI has seen its membership balloon in recent years, reaching a historical high of 215 members at the end of 2016, most of them based across Ontario.

Together, suppliers hold contracts worth billions of dollars for work to be done over the next two decades at both the Bruce site and on the Darlington refurbishment. And there are many more contracts yet to be signed. The shift at COG and OCNI is a direct reflection of industry change.

Suppliers are stepping up to partner on the work ramping up for the life extension project. Rencheck wants that partnership to extend to sustaining the community infrastructure that in turn sustains the plant. He is eager to see suppliers be a presence in the community surrounding the plant and to build relationships that will anchor the new collaboration model.

"We can't do this by ourselves," he says. "We're offering a business proposition for suppliers: Come into the community collaborate with us, work with us; together we're going to be successful and we're going to be around for a long, long time."

The age of collaboration

Community is not defined by geography alone. The same sense of common purpose Rencheck is working to achieve in Bruce County is also being applied across the CANDU industry.

Anyone who even casually observes the Ontario nuclear industry will not have missed the shift in the relationship between Bruce Power and OPG to one striving for seamless collaboration.

A 40-page publication entitled "Working together to deliver the future of nuclear in Ontario: An interim report on collaboration to extend Ontario's nuclear fleet" published in November 2016 re-enforced the strength of the collaboration commitment between the two companies.

Rencheck had a pre-existing and friendly working relationship with OPG's president and CEO Jeff Lyash, who took the reins

**"This is in my hands;
this is in your hands."**

from Tom Mitchell, a year before Rencheck took over from his own predecessor, Duncan Hawthorne.

Related: [Jeff Lyash \(article title and link COGNizant 2016\)](#)

As Ontario enters into its largest and longest nuclear project era, Rencheck credits the extensive efforts of Mitchell and Hawthorne to get the projects to the hand-off point.

At Darlington, similar preparation work to that happening at the Bruce now, took place over several years leading up to Darlington's current Unit 2 execution project now underway. At Bruce, Hawthorne oversaw the refurbishment of two A-side reactors. OPG's Pickering station played a role too as the subject plant for much of the life extension research that occurred in the past decade.

In addition to their work on the projects, Rencheck credits the two leaders for work to rebuild social licence for the Ontario nuclear industry and specifically, to regain public and government confidence after the industry's challenges of the late 1990s and early 2000s.

Today though, as the game has advanced, there is a new, more urgent requirement for choreography of resources and people between the two companies, requiring a new level of synchronicity.

"The sheer volume of what we're trying to do; if we try to do it the way we used to, we're going to overwhelm the system. We

"We're running nuclear reactors, right? We're splitting atoms. It's not every day the neighbour next door gets to split atoms in their basement. It's not something that's usual in the community. So with that we have to have the competence."

have to collaborate and be clear on what it is we're trying to accomplish, what are the things we want to do and also collaborate with the suppliers and the unions on how we're going to go about doing these items," said Rencheck.

The timeframe of the projects is long enough to require a multi-generational workforce strategy that includes allowances for changes in leadership due to the extended timeframe. Just the magnitude of parts procurement, for example, requires a well considered and choreographed response.

"It's not business as usual," said Rencheck. "What we were doing before is not good enough now. These are not normal times."

Or at least, they are a new normal. With a new level of operator-supplier partnership and a multiple supplier pool, it will require a collaboration commitment from more than Bruce Power and OPG, said Rencheck. Suppliers will also need to adjust to an increased intrusiveness into each other's work and processes.

"There's enough work happening in nuclear in Ontario that everybody has a good opportunity to keep them sustainable for a long time. No one company is going to win it all. It's too big. We're going to need the companies to collaborate together so if you win something and somebody wins another thing and you have to interface, that interface must be flawless because we as the owners still need the execution regardless of who has the accountability. Collaboration means everything in these coming years."

Fortunately, collaboration is not a new concept to the nuclear industry.

COG's long-standing vision of "excellence through collaboration" reflects the operator standard that began with its formation as well as the creation of other organization like INPO, WANO and the IAEA.

As president of Areva prior to his current role, Rencheck took the step of integrating the nuclear supplier into the same training programs operators were using in these organizations. The outcome was a significant increase in productivity and profitability.

"None of us," he observed, "are separated by more than one degree of freedom... we're all tied at the hip."

"It's fragile: We have to be able to execute, whether it's an OPG refurbishment or a Bruce Power life extension, we have to be able

cont. p. 10

to execute, flawlessly. We need to do it safely, with high degrees of quality and on time and on budget," said Rencheck. "And we can't just do one like that... we're going to have to repeat this over and over and over again. We really have to collaborate together to get our performance up."

An operations state of mind

The nuclear projects will require unprecedented energy and attention from those responsible for their delivery. Yet, the need to generate electricity safely, reliably and with continued cost improvement remains very real and present.

In today's challenging political environment, strong performance means only continually-improving performance will do. Standing still is sliding backwards. There will be increasing pressure to reduce operating costs while maintaining, and even improving, safety.

Currently, nuclear is a price moderator in Ontario. It's a position Rencheck says the industry cannot afford to relinquish.

"We're going to have to innovate, we're going to have to create new technologies. We're going to have to find new ways for people to work in our stations and innovate to do it better, safer, faster, less expensive each and every time," he said.

"We are the low cost producer... we need to keep that. We need collaborations like we talk about with COG to keep those


price curves down to keep that nuclear opportunity going forward well into the future."

It can seem daunting to think of the work ahead, yet that day in Toronto for the GBM, after a long drive from the Bruce, Rencheck didn't seem like a man losing sleep. He played with the room as he spoke, frequently smiling and breaking for light-hearted banter. He exudes optimism about the positive power of strong leadership in building competencies, communities and confidence.

"We are truly in the people business. When people get excited about something and they think they can do something, they generally get it done and do it, and do it well.

"We're running nuclear reactors, right? We're splitting atoms. It's not every day the neighbour next door gets to split atoms in their basement. It's not something that's usual in the community. So with that we have to have the competence.

"It's also always about bringing in the next generation and developing the next generation; around safety first and foremost. Safety is the bond we all have in the nuclear community with the civilian community that lives around us. It's also the bond we have between each other in that we're all in this together.

"This is in my hands; this is in your hands." 

Bruce Power's Economic Development and Innovation Initiative

Bruce Power and the County of Bruce have teamed up to establish a regional Economic Development and Innovation Initiative to maximize opportunities for local communities given Bruce Power's multi-year Life Extension Program.

The goals of the initiative are to:

- Increase regional supply chain presence that meets Bruce Power's long term needs
- Enhance regional training and employment opportunities
- Work with the community to support an expanded regional supply network and increased employment opportunities
- A Regional Advisory Committee with representatives from Bruce, Grey and Huron counties has been established with the goal to provide input and advice on the development and implementation of an Economic Development and Innovation strategy, while also serving as a resource to facilitate opportunities.

Learn more about the Bruce Power life extension here: <http://www.brucepower.com/about-us/life-extension/>

Two in a row

EPRI Technology Transfer Award goes to a COG member for the second-year running

New Brunswick Power Point Lepreau employee Jennifer Lennox was recognized for research on heat exchangers

For the second consecutive year, A CANDU Owners Group member has received the Electric Power Research Institute (EPRI) Nuclear Technology Transfer Award.

Each year, EPRI recognizes nuclear industry professionals who have shown exceptional application of research and technology in solving a problem of significance.

CANDU operators hold membership in EPRI through COG, which provides a conduit for information sharing and gathering both from the operators to EPRI and by identifying information and providing analysis relevant to CANDU operators.

The Nuclear Technology Transfer Awards Gala was held in Charlotte, North Carolina, on Jan. 31. Point Lepreau

Nuclear Generating Station (PLNGS) employee Jennifer Lennox was presented with an award for the station's **Use of Heat Exchanger Guidance to Develop In-house Program**.

Lennox, who works in the PLNGS Engineering Programs group, has worked at PLNGS for eight years. Her current role as program specialist involves managing the Heat Exchanger Program. This includes preventive maintenance and health monitoring of all station-critical heat exchangers, coolers, heaters and condensers.

In 2015, Jennifer led an effort using EPRI reports and resources to assist in the development and implementation of a program to maintain operability, and ultimately protect equipment reliability of heat exchangers at PLNGS. An immediate benefit of the program was improved management of degradation of the seal oil cooler.

"It's an honour to receive external recognition for something I've put a lot of work into," says Lennox. "Attending this gala was an exciting opportunity for me to network with other engineers from North America and beyond. It was humbling to be a part of a diverse awards program for all aspects of the nuclear industry."

