

COGNIZANT

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SCIENCE!

Temperature impacts on fuel bundles explored

REFURBISHMENT

A partnership between suppliers and utilities

RESILIENCE

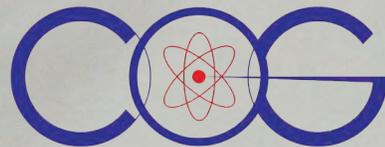
Reflecting on Fukushima five years later

EQUIPMENT RELIABILITY

Achieving results through diversity and a condition-based approach

Stakeholder Edition

CANDU Owners Group Inc.



"Excellence Through Collaboration"



A message from CANDU Owners Group President Fred Dermarkar

Lessons from the road

Reflections from IAEA and WANO:

Events from the past and lessons for the future

This year marks a coincidence of milestone anniversaries for the two most significant nuclear events in history. The 5th anniversary of Fukushima and the 30th anniversary of Chernobyl occur in March and April, respectively.

The IAEA held a conference in Vienna focussed on safety culture to reflect upon what we've learned since Chernobyl. In Tokyo, WANO looked at lessons learned, and actions taken, as a result of Fukushima.

In my role as COG president, I was fortunate to participate in both, and perhaps equally, fortunate for the long airplane rides back that gave me time to reflect on them. By happenstance, some of the lessons I took away were from the airline industry, which, like the nuclear industry, lives in the shadow of low incidence, high consequence events. Here are a few of my in-flight thoughts, from the time well-spent with my international colleagues.

1. We want to control everything but we can't

As engineers, perhaps we are more prone even than other humans to try to control everything in our life and certainly in our nuclear plants. The reality is we cannot. The sooner we accept this and start to instead, prepare ourselves to react to the unexpected, the more resilient we will become.

2. We cannot get too enamoured with our own brilliance

Over the past two decades, plant performance has continued to improve and we have seen a steady decline in the rate of events. However, improved performance is not a full inoculation from high consequence events, which can come from activities not previously considered. While we can and should celebrate success because it is a strong motivation to strive for further success; we must be careful to avoid complacency.

3. Listen for the whispers

I don't mean this literally but it is a good way to remember it isn't what we don't know that hurts us most often. It is what we fail to see and hear. In the busy work of running nuclear plants, it is easy to get distracted by the problem of the day. Often the things that get us into significant trouble are the ones we never expected yet in retrospect, when we look back, there were signs if we had been able to see and hear them. A healthy safety culture is founded on trust and a questioning attitude. It helps us to see the shadows and to hear the whispers.

4. Nuclear energy is an eco-system with many parts

A systemic view of human and organizational factors (HOF) is important across all organizations interacting with nuclear energy. This includes regulators, suppliers, labour unions and other stakeholders. Each is an input to the safety eco-system and, it is a cliché for a reason -- we are only as strong as the weakest link. Following Chernobyl, the focus was on utilities; after Fukushima, it was the regulators. Today, we have a

better understanding of the important role of suppliers, as is illustrated throughout this issue of COGNIZANT.

And here we end back on the airplane that safely delivered me home. In the years leading up to 1997, the airline industry's safety record was steady and acceptable. And yet, between 1998 and 2007, a concerted effort of all relevant stakeholders working together resulted in an 83 per cent reduction of fatalities through a systematic and collaborative approach.

This is what we must strive for: safe landings regardless of weather conditions or unforeseen events. We must have procedures to reduce the likelihood of these events and, at the same time, encourage a culture of knowledge and a bias toward action that allows us to avert or recover from them should they appear.

Working together for nuclear safety



CANDU Owners Group recently signed a practical agreement with the International Atomic Energy Agency (IAEA) confirming cooperation between the two organizations on matters of nuclear safety including COG members' participation in meetings, workshops and other activities of common interest, information exchange and mutual technical support. The technical support also reflects the participation of COG members in activities such as the Operational Safety Review Team (OSART) and Safety Aspects of Long-Term Operation (SALTO). COG President Fred Dermarkar, (above with Greg Rzentkowski, director of the IAEA Division of Nuclear Installation Safety) says the agreement is an example of how collaboration can bring diverse stakeholders together to achieve positive impacts for nuclear safety.

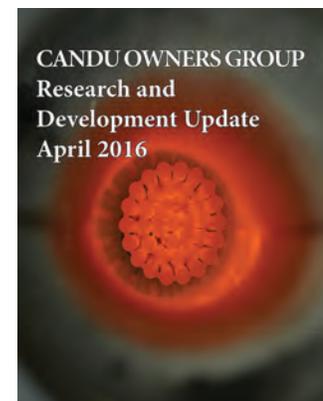


Suppliers and utilities stand together 12

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COVER PHOTO:
 Courtesy of Canadian Nuclear Laboratories
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Engineering safety culture through collaboration

COG panel triangulates perspectives at IAEA safety culture conference

A workplace is as safe as the organizational foundation it is built on and the actions and behaviours of its leaders, its regulator, its operator, its workers and its suppliers.

Canada's representation at the 2016 International Atomic Energy Agency (IAEA) International Human and Organizational Aspects of Assuring Nuclear Safety Conference in Vienna was symbolic of the industry's increasing commitment to a collaborative safety principle, with a diversity of industry stakeholders in attendance and presenting.

CANDU Owners Group President Fred Dermarkar chaired a panel with Bruce Power Executive Vice President and Chief Nuclear Officer Len Clewett and AMEC Foster Wheeler's Director Major Component Engineering Dave Dennier who together were able to bring both the utility and supplier perspective on an evolving industry with changing expectations on its supplier community.

Fellow-Canadian presenters from the Canadian Nuclear Safety Commission (CNSC) and other members of the nuclear consulting community also presented on some of the industry's most recent thinking on the topic of organizational behaviour and human performance; including how to drive culture change within organizations.

"An important point conveyed at the conference is safety is not at the utility level or the supplier level – it is at the *project level*," says Dermarkar. "It must be a collaboration between all stakeholders and it must be embedded into the industry's culture in an authentic way."

Dennier, echoing words he has spoken at recent COG workshops and in his role as COG Supplier Participant Committee chair, said the increased participation of suppliers in COG reflects the supply community's new role. And, he said, with this evolving role, comes a new responsibility on that community to create its own collaborative culture in which OPEX, especially as it relates to safety, is shared.



Utilities have new expectations on suppliers, agreed Clewett, who said they specifically look to work with suppliers who have the right mindset. There needs to be a willingness to engage and investment in the resources and efforts required to ensure workers are job ready not just with the tools and technical knowledge but also with an understanding about safety expectations. Clewett listed utility expectations of suppliers as including:

- A commitment to safety,
- A customer focus,
- Excellent quality management,
- Strong ownership and advocacy for human performance,
- A robust human performance program,
- Healthy safety culture, and
- A learning organization.

Dennier said the supplier community's awareness of the expectations on safety culture has risen significantly in recent years. Now, he says, the focus is on execution. 🚫

Beyond nuclear: Other industries share similar goals

A mixed representation from diverse industries was one highlight of the IAEA 2016 safety culture conference, says COG President Fred Dermarkar.

Participants heard from the chemical, oil, gas, transportation and aviation sectors. Dermarkar says one point that stuck with him was the significant improvements made in the airline industry in the early 2000s after that industry adopted a unified approach to fatality reduction.

"They took a systematic approach of operators of the

airlines, regulators, labour and manufacturers all working together," he says, noting in the span of a decade the industry accomplished an 83 per cent drop in fatalities.

"It is a change in paradigm to have all these stakeholders working together. There is tremendous value to a diverse peer group on safety culture, human performance and organizational behaviour, all working together and sharing views, each from their particular viewpoints. That is a powerful opportunity to impact safety."

Building Resilience: Lessons Post-Fukushima

COG president presents Fukushima Daini case study at WANO conference

Five years after the events at Fukushima, March 11, 2011, the global conversation surrounding the earthquake and subsequent tsunami most often refers back to the outcome at the Daiichi nuclear plant, the one that prompted a full-scale industry response and a new standard of preparedness.

At a presentation to the World Association of Nuclear Operators Post-Fukushima conference, held in recognition of the anniversary, CANDU Owners Group President Fred Dermarkar focused on the outcomes at the other affected nuclear plant, Fukushima Daini, six miles north of Daiichi. And, he spoke to the “innovative approaches and insights” COG member organizations have taken in their subsequent response.