"It speaks to the caliber of work being done by COG and its members in the area of research and development that for two



A team celebration at the EPRI gala where the award was announced, Jan. 31. From left: Steve Woods, Ontario Power Generation, Brent Smith, Point Lepreau, Jennifer Lennox, Point Lepreau, Kurt Crytzer, EPRI, Heather Feldman, EPRI, Don Wilson, CANDU Owners Group (COG), and Kerry Clemen, COG. (Photo courtesy of EPRI)

years in a row, a COG member has been recognized with this award," says Don Wilson, COG's director of Information Exchange. "We are proud of Jennifer's work and her contribution not only to Point Lepreau's operations but to the entire nuclear industry."

Wilson notes the CANDU community invests significantly in research and development and says customers receive an exponential return.

"COG, on behalf of its members, invests more than \$65 million in nuclear R&D and joint projects annually. As a result, we have seen greater safety, efficiencies, extended plant life and cost benefits worth billions of dollars. This is a direct benefit to the electricity users COG members collectively serve," he says.

Brent Smith, Programs Engineering Manager at Point Lepreau, says the entire station team is proud of Lennox's achievement.

"Jennifer has been committed to developing a quality heat exchanger program from the outset," says Smith. "PLNGS did not have a well-established heat exchanger program, and we identified this as a gap to excellence in the industry."

"It's the staff at EPRI that nominated Jennifer for the award and I think that speaks to the recognition of her comprehensive work in maximizing the use of the EPRI products available to establish a quality heat exchanger program."

-- Files by New Brunswick Power

6th *International* **CANDU** *In-Service Inspection* **Workshop**

Co-hosted by CANDU Owners Group and
the Canadian Institute for Non-Destructive Evaluation
November 15-17, 2016



The bi-annual International CANDU In-Service Inspection Workshop and NDT in Canada Conference, was held in Burlington, Ontario this past November.

Co-sponsored by COG, it provided participants an opportunity to learn about the latest non-destruction testing, evaluation and inspection technologies.

COG program manager Jeff Weed (below, right) in photo with CINDE's Don Courchesne, was a conference co-chair.



The CANDU Promise

The CANDU Owners Group Board of Directors has a new chair and two new members. They take stock of the industry today and the organization's role in creating a nuclear future through lower costs and optimized performance in CANDU plants globally.

To put it mildly, the CANDU industry has a lot going on. With life extensions, refurbishments, aging fleets and more stringent emergency preparedness requirements, there are unprecedented challenges for nuclear operators and suppliers to tackle at a time when the public is acutely tuned into the price of electricity.

But, there is also tremendous opportunity. No longer in the pioneering stage, the industry has come into its own with more than a half century of expertise, research and increased understanding of the technology. Operators are applying innovation in digital technologies, obsolescence management strategies and new methodologies in human performance. There's a higher industry benchmark with reduced trip rates, increased capability factors and extended life. And, a new partnership has emerged with suppliers.

“With the projects at Darlington and Bruce, we haven't seen this level of activity since the heyday of new build in the seventies and eighties. This is a really exciting time again.” ~Paul Thompson

The result is exponential improvement in operations, maintenance and supply chain management over the past few decades with greater safety and lower operating costs.

As the nexus for collaboration on research and development activity and information exchange for CANDU operators and suppliers, the role of COG is evolving too. Following retirements by COG Board members Paul Spekkens and Bill Pilkington in late 2016, COG welcomed **Steve Woods** from Ontario Power

Generation and **David Cox** from Canadian Nuclear Laboratories. They join long-time board members **Paul Thompson** from New Brunswick Power and Bruce Power's **Gary Newman**, who took over as chair.

Here, the board members reflect on the “burning platform” for the industry, new technologies and strategies as well as COG's role in helping the CANDU industry achieve its potential as generator of safe, affordable, reliable and clean electricity.

INDUSTRY TRENDS AND INSIGHTS: A VIEW FROM THE COG BOARD

The need: Lower cost while maintaining continuous improvement on safety and reliability

In the United States, the nuclear industry is committed to cost reductions of 30 per cent as it strives to meet its “Nuclear Promise,” of achieving power that is competitively-priced in addition to being safe and reliable. In some markets, low gas prices and renewable subsidies are a threat to continued nuclear operations even in strong-performing plants and despite the positive impact of nuclear in the fight against climate change.

While the characteristics of the U.S. market are unique, the need to make nuclear as affordable as it is safe and reliable is just as relevant for CANDU operators worldwide.

“We don't have the same burning platform as the U.S., nonetheless we do *have* a burning platform,” says Gary Newman. For example, in Ontario, he says the stations' operational costs need to be tightened to help counter the cost of infrastructure investment in refurbishment and life extension projects to ensure nuclear

cont. p.15

CANDU OWNERS GROUP 2017 BOARD OF DIRECTORS



GARY NEWMAN

Bruce Power
Senior Vice President
Engineering &
Chief Engineer

CAREER HIGHLIGHTS

- Leadership in fuel channel life management research and industry collaboration on engineering joint projects
- Following passage of the 1998 Energy Competition Act, helped Ontario Hydro restructure into five separate entities
- Helped create what is now AMEC Foster Wheeler before joining Bruce Power with responsibility for major component replacement and fuel channel replacement
- Chair of the COG board; past chair and current participant on Equipment Reliability Oversight Committee at INPO; Vice-chair of UNENE and past board member of AMEC Foster Wheeler



PAUL THOMPSON

New Brunswick Power
Senior Strategic Advisor
to the Chief Nuclear Officer

CAREER HIGHLIGHTS

- Almost four decades in technical and managerial roles at New Brunswick Power and before that, at Atomic Energy Canada Limited
- Career has spanned all three phases of the NB Power Refurbishment Project; the planning, preparation, and implementation, along with re-start and post refurbishment operation
- Extensive experience in conduct and management of safety analysis, reactor physics and fuel behaviour as well as plant aging and emergency response and regulatory affairs
- Chair of the COG C-6 Fleet Steering Committee, and a member of the Centre of Nuclear Energy Research Advisory Board, Paul is a fellow and past president (twice serving) of the Canadian Nuclear Society



DAVID COX

**Canadian Nuclear
Laboratories**
Vice President,
Operations and
Chief Nuclear Officer

CAREER HIGHLIGHTS

- More than three decades at Atomic Energy Canada Limited and its successor company Canadian Nuclear Laboratories (CNL)
- A decade and a half of progressive leadership roles primarily focused on performance improvement in nuclear operations including project management and safety and licensing
- Extensive experience as a nuclear engineer and researcher on fuels behaviour related to severe accident conditions and development of fuel performance codes
- A long-time participant in COG collaborative research projects including former chair of COG fuel technology working group



STEVE WOODS

Ontario Power Generation
Senior Vice President
Engineering &
Chief Nuclear Engineer

CAREER HIGHLIGHTS

- Currently responsible for oversight and development of engineering strategies, services, training, processes and regulatory issues for OPG fleet-wide on project and operations teams and knowledge transfer with external organizations like EPRI, COG, WANO and NEI
- Nuclear operations, maintenance, and engineering leadership at both Darlington and Pickering Generating Stations in multiple management roles including director of engineering, operations manager, plant manager and VP fleet operations and maintenance reporting to the Chief Nuclear Officer
- Project experience includes leadership role on the Darlington Refurbishment Project as VP of operations and maintenance during the preparation phase
- A 2007 secondment to the Institute of Nuclear Power Operations (INPO) focused on organizational effectiveness

Continued from page 13

continues to play a moderating role on price.

As a single-unit station, New Brunswick Power's challenge is a lack of economies of scale, says Paul Thompson. International CANDU members each have their own demands driving a need for cost reductions too. While each jurisdiction is somewhat unique, they share a common goal on cost because value for the ratepayers is a destiny issue for nuclear universally.

"All the work being done in the US will provide us with opportunities to reduce our costs," says Newman. "We're watching it very carefully. We may do things a little differently in Canada, as we sometimes do, but all the work being done in the US we view as being very helpful."

David Cox agrees.

"Delivering the nuclear promise coming out of NEI (Nuclear Energy Institute) -- we've got to grab hold of that and take it as far as we can recognizing it's a difficult balance to achieve... There's important R&D programs that enable us to ensure we're doing the necessary minimum but we're not overdoing the amount of work that drives a lot of cost in the industry," Cox says. "It's how we can continue to become more competitive and reduce operating and corporate costs," he says.

The Initiatives: Strategies for cost reduction and improved performance

Value-based maintenance

One initiative on the deliverables list of the U.S. Nuclear Promise is value-based maintenance. It represents a culture shift from the traditional goal of working to achieve reliability at any cost. The goal is to move to a culture that treats maintenance as a highly-valued resource targeted to the most critical work.

Specifically, NEI's deliverable statement is "to optimize safety and reliability through the most efficient utilization of maintenance," to drive out cost.

In CANDU plants today and through an on-going COG peer team initiative, predictive, condition-based maintenance is replacing time-based scheduling to ensure equipment gets appropriate attention versus rote servicing. By focusing on condition and criticality of the equipment, failures on the most vital equipment are being reduced, improving station reliability and capability factors, Newman says. COG has been tracking the results over several quarters and has identified continual improvement in reliability results since the initiative began.