Daini: Extraordinary response in the face of a dire situation

When the tsunami hit the Daini plant, the station lost AC power to three of the four units, with only residual heat removal on Unit 3 available. The other units relied entirely on the reactor core isolation cooling for their heat removal.

- The team took four basic actions to recover the plant:
- Took stock of the situation;
- Established priorities;
- Pulled together the equipment required;
- Systematically executed the actions identified.

On the ground, this meant working with unprecedented speed to lay nine kilometres of heavy cable, installing power transformers and replacing pump motors within 60 hours of the initial tsunami strike; all during aftershocks and under the threat of another tsunami. For many of the workers, it also meant intense focus during a time of great duress as they worried about family affected by other aspects of the earthquake and tsunami.

The team was backed up by staff at their corporate office, who pulled out all stops to procure and deliver large motors, cable, mobile power vehicles, fuel oil and power transformers, all within hours as the country’s turmoil raged on around them.

In short, says Dermarkar, it is a “case study of what can be accomplished through human and organizational resilience, which is the ability to adapt and successfully respond to unexpected events.”

“Forced circulation to Units 1, 2 and 4 was restored directly as a result of the ingenuity, commitment and teamwork of the leaders and workers at the site, not to mention their courage,” he says. “They demonstrated extraordinary resilience, both as individuals and as an organization.”

The roots of resilience

As Dermarkar sees it, the Daini outcome, while heroic, was equally a reflection of the principles all nuclear operators work to build into their programs, and, when successfully inculcated, can bring a measure of predictability to outcomes during unanticipated events.

“We have developed very robust processes for selecting and training nuclear professionals at all levels in the organization. And we have developed best-in-class experiential and leadership training and development,” says Dermarkar. “But we cannot be complacent.” The question, he asks, is what would have happened if a different crew had been on deck during the incident? Would the result have been the same?

The answer: Our processes, our training and our selection of personnel must ensure that it would be.

A COG member response

After Fukushima, the world’s nuclear operators took stock of what occurred at both Daiichi and Daini. It was a time for introspection and then for action. Operators responded to their own motivation to learn and improve. They were also reacting to demands from outside forces: regulators, governments and the communities who trust them to safely generate electricity on their behalf.

Five years later it is possible to look back at what has been accomplished and know that changes were made that not only prepare for tsunami events but for any unexpected, even unpostulated activity.

Innovative approaches to strengthen resilience

One of the first responses was an equipment-based response; a full review and reinforcement of location and redundancy of site power generation in the event of an emergency.

Beyond the physical system hardening, the operators recognized a need for human and organizational resilience – ways to ensure certainty in event response.

Bruce Power spent two years developing a simulator for damage modelling specific to their site, such as high winds. The objectives of the project included an ability to better quantify probability of success for different strategies and to create a tool for training that allowed staff to directly interact with realistic scenarios.

WANO continued...

To facilitate the transition from the traditional rule-based paradigm to knowledge-based decision-making, OPG developed tools to assist its operating crews and thereby enhanced their resilience. This meant rethinking culturally-embedded norms around how decisions would be made in crisis events and preparing for them in a new way. It also meant reconditioning staff to be more comfortable and confident in decision-making scenarios outside of textbook events.

As well, recognizing there are often competing demands and insufficient resources in a significant event, OPG developed a prioritization system and captured it in the relevant operating documents with the intent to empower their teams to act decisively in the face of difficult choices.

“The prioritization and decision-making guide is founded on a bias for action: that a good plan executed today is better than a perfect plan executed tomorrow,” explains Dermarkar.

In undertaking these initiatives, what the operators found was staff eager to innovate and create new ways of applying their knowledge and skills. As well, it became apparent muscle memory builds the confidence and decisiveness required to execute. Managers who had prior experience working with ambiguity were more comfortable in the new paradigm, and more adept at adapting their thinking

to address unanticipated events. The challenge, says Dermarkar, is figuring out how to give new workers, working in highly reliable operating plants and using near-perfect procedures, the experience and ability to improvise that older workers acquired at a time when procedures were less than perfect and plants experienced more frequent events.