Gary Newman explains, that to determine maintenance resourcing, risk assessment is used to calculate the right level of tolerance for failures based on the equipment's function in combination with on-going assessment of equipment condition.

Human performance comes into play as well. Increased emphasis is placed on a cross-department team-based approach to assessment. It ensures more timely identification and proactive maintenance when issues arise on equipment of high criticality, reducing equipment stress and ultimately, failure rates. Conversely, less important equipment will receive a reduced ranking and will wait longer for maintenance but will be flagged for monitoring.

By replacing unnecessary or low-value maintenance with the
cont. p.16

A role for COG

Thoughts on the contribution of CANDU Owners Group to members and the industry

David Cox:

"COG's vision of excellence through collaboration really hits it so nicely with a focus on nuclear safety, operating experience and R&D. Nuclear safety, for us as an industry, it's table stakes... our social licence demands those high standards and they're standards that exceed other energy industries. In my view COG has a critical and essential role in facilitating the learning from others and learning from self; self being the unique lessons that apply within our own CANDU community."

Gary Newman:

"I've always viewed COG as the leading collaborative forum where the domestic and international utilities have an opportunity to share not only R&D but also operating information. I see an ever-expanding role for COG as we develop a better understanding of the work that's being done in the US. It would be a natural flow for those concepts, with COG as a natural place for that collaboration to occur."

Paul Thompson:

"I'm extremely supportive of the role that COG can play. Our biggest challenge here in New Brunswick is making sure we're getting the most out of what COG has to offer. That sounds simple but when you're trying to run the station a lot of focus is on short-term issues but these bigger programmatic issues are also where you have to spend your time or they're going to come back to get you."

Steve Woods:

"My experience in OPG is that collaborative organizations achieve more. I think that's transferable on a greater scale... I'm seeing it in my work with EPRI and my U.S. peers that the Nuclear Promise has driven the level of collaboration up. COG clearly has a role to play there. It's not just getting more bang for your buck on a particular project. It's collaborating on solutions and sharing them. It makes the industry better, not just more efficient."

most necessary, backlogs are reduced. In addition to better reliability and cost outcomes, it can have a positive impact on safety by keeping the plant operating smoothly and event-free longer. So how does the operator know it has the right balance of risk management?

“If you’re looking at a large enough picture including reactor de-rates or trips; if you roll that all into the cost of running your business, you’ll always make the right decision,” says Newman. “So safety and economics can be married.”

Artificial intelligence

Where computers were once something that sat on our desk and connected us to the rest of the world, digital evolution has created workplaces where workers seamlessly harness artificial intelligence (AI) as work tools to accomplish tasks faster and more effectively than humanly possible. The use of technology can be an added tool in many areas of plant management including when making those value-based maintenance decisions, says Steve Woods.

“For engineering it’s how do you use technology to reduce cost. A strong push in the US we’re getting on board with is to improve our capability to monitor plant equipment through use of things like advanced analytic software to monitor subtle deviations in equipment performance that operators or engineers might not otherwise notice,” he says.

All of the plants today have a plant information system with detectors that already provide a plethora of information about the operations, Woods explains.

“These are available to engineers today. What the change is, when you use pattern-recognition software, you can build a virtual model of the equipment using these inputs and detect very subtle deviations from normal and investigate to either pre-empt an equipment failure or understand the equipment condition so that you might defer an overhaul and save the maintenance and engineering effort because you’ll know the equipment is running well. So you use it to optimize when you do your maintenance.”

Bruce Power is part of an Electric Power Research Institute (EPRI) pilot project for the use of online equipment monitoring. As part of its inspection tooling, in 2015, it began using a Bruce Reactor Inspection Maintenance System (BRIMS) and this February, took possession of BRIMS II from BWXT Nuclear Energy Canada Inc. BRIMS is a robotic system, which delivers inspection tools to the reactors without worker dose. It precludes the need to rely on important fuel handling machines that can otherwise now be deployed to maintain fueling levels within the units.

The cost of new technology is small when the additional life expectancy of the Darlington and Bruce plants are factored in, Woods says. In fact, the upfront investment will result in a significant cost savings over time as nuclear workers shift their focus to “higher-value work and less fire fighting.”

Some companies, such as Exelon in the U.S. are making a move to become fully digital and optimize the entire business, not just equipment management, says Woods, who notes, the shift to digital will require increased cyber security.

“Attitudes are changing. The old attitude was if it’s wireless we can’t do it. It is no longer possible to say we just won’t do it. So the cyber security has to evolve along with these other changes,” Woods says.

“Some of these things are transformative. It’s not just business as usual with new tools. It’s new business with new tools.”

Life extension

The value of life extension is a simple premise: The longer a nuclear plant operates, the more electricity produced from the original capital investment. This reduces the cost associated with each unit of electricity and increases the return on investment and ratepayer value.

CANDU nuclear plants were pioneered through the sixties and seventies but it has primarily been breakthroughs in the 21st century, built on those decades of operating experience and ongoing research, that has provided insights into the potential for longer operating life with continued strong performance.

A COG joint project started in 2009 and continuing today has helped to extend plant life by validating the lifespan and health of fuel channels. It has also provided insights that form the basis for an age management program that will optimize the channels’ condition and allow them to continue optimal operation to IAEA and CNSC standards for longer than the original design estimate.

The work by COG, with OPG, Bruce Power, CNL and Kinectrics was used in OPG’s successful application for regulatory approval to pre-extended operation at Pickering Nuclear. It is also allowing for pre-refurbishment extended operations at Darlington and Bruce Power.

As a result, the companies are able to stagger the refurbishment and major component replacement projects on the various units to optimize resources and keep a steady supply of electricity on grid from the two generating powerhouses.

Completed research has already extended fuel channel life by about four to five years and further research is ongoing to support

cont. p.17



The length of refurbishment and major component replacement projects mean many roles will be inter-generational. COG peer teams, databanks, OPEX and workshops are helping operators share knowledge across generations, between operators and suppliers and across geographies. *Photo courtesy of Bruce Power*

additional extended operation. In addition to the benefit to the original joint project members, the research could also prove valuable for COG's international members in future.

"They've done some great work on that project to understand the material properties... there were a number of technologies that were brought to bear to achieve that," says Gary Newman.

Ultimately this innovation increased the value earned from the plants by billions of dollars. Equally valuable are the positive environmental impacts of avoiding carbon-emitting alternative electricity sources during the Darlington Refurbishment and Bruce Power Major Component Replacement projects.

In addition to this recent research breakthrough, cumulatively, decades of R&D has resulted in longer, healthier plant life, says David Cox. Like the fuel channel project, other research has also added to improved predictability of safety margin and other projects have improved knowledge of fuel and fuel channel materials. This is true of steam generators and other equipment as well. Together these research projects contribute to longer life, reduce wear and provide safer operation, says Cox, all of which contribute to CANDU's value proposition.

"What COG does is enables efficiency gains in things like life extension outage execution, outage work processes, refurbishment equipment design and deployment. " ~ David Cox

Age management and the C6 Fleet

Older plants have unique operating challenges but a number of COG teams are creating opportunities for better age management resulting in healthier plants into the later stages of operating life, says Paul Thompson.

As an operator of a single-unit station, one of the great benefits of COG for New Brunswick Power is the interaction with other CANDU operators including members of the C6 Fleet. Coordination of equipment replacement, a shared stock of spare parts and shared design research are some of the initiatives the C6 Fleet Committee has initiated.

"In the past we (C6 operators) were working independently, which was a significant wasted effort," says Thompson, who serves as committee chair. "So, we're trying to identify things in our longer-term plans we believe we need to move on from an aging or obsolescence perspective and identifying if there is common interest in cooperating on a common design across the board," he says.

"The big focus everyone enjoys is the information exchange. What we tend to do is pick two or three high profile events that happened and go into a fair amount of detail and what the lesson learned is. By spending a bit more time and going into these events, it becomes much more usable for everyone. We've gotten quite a bit of good feedback from the offshore utilities and as a result we have received very good OPEX back from them," he says.

Working together across the C6 fleet is also an opportunity to bring the designs back to a common point that will allow for more alignment and cost sharing. "That concept probably brings the biggest single benefit," says Thompson. And, he points out, many

Delivering the Nuclear Promise

Companies that operate America's nuclear energy facilities have partnered on a multiyear strategy to transform the industry and ensure its viability for consumers as well as its essential role in protecting the environment.

This strategic plan, called Delivering the Nuclear Promise, strengthens the industry's commitment to excellence in safety and reliability, assures future viability through efficiency improvements, and drives regulatory and market changes so that nuclear energy facilities are fully recognized for their value.