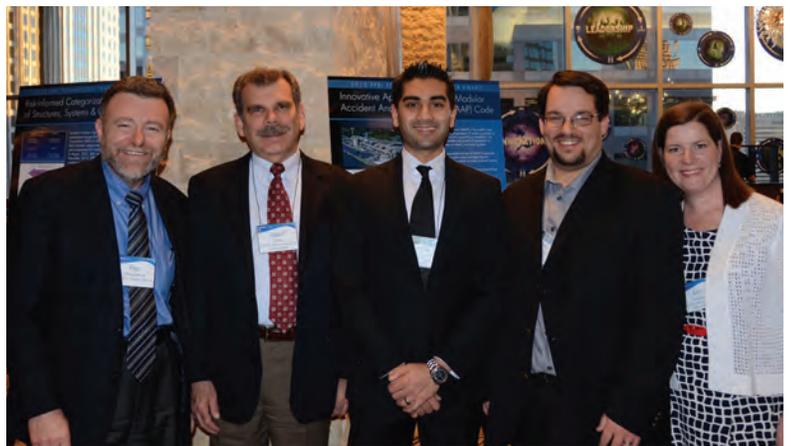
To go back to the initial question of what if there was another crew on that day at Daini, Dermarkar notes training and preparation needs to go beyond the intellect. In part it is about identifying and selecting for other ideal traits.

“There are complex challenges to human and organizational resilience that need to be better understood,” says Dermarkar. “For example, stress, fatigue and degraded communications are all known to have an adverse impact on leadership, decision-making and team dynamics.”

And, he adds, there is much work on the topic outside of the nuclear industry that can be adapted as well.

“Ultimately, we could work towards a set of principles that define or describe what excellence in resilience looks like.” Resilience, he says, is a critical building block in the foundation of nuclear excellence. 🌟

COG Member wins EPRI Technology Transfer Award



COG President Fred Dermarkar (far left) stands with EPRI Technology Transfer Award winners Ghulam M. Khawaja (middle), Bryan Villemaire (middle right) and colleagues at the EPRI conference.

Ontario Power Generation receives prestigious award for its innovative applications of the Modular Accident Analysis Program (MAAP) Code

Ontario Power Generation (OPG) employees Ghulam M. Khawaja, M. Sc., P. Eng. Senior Technical Engineer and Bryan Villemaire, Assistant Technical Officer were recently honored for their work in applying research and development (R&D) by the Electric Power Research Institute (EPRI).

The OPG employees received EPRI Technology Transfer Awards, given annually to EPRI members who have led technology transfer efforts on behalf of their companies and the industry at large. The awards were presented during EPRI's Nuclear Advisory meetings in Austin, TX, Feb. 9, 2016.

EPRI's Modular Accident Analysis Program (MAAP) is the most widely used tool for investigating the progression of severe accidents in nuclear power plants. OPG expanded the use of MAAP to evaluate and

consider uncertainty in nuclear plant severe accident evaluations and to include the ability to model multi-unit severe accidents.

OPG developed and implemented two first-of-a-kind applications of the MAAP code, running the code hundreds of times as part of a probabilistic safety analysis and submitting MAAP results to the Canadian regulator in response to regulatory requirements. OPG shared its methodologies and lessons learned with EPRI to inform further improvements to the MAAP code.

“Through this project, we learned a great deal about multi-accident scenarios and how to address uncertainty in severe accident analysis,” said Neil Wilmshurst, EPRI chief nuclear officer. “The collaboration demonstrated by OPG will enable the nuclear industry to continue improving with respect to safety, reliability, and affordability.” 🌟

EQUIPMENT RELIABILITY

Diversity initiative gains traction

A cross-functional approach to reliability is delivering promising results

Over the past three years, the COG Equipment Reliability Peer Group (ERPG) has been developing a more diverse approach for a committee once comprised primarily of engineers.

In 2013, the group, facilitated by COG Project Manager Ken Keown, and then-group chair Steve Miller of Bruce Power, moved to a cross-functional peer group to capture the knowledge and input of people working across the spectrum of plant roles. It has given them a 360-degree look at how to better tackle equipment reliability.

At their semi-annual conference, held in November 2015, the group was able to look back at the work of the past three years and celebrate the improved results at the various stations, aided in part, by this strategy.