Source: Nuclear Energy Institute

of the lessons are equally relevant to the other Ontario plants.

Thompson says the collaboration has also highlighted for him, an opportunity to benefit from research in the offshore facilities, especially where the capability doesn't exist in Canada.

Knowledge transfer

Projects that continue across decades and plants that can operate for as many as 60 years or potentially more bring with them another challenge: transferring knowledge from one generation to the next and from one geography to another.

Paul Thompson sees an ongoing need for increased attention in the industry on data management, especially with the continued baby boom departure from the industry.

"You refurbish a reactor at 30 years but 30 years is generally the length of people's careers and unfortunately they coincide," says Thompson. "We're building our team here at Lepreau back up again but it is daunting. It's amazing, when a person retires who's worked 30 or 40 years, there's such tremendous knowledge that leaves with the individual and that takes a long time to rebuild."

And, while there is a lot of data on lessons learned and operating experience, Thompson says, "I'm amazed at the power of the internet and the power to look up things yet, we have a myriad of documents in the industry without a really good way to tap into it. We don't want to learn the same lessons the hard way."

Currently, COG is upgrading its member internet, COGonline, due to launch in mid-2017, and it is looking at ways to improve the access to data and analysis.

David Cox adds the learnings across geographical boundaries as well as generations are important for the industry and an important part of the COG program.

"We have our domestic CANDU plants and there's a tight-knit collaboration there... but I think the strength of that bond between the Canadian domestic players and the international players is made stronger through COG and I think it's essential," he says. "COG, on behalf of its members can influence nuclear standards worldwide"

That connection is an important one, says Gary Newman, who points out COG's role with sharing through the IAEA, WANO, INPO can also be expanded to one of collaboration with universities both domestically and abroad, such as at Strathclyde University in Glasgow, that serves as a centre for excellence. It can provide

cont. p.18

COG members with important insights into the European industry perspective, he says.

"It's a nice fit between what COG already does and where Fred (Dermarkar) is trying to lead COG on a more international platform. I also think linking into the Canadian universities has tremendous capabilities. I think hooking them together with Strathclyde could drive even greater collaboration."

Supplier partnership

As the industry has shifted its business model from the traditional patriarchal operator role to one where suppliers are more integral partners in nuclear management, the expectations for supplier knowledge and expertise have increased. An important strategy for the Canadian CANDU industry in particular, has been filling the void for supplier training and onboarding to ensure the new business model is seamless in the delivery of nuclear excellence.

"What COG does is enables efficiency gains in things like life extension outage execution, outage work processes, refurbishment equipment design and deployment," says David Cox. "Through sharing the lessons learned and the collaboration between members and also a key part -- with our suppliers in the supplier participant program -- each COG member isn't burdened every time a contractor comes on board. They can be confident through COG's efforts those suppliers have already been engaged and exposed to the key learnings that are available. That alone is an efficiency; having a standardized approach to getting our suppliers up to speed on the standards and requirements for work in our plants."

Business management

While innovative technology and game-changing R&D like life extension are making tremendous gains for the industry, some of CANDU's competitiveness must come from basic business management, all the directors agree.

"So much of it will come as we examine our support processes; making sure our corrective action programs are truly efficient, right-sizing of security and fire protection to address the safety basis and security basis for operating the plants," says David Cox.

"Consistent with delivering the nuclear promise we need to examine all of those factors and find ways to maintain safety but challenge our cost basis and reduce it so we can become more competitive. In the past it was always easier to lather on additional process under the guise it will improve safety without assessing

the incremental cost," says Cox.

Paul Thompson agrees that processes need constant monitoring to ensure they have not become overburdened by years of layered additions and tweaks.

"You need to really think about the true quality. Yes give the guidance there but allow a bit of the flexibility so it can be efficient because if all you're doing is jumping through a whole bunch of hoops, your not thinking. And not thinking is not safe," he says.

"I think we really have to look at all our documents and simplify them. I think it can improve efficiency and increase real safety... We need to change the paradigm." This, says Thompson, is where COG can play an important role in sharing strengths, and common work, across the industry. As processes begin to be passed through generations of nuclear workers, this work becomes more urgent.

Decommissioning and waste management


With reactors like those at CNL and Gentilly in Quebec preparing for shutdown and Pickering a few years later, the industry is in ramp up for large projects on decommissioning and waste management.

"Arriving at an efficient and cost-effective process for decommissioning and managing the associated waste is one of the emerging challenges we have," says Cox. "It's the nuclear liability and eliminating that liability that's achieved through the decommissioning process... That's a critical area coming ahead that is going to require attention for which COG can help to play a role going forward."

From challenge to opportunity

As the COG board members reflect on the enormity of the tasks ahead, they are realistic on the challenges but not daunted. They are optimistic the groundwork of research and knowledge gained has positioned the industry for a future where nuclear can continue to provide a large, clean and reliable source of electricity.

Today, with work post-Fukushima and through collaboration initiatives, nuclear is even more safely providing a strong quality of life of citizens worldwide through reliable electricity while avoiding the effects of climate change and smog that cause health and environmental distress. It is providing high-value work for thousands of people. And, it is working to increasingly improve the economics.

As Thompson puts it, "With the projects at Darlington and Bruce, we haven't seen this level of activity since the heyday of new build in the seventies and eighties. This is a really exciting time again." 

Are you a COG member?

If you're employed by a CANDU operator or a CANDU Owners Group Supplier Participant, you can strengthen your knowledge and skills while participating in research, development and information exchange activities.

Go to the CANDU Owners Group member site through your organization intranet; check out the COG event guide or the COGNIZANT Plus Members Only magazine to access up-to-date station OPEX, get answers to research questions, learn about international industry news and events and much more.

A fleet mentality

Through the C6 Fleet Steering Committee, individual operators gain exponential benefits

Two years ago, the CANDU 6 Fleet Steering Committee (SC) was formed with the idea of exchanging designs, safety analysis basis, equipment lifecycles and to discover what else could come of gathering operators with common technology and common issues together.

After several technical workshops and a three-day meeting in Korea at Wolsong Nuclear Power Plant in September 2016, the group has leveraged individual experience into the benefits that accrue from a global fleet.

“One of the interesting things for us (in New Brunswick) was the closure of the G2 plant,” says Point Lepreau’s Paul Thompson, who chairs the committee. “It had a significant impact on us because we shared a lot with Hydro Québec. That’s one of the reasons for our interest in the CANDU 6 Fleet.

“What I am seeing that is working quite well is the information exchange and questions being asked by the fleet members. It’s a very healthy dialogue developing and in time, I am hoping we get to share more projects, more common work so that we can not only share in the cost but also bring the designs back together, which will lead to even more sharing.”

Facilitated by COG’s Joint Projects director Macit Cobanoglu and project managers Nidhi Gaudani and KiSang Jang, in 2016 the operators held six technical workshops followed by the three-day meeting at Wolsong, hosted by Korea Hydro and Nuclear Power (KHNP). Other fleet members — CNNO, China, New Brunswick Power, NASA, Argentina and SNN, Romania as well as the original equipment manufacturer, Candu Energy, also participate.

The Wolsong meeting started with a discussion about critical CANDU 6 OPEX and plant performance status. The second Day 2 workshops focused on safety analysis, and ageing and obsolescence. Fleet members had an opportunity to visit Wolsong NPP1 for a plant tour on the last day. The tour included the control room, turbine building and a fish farm built to demonstrate to residents of local fishing villages that Wolsong has no adverse impact on the



Members of the C6 Fleet Steering Committee were hosted by Korea Hydro and Nuclear at the Wolsong Nuclear Power Plant in September 2016. The committee, which began in 2015, meets throughout the year, often using CANDU Owners Group teleconferencing technology but gather in person each year. The next annual meeting is November 20-21, 2017 the C6 Fleet Steering Committee will meet again, this time in Argentina. The meeting will be followed by the COG-IAEA sponsored Technical Committee Meeting (TCM) to be hosted by NA-SA Argentina.

environment and the fish stocks.

Fleet members identified derating of their CANDU 6 units towards the end of fuel channel life due to various fuel channel and primary heat transport system aging related concerns as their “top of mind” issue. Various remedial measures to delay or eliminate derating such as deployment of 37M fuel, steam generator primary side cleaning, and use of EVS-ROP/NOP methodology for margin recovery were discussed in detail during workshops that followed the C6 Fleet SC meeting.

Meeting participants identified obsolescence, parts availability, and enhancements in sharing of emergency spares as other top priorities issues.

The cost of delays in securing required emergency spares could reach into many millions of dollars in lost generation resulting from outage extensions. Conversely, creating a solution through collaboration could mean maintaining both revenues and reliability as happened in 2016 when COG members were able to

cont. p. 20



During the three-day meeting in Wolsong in September 2016, the C6 committee had the opportunity to build on six technical workshops facilitated by COG leading up to the September event. The workshop topics, each of common interest to the C6 operators, were: Primary heat transport system; ageing; rod-based guaranteed shutdown system; airlock obsolescence; fuel handling system obsolescence; and emergency diesel generator obsolescence.

come to the aid of Wolsong.

Another topic where good exchange of information took place was the development of Single Point Vulnerability (SPV) lists. Presentations by AMEC Foster Wheeler and SNC Candu Energy led to an exchange of many ideas and a path forward on use of the EVS-ROP/NOP methodology for CANDU 6 reactors along with a number of other primary heat transport system aging mitigation strategies. COG is currently in the process of developing a phased joint project on the use of EVS ROP/NOP methodology for CANDU 6 reactors.

Other discussion topics included improvements in integrated reactor building leak rate test frequency, a review of the enormous benefits of COG's Fuel Channel R&D and Fuel Channel Life Management (FCLM) Joint Projects, and the ongoing and planned refur-

bishment projects.

Year round the benefit of the committee is the opportunity for ongoing development on these issues as well as a chance to really delve into operating experience, says Thompson. Many of the meetings are facilitated by COG's teleconferencing capability.

In addition to video conferences, there are periodic face-to-face meetings of the steering committee. So far there have been meetings in Romania, China, Korea and Canada, in addition to the planned meeting in Argentina this coming November.

"Our big meetings are generally quarterly and there's a section dedicated to information exchange. We tend to pick two or three high profile events that have happened and go into a fair amount of detail and what the lesson-learned is. By spending a bit more time and going into these events it becomes much more usable and useful for everyone. We've gotten a lot of positive feedback from the offshore utilities and in return we are getting very useful OPEX from them."

Aside from the common topics of interest, Thompson says the international diversity brings a unique opportunity as well.

"It's always good to see how others have approached things. Certainly when you are looking at five different countries, it is interesting to see how approaches are adapted. We're seeing a much more open approach than in the past and I think we'll continue to see that coming along."

With only one unit of the 10 CANDU 6's worldwide, Thompson notes Point Lepreau is the minority shareholder in the group. But, all the more reason why there is such value for New Brunswick Power to participate, he says.

"New builds of CANDU reactors still help everyone, even if those reactors aren't in Canada, it does benefit the other members. COG needs to continually strive to continue to serve the domestic interests while at the same time continuing to reach out to make it easier for the off-shore participants to participate fully in all the endeavours that COG has. As some of the offshore members join

cont. p. 21

C6 issues and action list

At its September 2016 meeting, the Steering Committee identified a number of issues and is developing solutions and shared resources to manage challenges, many of which are related to operating units in the second half of their life. By combining resources, the cost of managing many of these issues can be reduced. Committee chair Paul Thompson says many of the lessons learned here can be extrapolated to the rest of the CANDU industry. Focus areas include:

- Derating of their CANDU 6 units towards the end of fuel channel life due to various fuel channel and primary heat transport system aging
- Spare parts exchange opportunities
- Methodologies for margin recovery

Among its actions, COG will facilitate a table-top exercise on the efficacy of emergency spare part sharing and is currently in the process of developing a phased joint project on the use of EVS ROP/NOP methodology for CANDU 6 reactors. Other COG research projects including the use of 37M fuel and Fuel Channel R&D and Fuel Channel Life Management (FCLM) Joint Projects are also valuable in addressing the identified issues.

more of these working groups, it is important to ensure we're giving them the opportunity to contribute."

Thompson says the committee's success has in part been based on everyone's willingness to overcome language barriers and time zones. This includes strategies such as preparing and distributing materials in advance, having meetings on a 24-hour clock and taking "time outs" to allow time for full translation during meetings.

"Working at a power plant, it's not unusual to switch to a night shift. So if every few months, I need to have a meeting at 2 a.m., I am OK with it," says Thompson who describes the commitment by all participants as highly collaborative.

While the C6 Fleet has a more specific technology bond, Thompson says the C6 group is an adjunct not a replacement for the bigger COG membership.

"It's important that it not become a second COG because there's still a block (of information) that needs to be shared back with the Ontario units."

Like all things COG, it is an incredible opportunity for collaboration that all CANDU operators can benefit from.



Mr. Hwee-Soo Jeon, vice president, Wolsong Site, KHNP speaks to the international participants of the C6 Fleet Steering Committee meeting hosted at the station.

THANKS FOR THE HELP

Korea sends a note of appreciation after COG network tracks down an emergency part and provides installation OPEX

Each year COG Joint Projects & Services receives several hundred requests including emergency spare part (ESP), benchmarking, technical information and other miscellaneous requests. Sometimes these are associated with a joint project or a project initiation form (PIF) and the original request can result in more questions requiring detailed answers to get to a full resolution of the issue.

Some questions are out of the ordinary! Have you ever heard of a dog bone expansion joint?

On March 7, 2016 the Wolsong Nuclear Power Plant 1 manager Jongha Jeon called COG to request support to resolve an emergency need to replace a condenser expansion joint prior to restart from an annual outage in early April. Previously KHNP's Yeong-gwang Unit 1 PWR had shut down from failure of a dog bone expansion joint (condenser exhaust neck expansion joint) due to a defect. Wolsong Unit 1 was now on outage and planned to replace the same joint, in part, to meet a regulatory requirement.

However KHNP did not have the spare part. Wolsong urgently requested COG arrange the buy-in of the part or facilitate an emergency spare part exchange. The initial KHNP request was for an ESP made by the W1 plant manager. COG was able to leverage other COG members and its Inter-station Assistance Program to find the missing drawings and identify a potential supplier that same day. Using COG information, KHNP was able to obtain an emergency

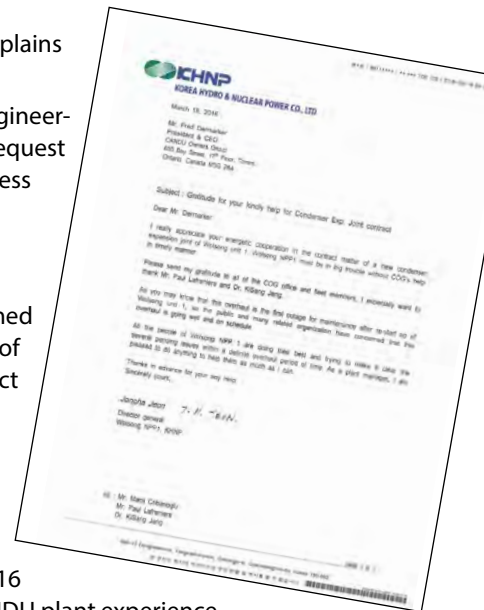
quotation from the vendor, explains COG's Paul Lafreniere.

Mr. Song (the Wolsong engineering manager) made another request to COG for OPEX as lack of access prevented a good assessment of the installation issues to be expected.

"COG immediately performed benchmarking (15 questions) of COG member stations to collect the required OPEX," Lafreniere relates.

The benchmarking results from New Brunswick Power and SNN-Romania were sent to KHNP on March 18, 2016 providing information on CANDU plant experience with the joint defects and solutions, replacement periods and spare parts. The end result was KHNP got the part they needed, the knowledge to install it and a happy ending thanks to facilitation by the COG team and the members' collaborative efforts.

Benchmarking Q&As are recorded in the Joint IE / ISA COGonline website.



COG fueling machine valve research creates big cost savings and improved reliability

The success of a joint project to re-engineer a fuel-handling system valve could be replicated to address other obsolescence issues

One small valve had a history of creating big headaches for several COG members. A valve used in the heavy water flow circuits of fuel handling systems, had been proving unreliable for years and, due to sole-source availability, had been escalating in costs.

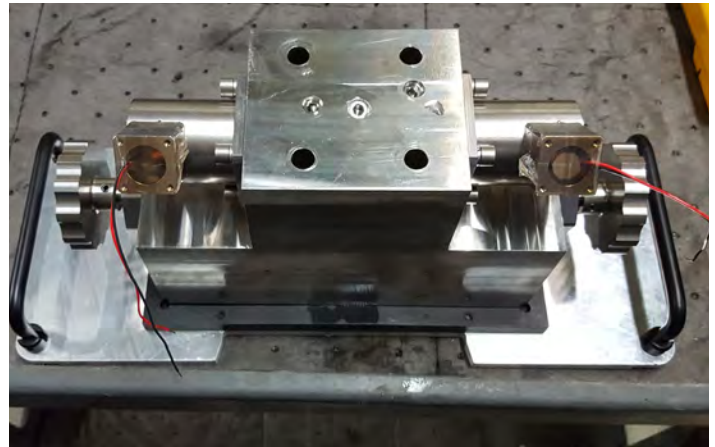
“Operators were forced to refurbish old valves because the cost of the new valves was too prohibitive,” explains Deny See Hoye who project managed the initiative.