Prior to 2013, “the committee was highly-engineering centric,” says Miller, who finished his role as committee chair this year but who continues to participate on the peer group. Given the field dynamic requires a cross-functional team approach, it only made sense for the COG peer group to mirror that.

“The information from the people working in the field needs to get back to the engineers responsible for maintenance strategy to make it more effective. Everyone needs to be working together and providing feedback so we know the right resources and where they should be applied,” says Miller.

Adds Keown, the result has been products that reflect well-rounded insight and can be integrated into plants across the CANDU fleet for better operating results.

The international composition of the ERPG means lessons are being gathered from many perspectives and different approaches. The peer group consists of all the Canadian operators as well as Argentina, China and Romania. Results from implementation of the group’s work are also trending upward on an international basis, which is

significant given the integral role of reliability in a nuclear plant’s success.

“You cannot have effective station performance if you haven’t got equipment health,” says Keown. “And station performance is a measure recognized worldwide... and with these economic times you’ve got to maximize performance while maintaining safety as the primary focus.”

As for the November conference at Bruce Power, Keown says it was of tremendous value for those who participated to have not only the opportunity to network and discuss but also to see strategies in practice.

“Not only did we work collaboratively on key equipment reliability activities and share practices that will help each other, but we were able to witness first-hand Bruce Power’s strategic activities and important meetings that support equipment health,” says Keown.

As a peer team, the ability to collaborate, create guidance for best practice processes and then see them executed is full circle of what peer groups are intended for. Seeing that reality coming together was hugely satisfying. 🌟



Photos courtesy of Bruce Power

Step 1: Creating a blueprint for reliability

Gathering lessons learned is just the starting point to tackle a problem. The next step is creating a strategy that can be replicated to effectively manage it on an on-going basis and making it work in the plant.

The Equipment Reliability Peer Group (ERPG) has developed a series of documents that provide tools to be adapted to each COG member's own situation and needs (see links at the end of this article) to move the theory into reality.

"One of the key aspects of getting this group together is working on products that everyone can use to improve equipment reliability," says Keown. "They can use part of it, all of it – it's the best practices from all of the sites in one spot and that's the advantage."

At the peer group's November conference, Bruce Power shared how some of the initiatives have taken root at their site.

The Equipment Health Initiative has helped the company better identify priorities for their maintenance programs and the results have included improved performance and lower backlogs. As well it ensures critical safety equipment remains available for service. At its roots, the initiative uses the principles of the cross-functional team approach to bring engineers, operators, maintainers and schedulers together more immediately and in a more coordinated manner.

Preventative maintenance (PM) strategy: At Bruce Power, engineers once relied on an equipment rating report from maintainers that might be a month old by the time the report was filed and the engineering team actually reviewed it. Now, the connection between the engineer and the maintainer has become much closer, with meetings taking place within a week of the job completion and more fulsome reports that include more detail of what the maintainer saw during the field inspection and maintenance process.

The assessment process for the equipment has changed as well. **A component classification and maintenance strategy review**

allowed CANDU operators to rethink how they categorize equipment in two criteria: Required maintenance frequency and criticality. The two criteria in tandem create a matrixed approach to maintenance decisions that helps the organization better determine which equipment gets priority and when.

At Bruce Power, some preventative maintenance was actually scaled back after the analysis indicated the component condition was consistently high. By reducing unnecessary maintenance, managers were able to ratchet up maintenance on higher priority equipment, such as parts related to safety, more critical to performance or components found to be degraded during routine preventative maintenance visits.

"This is about doing the right work at the right time and we want to make sure we are doing the most necessary work," says Miller.

Condition-based maintenance (CBM) strategy: While the move to an optimized CBM strategy in itself has been helpful to improving reliability across the CANDU fleet, the group didn't stop there. The approach has been subjected to further refinement.

One initiative the peer group observed while at Bruce Power is the **Catch, Saves and Misses** identification process that helps the company track its human performance on reliability initiatives. Each maintenance report is binned into one of three categories:

A Catch: Information was proactively used to get equipment onto the maintenance schedule before it failed;

A Save: Equipment that should have been identified sooner but still gets repaired ahead of a failure;

A Miss: Information was not used in time to avoid a failure.

The program reinforces the value of communication across work groups, says Miller. "It helps people think about how we use information and also helps us to engage the maintenance folks by showing how their information is useful."