So, through a COG joint project, initiated in 2010, a group of engineers set out to design, develop and procure a replacement valve that met the requirements of the plants using it, including Pickering Nuclear, Point Lepreau, Cernavoda, Embalse and Gentilly 2.

“The goal was to develop a valve that could duplicate the fit, form and function of the original valve at a much lower cost while improving the standard of endurance and reliability,” says See Hoye.

Phase 1 of the project was creating a technical specification to allow COG to solicit bids for the design, development and qualification of the valve. Following a competitive process of qualified vendors, Kinectrics was selected, using GW Lisk of Clifton Springs, New York as the developer-manufacturer.

Phase 2 of the project, also awarded to Kinectrics, included development and supply of the valves for Ontario Power Generation (OPG), New Brunswick Power (NBP) and Hydro-Québec. A fully-functional prototype, meeting all technical specifications, was developed, qualified and tested to validate performance. This included a 100,000 cycle endurance test



The implications of a successful COG joint project on a fuel-handling valve (above) could be far-reaching. The same approach could be taken to address many spare part issues where original manufacturers are no longer in business or a single source is cost-prohibitive.

representing approximately 30 years of service life. Post-test inspection revealed no observable degradation.

“In addition to being extremely robust and reliable, the Lisk valve comes at a unit cost significantly less than the original part,” says See Hoye, who adds, “It is also anticipated to function for 30 years with minimal maintenance. This is also a big improvement over the original valve.”

The initial funding utilities, OPG and NBP, will take delivery of their production valves this year.

The project’s benefits go far beyond the implications for this single component, says Macit Cobanoglu, COG Joint Projects director.

“The success of this project will enable COG and its partner utilities to address many similar spare part and equipment issues stemming from a variety of obsolescence scenarios.”

Download the CANDU Owners Group 2017-2018 Event Guide featuring COG Collaboration Week from the homepage or event page of COGonline



gathering steam

BWXT Canada Ltd's roots go back more than a century. However, what makes the company worth watching is its role in the industry today and what it means for the industry's future

Photo: Vagengeim, Shutterstock

Spotlight on suppliers: BWXT

John MacQuarrie, the president of BWXT Canada has a pedigree as Canadian as CANDU itself. Described by those who know him in the industry as 'easy going' and 'friendly,' his manner is quintessential Canuck as are his two engineering degrees from the University of Toronto. So too, his nuclear roots, starting with a three-year stint at Atomic Energy Canada Ltd. (AECL) as a fuel engineer before he joined what was then known as Babcock & Wilcox Canada in the mid nineties.

The company he leads, BWXT Canada Ltd., may have a U.S. parent but in the Cambridge, Ont. plant that serves as its Canadian headquarters, the vibe -- personified in the super-sized flag on the wall and the Maple Leaf emblems on workers' hard hats -- reflects CANDU pride.

In some jurisdictions of the challenging U.S. nuclear market, even strong performing plants are in a fight for their lives, competing against cheap natural gas. In contrast, the refurbishment at Ontario Power Generation's Darlington plant, and the major

component replacement (MCR) project on Bruce Power's units, make for bullish conditions for suppliers here. Ontario is a growth area for nuclear suppliers who possess the right mix of competencies and culture.

"BWXT is very supportive of the Canadian market," says MacQuarrie. "It is a really attractive market and we've had a solid Canadian presence for over 150 years."

And, unlike in the U.S. where current political policy does not look to be helpful to greenhouse-gas reducing technologies such as nuclear, in Ontario, MacQuarrie says, "There is a nice nexus of provincial and federal policies," that are helpful to the industry.

BWXT Canada was birthed out of boilermaker, Babcock & Wilcox. The inventions of the company's namesakes made them pre-eminent boiler suppliers of the 19th and 20th century. The more recent history of BWXT Canada has been no less a success but can be a bit harder to follow.

In 2015, BWXT Canada Ltd., formerly Babcock & Wilcox Canada Ltd., was rebranded after its parent company, BWX Technologies, Inc. (formerly known as The Babcock & Wilcox Company), spun off the fossil business, which kept the B&W moniker.

cont. p. 24



John MacQuarrie (above) took the helm at BWXT Canada Ltd. in 2013. The company has been in perpetual motion ever since, including the recent acquisition of GE Hitachi Canada. Today, BWXT has more than 850 employees.

In addition to steam generator manufacturing, BWXT Canada and its Canadian affiliates also manufacture nuclear fuel, reactor inspection and maintenance tooling, feeders and other heavy nuclear components, including heat exchangers and nuclear storage containers. The company also offers an array of inspection and maintenance services for the components it supplies as well as other reactor services.

MacQuarrie may have called upon his fuel engineering background when, in late 2016, he oversaw the acquisition of GE-Hitachi Nuclear Energy Canada Inc. (GE Hitachi), now named BWXT Nuclear Energy Canada Inc. (BWXT NEC). It brings the capabilities of the two nuclear service and manufacturing powerhouses together. While the acquired business remains a subsidiary of BWXT Canada, the acquisition created an integrated organization with a lot of range and benefit for its customers, says MacQuarrie, who is now focused on offering increased value for BWXT's Canadian customers.

"We're moving to an integrated model so the customers have one team to deal with. We're adopting best practices from each of the companies and trying to utilize those across the entire business," he says.

There have been a lot of moving parts in the last couple of years but effectively, since MacQuarrie became president in 2013, BWXT Canada Ltd. has shed its fossil roots and become an even more significant nuclear player, now with about 850 employees across five Ontario locations. In addition to its long-standing steam generator and component manufacturing and service capabilities, it adds BWXT NEC's deep history and capability in the fuel end of the business. On a global scale, this works well for BWXT's parent company, and at the same time it broadens the company's scope on current Ontario project work.

The acquisition "is something that was very strategic for us," says MacQuarrie. "BWXT is a leading supplier of nuclear components and fuel to the United States government ... we like fuel and we like operating facilities that make fuel.

"The other part of the recently acquired business is the fuel handling business. That has a lot of synergy with our business in Canada because they do things that we don't do in Cambridge. When you put those things together, they create greater value for our customers."

In the past, BWXT and GE Hitachi had collaborated on bids for the nuclear refurbishment project work at Darlington. Now, as a

single company, BWXT can offer a "more complete solution than we could separately," MacQuarrie says.

"It's what most customers are looking for. They can get a full solution and all the protections that come with that, including a full warranty. As a customer you want simplicity and clarity when dealing with your supply chain."

The personalities of the two companies seem well matched. Both the Cambridge and Peterborough facilities have demonstrated capabilities in delivering new technologies that have innovated nuclear operations; an important mindset for plant operators here as they try to get ahead of ideals set by the *U.S. Nuclear Promise*.

The Peterborough facility is already showing its worth with the support they provided to OPG to achieve the ahead-of-schedule delivery of the Unit 2 defueling at Darlington in January. And, it just delivered the second Bruce Reactor Inspection Maintenance System (known as BRIMS II) to Bruce Power. These systems help shorten outages using remote inspection capability; something *cont. p.25*

BWXT in Ontario's nuclear projects

BWXT has a significant role in both the Darlington and Bruce Power mid-life projects

At Darlington:

Darlington's current 16 BWXT-designed and built steam generators have been given a clean bill of health to operate post refurbishment. BWXT has held service contracts for the generators since Darlington was commissioned in the early 1990s. Now, it has been awarded contracts on Darlington's refurbishment which include steam generator modifications and maintenance.

Recently acquired BWXT NEC, also holds defuel and fuel handling hardware, software and services contracts with potential for further work as the refurbishment project and contracting progresses to the other three units.

BWXT Canada is contracted to provide manufacture and service for other components including the nuclear storage containers for materials removed from the reactor BWXT Canada is supplying the feeders for the refurbishment's lead unit, out of its Cambridge facility.

At Bruce Power:

In June 2016 Bruce Power awarded BWXT a \$130-million contract to replace eight steam generators as part of the operator's major components replacement (MCR) project, which runs from 2020 – 2033.

There will be further potential opportunities for BWXT Canada to offer its new combined capabilities as Bruce Power continues its project planning and procurement.

that promises improved worker safety and improved maintenance schedules for nuclear operators.

Related:

Read [BRIMSII announcement](#).

Read [The CANDU Promise, page 13](#)

While all of these developments are critical, in an increasingly competitive energy market, even the latest technology is not enough. Strong nuclear safety culture and human performance improvement programs have long been recognized as key contributors to success in the nuclear industry. MacQuarrie has been a strong promoter of suppliers as active participants in improve human performance across the industry and has worked with CANDU Owners Group to highlight some of the operator collaboration practices with the supplier community.

“There’s a lot of capability that has been developed and is now being brought to bear on human performance,” says MacQuarrie. “And we’re seeing collaboration amongst the contractors. Initiatives like the COG Supplier Participant (SP) program and its expansion has been very helpful. The focus we have with programs like human performance, looking at quality and having an awareness of counterfeit and fraudulent activities within the supply chain has been really beneficial. Suppliers are evolving to meet the needs of their customers and the refurbishments are providing a lot of opportunities for performance improvement.”

As suppliers and operators create a new framework for partnership, not only in business but also in the development of improved safety culture, human performance and technology innovation the table is set for the Canadian nuclear industry to have a long, healthy future.

MacQuarrie on international opportunities

While, the strongest market for domestic players is here in Canada, BWXT Canada does see a healthy export business as well. However, its president John MacQuarrie sees some challenges for Canadian suppliers hoping to expand, or even sustain, current business in foreign markets.

“There are good opportunities internationally. 2016 was our best year for international business. However, the issue is many of these markets like China and South Korea, are increasingly becoming less open... they’re increasingly developing capability so they can support themselves and they also want to export.”

And while there are new emerging markets, Canadian companies can also expect increasing competition from new players.

MacQuarrie’s advice: “Find a niche and be competitive.”



There have been plenty of reasons for announcements at BWXT Canada lately. Above, the company’s president John MacQuarrie talks with employees at a recent media event.

Nuclear suppliers are in demand... if they have the right stuff

Suppliers can skill up to meet new expectations and gain opportunities through programs like COG’s Supplier Participant Program and other initiatives

Ontario is the hub of Canada’s nuclear industry and currently, and in some respects, one of the most desirable markets for nuclear suppliers in North America today.

At the same time, it’s never been an easy road. It is an industry constantly under the microscope, with a history of market disruptions that serve as reminders of the need for continuous improvement in safety, reliability, affordability and community support. Today, suppliers play a bigger role than ever. And with that added opportunity comes a new level of accountability.

Following the dismantling of Ontario Hydro (OH), and its construction arm, Ontario’s nuclear industry went through a challenging recalibration period in project capability. OH’s successor companies, Ontario Power Generation (OPG) and Bruce Power, had to reframe their approach to large projects and with that came a need to rethink the relationship with suppliers.

The new model that has emerged includes greater partnership with large contracts for engineering, procurement and construction (EPC) as a single package, such as the \$3.4 billion agreement joint venture SNC/Aecon struck with OPG for the Darlington refurbishment project.

Beyond the work captured in the SNC/Aecon agreement, there is much more; hundreds of millions in contracts for work to be

cont. p. 26

completed either through direct contract with OPG or through the SNC/Aecon JV. Bruce Power has already begun significant work on its life extension project and once the Major Components Replacement begins in 2020 that will multiply further. The last time there was this much Ontario nuclear work was when the plants were built, but then, much of it was in-house.

“There is definitely a significant shift to have suppliers play a larger role and that is increasing with these refurbishments,” says MacQuarrie. “We as suppliers really have had to increase our capabilities and develop our programs to be at the same level as our customers in being able to deliver our work programs.”

The work to improve capabilities continues. MacQuarrie points to the COG Supplier Participant (SP) program and joint supplier-operator initiatives on issues like human performance, counterfeit and fraudulent parts and safety culture.

In fact, it was MacQuarrie who tabled human performance and safety culture with COG’s SP program team after his experience with a similar model at the Institute for Nuclear Operations (INPO). He says the pre-existence of the INPO supplier forum reflects the traditionally more supplier-centric business model in the U.S.

“They have human performance programs and programs on how to improve the performance of suppliers. I saw that and I thought it was really something we should be expanding here.”

This was new ground for COG whose traditional R&D and information sharing programs had been very operator-focused. But, since the SP program started with three participants over seven years ago, it has now grown to 18 companies and an active peer group that meets several times each year.

“Fred (Dermarkar) and others like Ian Trotman have really picked up on that. I didn’t have a major role but I encouraged it because we’re going to need to perform really well here,” says MacQuarrie, who adds, the Canadian program has an advantage in that there are fewer competitors with less overlap, than in the U.S. market. This difference allows more room for the collaborative approach needed for meaningful knowledge sharing.

For his part, Trotman, the COG SP program manager says the support and leadership from MacQuarrie and other supplier leaders is crucial to the program’s success. And, as more suppliers get

involved, it becomes a virtuous circle building more value for the participants.

“BWXT, with John’s support, has been a very active participant, attending all the SP meetings and presenting OPEX at every meeting. It’s clear that the BWXT representatives have John’s support and this has been instrumental in the success of the program,” Trotman says.

MacQuarrie says his company is always looking for ways to do things more efficiently and he views the COG program as a means to achieving that.

“With what we’re doing now, I would say COG has surpassed what I’ve seen in terms of collaboration in the U.S. market. And it’s still growing. I think it’s great. We’re trying to support it any way we can,” he says.

“I am really pleased with our engagement in COG these days – we’re getting more out of it than we ever did. The other thing COG’s done really well is bring the owners in... it’s a really good vehicle to bring them in. Without that engagement, suppliers wouldn’t get together as often as we do. I think it’s worked out really well. I’d like to see more suppliers join COG and see the program continue to expand.”

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BWX Technologies Inc., (December 2016). BWXT completes acquisition of GE-Hitachi Nuclear Energy Canada Inc.; <http://www.bwxt.com/news/2016/12/19/BWXT-Completes-Acquisition-of-GE-Hitachi-Nuclear-Energy-Canada-Inc>

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The Canadian flag is displayed large and proud in BWXT Canada Ltd’s headquarter facility in Cambridge, Ontario.

A century and a half ago the company’s predecessor got its start manufacturing boilers for fossil plants. Today the company manufactures a wide-range of products and provides many services for the nuclear industry.



A good steam cleaning

A new initiative improves safety and reliability in older steam generators

Steam generators have a historical role in electricity production but their potential to make or break cost curves remains as strong today as ever.

With advances in maintenance procedures and manufacturing materials, a well cared for steam generator can offer predictability and cost effectiveness. But aging boilers require special care or else they can be one of the greatest threats to reliability and productivity resulting in derating and lost revenue.

Best practices in boiler maintenance remains a critical focus area for operators looking to improve reliability and safety. In turn, these improvements can help operators attain the desired outcomes ascribed to the “nuclear promise” of safe, reliable operation that remains competitive with other generation technologies.

A COG primary side cleaning joint project

Primary Side Cleaning of boilers has been performed about a dozen times in CANDU reactors over the last two decades with uneven results. In December 2016, COG held a workshop to kick off the planning for a joint project (JP 4556 Boiler PSC) on primary side cleaning (PSC), which includes an effectiveness study to be completed in 2017-18.

Workshop participants created a list of 27 issues and agreed to 15 actions as a basis for an integrated industry plan to improve performance of the boilers through improved PSC. The workshop covered all aspects of PSC including reactor inlet header temperature (RIHT) gain, other PSC impacts as well as PSC process, technology, methodology, planning and execution in such areas as waste management, dose control and outage management. Participants also shared lessons learned and explored improvements in PSC technology.

“We have an ongoing need to monitor, analyze and mitigate the impacts of heat transport system aging,” says COG’s Paul Lafreniere, co-facilitator of the workshop with COG’s Bill Anderson.

This isn’t a new issue but there is a new emphasis on addressing reactor derating, says Lafreniere, recalling efforts to address issues such as RIHT going as far back as the early 1990s.

“RIHT rise due to oxide deposits in steam generators generates considerable interest among COG members,” he says. “This issue impacts all CANDU stations because it causes loss of safety margin and creates deratings. It remains one of the top threats to new and/or increased derating events for both C6 and Ontario stations despite these long-standing efforts.”

Workshop executive sponsors and co-chairs were Bruce Power’s Gary Newman and Peter Purdy. Bruce Power will need to keep its 1980s vintage B-plant steam generators at the top of their game until they are replaced as part of their major component replacement execution that runs for about a decade across the four units beginning in 2020. Some of the seminal 1990s research on boiler maintenance occurred at the Bruce site (see Reference List: Basu, Bruggeman, 1997).

Photo credit: Bruce Power



Lafreniere says bringing together operating experience and knowledge from across the industry on this initiative will be important to pulling together the empirical data and trends that will “allow us to better understand the heat transport system’s key aging parameters.” As well he says, it is important to “monitor the operating and safety margins, as well as effectiveness of any actions taken to mitigate aging impacts.”

At the workshop’s conclusion, specific goals for the project were identified:

- Measurable benefits from cleaning;
- Predictable RIHT gains from cleaning;
- Boiler tube ID fouling characterization;
- Effective cleaning application;
- Standard CANDU cleaning database to inform understanding; and
- Technology innovation.

A medium-term plan will be presented to members by March 31, 2017 with the effectiveness study to be concluded in the spring-summer period.

Why is effective primary side cleaning essential?

As they age, steam generators experience “corrosion, fouling degradation, and fretting of the upper bundle... leading to thermal and hydraulic inefficiencies as well as tube integrity concerns,” (Marsuka, Nickerson, Spekkens, Tapping, 2000). As well, an increase in reactor inlet header temperature can impact fuel integrity, resulting in a reduction of safety that triggers unit derating. Effective primary side cleaning can mitigate the effects of aging, thus maintaining safety and reliability thereby preventing deratings.

What is reactor inlet header temperature (RIHT) and why does it matter?

CANDU reactors operate within a small RIHT range during normal operation to ensure optimal safety and reliability. When the temperature rises above that window, it impacts critical heat flux in the reactor channel thus impacting fuel integrity. When this safety requirement is exceeded, it forces the unit to be derated. As they age, boilers and feedwater pre-heaters become less efficient at removing heat. Proper maintenance for older reactors as well as new materials in newer steam generators can significantly improve performance outcomes.

Steam generator maintenance application for the Darlington refurbishment project

Darlington Nuclear is currently undergoing its mid-life refurbishment. In total there are 16 steam generators (four on each unit). Extensive testing has verified the Darlington steam generators will not require replacement and are fit for the next 30 years of operation in part because the generation of steam generators used at Darlington had material improvements over those of previous plants.

The second factor in the generator health was advancements in maintenance occurring prior to Darlington’s start of operation and in its early years.

The units will be rejuvenated during the refurbishment outages with work to include water lancing, primary side cleaning (PSC) and installation of access ports to facilitate easier inspections post refurbishment. (Hunt, 2014)

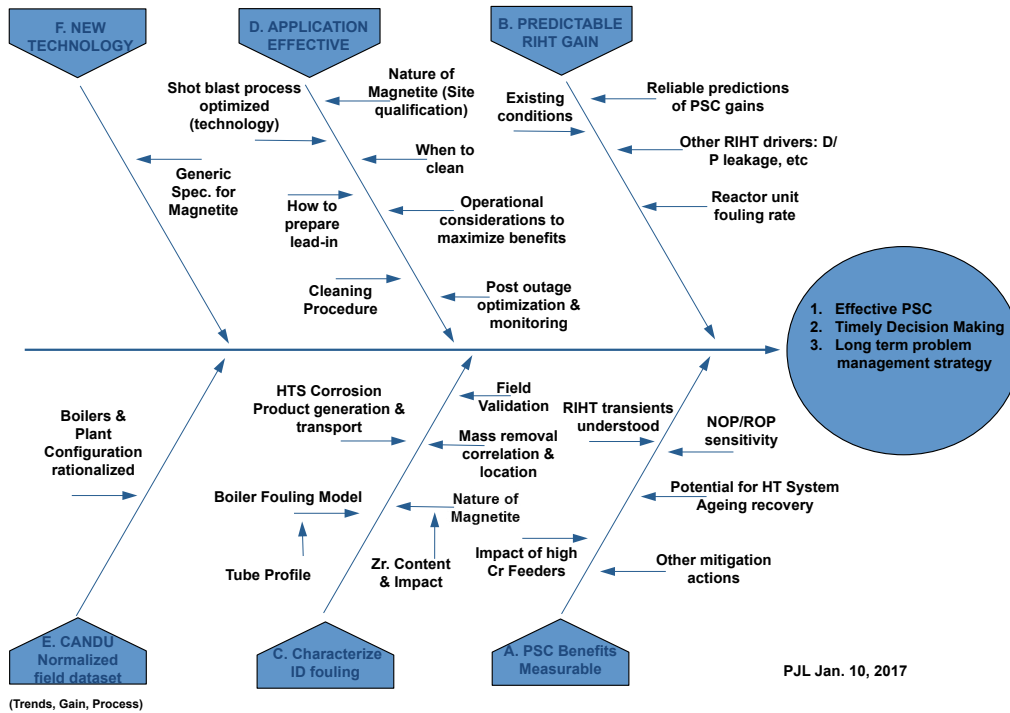
Bruce B’s steam generators are of an older vintage than Darlington’s. The four reactor units each have eight steam generators that were manufactured with older generation materials than the newer Darlington plant.

In 2015, Bruce Power signed a contract with BWXT Canada Ltd. (the successor company to original equipment manufacturer Babcock & Wilcox) for replacement steam generators to be installed as part of Bruce’s major component replacement project, which begins in 2020. There will be more than 350,000 engineering and labour hours resulting from the development and manufacturing of the new steam generators, according to BWXT Canada Ltd.’s president John MacQuarrie (Bruce Power, 2015).

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Boiler PSC Enhancement Fishbone Diagram



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SAFETY: THE NUCLEAR INDUSTRY'S #1 PRIORITY

Canadian delegation presents **Canada's report** at the Seventh Review Meeting of the Convention on Nuclear Safety

On March 30, a Canadian delegation led by the Canadian Nuclear Safety Commission (CNSC) Director General of Power Reactor Regulation, Gerry Frappier, presented the Canadian National Report at the Seventh Review Meeting of the Convention on Nuclear Safety.

The meeting hosted by the International Atomic Energy Agency in Vienna from March 27 – April 7 creates a forum for nuclear operators and regulators worldwide to convene every three years and report on their nuclear safety programs relevant to the convention. It is also an opportunity to review other country's nuclear safety programs, as well as discuss common issues, proposals and to create a summary report. The goal is to challenge and learn from others in an effort to continuously strengthen nuclear safety around the world.

In its presentation, the Canadian delegation, which included CANDU Owners Group (COG) President Fred Dermarkar, outlined how Canada continues to meet its obligations under the terms of the Convention and has strong measures in place for the safe operation of nuclear power plants in Canada, as well as to protect the health and safety of the public and the environment.

"Safety is always the industry's first priority," says Dermarkar. "When we collaborate to strengthen nuclear safety, we build upon the most foundational aspect of our operations and our social licence."

Read the presentation:

http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/Canadian-National-Report-for-Convention-on-Nuclear-Safety-Seventh-Report-eng.pdf

Read the Canadian National Report for the Convention on Nuclear Safety:

http://www.nuclearsafety.gc.ca/pubs_catalogue/uploads/Canadian-National-Report-for-Convention-on-Nuclear-Safety-Seventh-Report-eng.pdf

Read the responses to questions raised from peer review of Canada's Seventh National Report for the Convention on Nuclear Safety report:

<http://nuclearsafety.gc.ca/eng/pdfs/Reports/convention-on-nuclear-safety/responses-to-questions-raised-from-peer-review-canadas-7th-national-report-for-cns-eng.pdf>

For more information on Canada's participation in the Seventh Review Meeting of the Convention on Nuclear Safety, visit:

<http://nuclearsafety.gc.ca/eng/reactors/power-plants/convention-on-nuclear-safety/index.cfm#sec2>



CNSC Director General of Power Reactor Regulation Gerry Frappier and COG President Fred Dermarkar (above) presented the Canadian National Report. The CNSC's Executive Vice-President and Chief Regulatory Officer, Ramzi Jammal, was elected president of the Seventh Review meeting.

Canada's reports for the Seventh Review Meeting emphasize a commitment to openness and transparency, research and development, peer review, sharing operating experience, safety culture and continuous improvement. Achievements highlighted include Canada's excellent nuclear safety record; enhancements to the nuclear regulatory framework; and the completion of the Fukushima action items, which addressed safety improvements aimed at strengthening defence in depth and enhancing onsite emergency response.

Canada has been one of the staunchest promoters and supporters of the Convention's objectives and was one of the first countries to ratify the Convention in 1994. Recognized as a leader in nuclear safety, the CNSC's Executive Vice-President and Chief Regulatory Officer, Ramzi Jammal, was elected as president of the Seventh Review meeting. Since Mr. Jammal took on the role as president, he has advocated to increase participation and transparency, and to improve the exchange of information at the Seventh Review Meeting.

Dermarkar attended the event to support COG members and to identify opportunities to further address challenges that may face CANDU operators. The meeting also provided an opportunity to share operating experience (OPEX) and solutions created by COG members with the rest of the international nuclear industry.

"It is a chance for us to learn from others and to contribute to strengthening nuclear safety worldwide by sharing our experience as well," says Dermarkar. "For example, Romania was cited for good performance because of its use of OPEX feedback through the COG screening committee."

Dermarkar adds that the meeting in Vienna provides an excellent opportunity to connect with COG's international members to get a deeper understanding of both the challenges they face as well as the efforts they are making to strengthen their respective nuclear safety programs.

With files by: *Canadian Nuclear Safety Commission*



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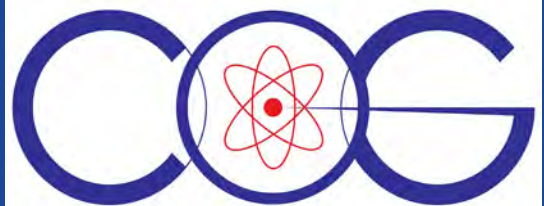
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