Step 2: Measuring progress

Whether its equipment reliability or any station performance indicator, the key to successful tracking is to ensure you have the right measures to catch emerging trends early thereby ensuring performance success in the places it matters most.

Over the past year, the COG Equipment Reliability Peer Group (ERPG) has developed a new set of metrics to ensure the right measures are being taken to optimize performance and work management efficiency.

This is particularly important in a nuclear landscape that is not standing still anymore, says Keown. "The US is changing and we have to be in step... As an industry we are progressively focusing on key elements that will drive up equipment reliability."

While the first step was identifying the focus areas the second is tracking them in a meaningful way and finally, it means relentlessly chasing down areas for improvement until they are trending GREEN. To achieve this, the team has developed a system that moves away from a four-colour system. Keown says the previous colour system may have inadvertently encouraged complacency so the team recommended a three-colour system that conveys a more appropriate sense of urgency. Where the old system included a WHITE level

between YELLOW and GREEN, today the system gives no middle ground between action required and a satisfactory rating.

"If you're in yellow, you want to get out of it and get to green," says Keown, adding, senior management have been on board and the new coding is being adopted elsewhere with other plant initiatives.

In addition to the change in coding, the new indicators also shifted the weighting on the items tracked to better reflect criticality. The changes were made only after significant input right across the international fleet, says Keown.

"There was a huge amount of collaboration, validation and stakeholder input," he says crediting the group for its tenacity in getting the new indicator into pilot testing. The group anticipates the full CANDU fleet will be using the new indicator by 2017.

Early results suggest it is making a difference, with steady improvements in 2015 including a particularly positive fourth quarter result.

Says Keown, "It was an unbelievable amount of work to get us here but it is just that important for the industry that makes it more than worth the effort." 

A Man for the Time

With his blend of operator and supplier experience, OPG's new president may have arrived just when we need him most.

You might say Jeff Lyash, Ontario Power Generation's (OPG) new president and CEO has made a career of supply and demand.

With more than three decades of energy industry experience under his belt including time as both a plant operator and as an engineering, procurement and construction (EPC) contractor, Lyash joins the CANDU industry at a time when the relationship between the two has never been more critical.

And nowhere is this truer than at OPG, poised to enter execution phase of the \$12.8-billion Darlington refurbishment, the success of which will depend on performance excellence from both sides.

A bit more than 90 days into his new post this past December, Lyash sat down with CANDU Owners Group (COG) members and supplier participants at COG's Toronto office to share a vision for refurbishment, operating success and the opportunities that might come if OPG and the CANDU industry can achieve both.

At the time of Lyash's visit, OPG was just a month away from announcing that after six years of planned preparation, it is on schedule to begin the execution phase of the Darlington refurbishment this fall. As part of the announcement, made in conjunction with the Ontario government, it also announced its intent to continue operation of the Pickering Nuclear Station until 2024. Pickering's continued operation will help Ontario maintain the low carbon electricity footprint it currently enjoys during the time when the OPG and Bruce Power refurbishments will cross paths.

In a free-ranging conversation with COG president Fred Dermakar, the OPG president shared his first impressions of the

"I was very pleased to see the health of an organization like COG because at the heart of this industry has to be sharing lessons learned, helping others learn from each of our experiences, collaborating where there are technical issues to be solved or where there are opportunities to strengthen nuclear safety performance, lower cost, extend asset lives."

Canadian industry as well as his thoughts about what the company, the industry and its members need to accomplish in the next decade and a half. He also spoke about the essential role COG and suppliers must play to ensure the industry's success.

The role of nuclear

"I think the power industry is one of the most vital careers you can engage in globally," Lyash said reflecting on his life's work. "We all know how important electricity — reliable, environmentally-sensitive, cost-effective electricity — is to quality of life and



OPG's new president, Jeff Lyash, brings three decades of experience with utility operation as well as engineering, procurement and construction expertise. All of these are directly relevant to the Darlington refurbishment project set to go into execution phase.

security." The nuclear industry, he added, is "a critical part of the long-term solution to providing electricity to the two billion people in the world who don't have it and to shrinking the carbon footprint of not just the generation industry but the transportation, home heating and (industrial sector) over the next 30 to 40 years."

Safety: Always the top priority

While refurbishment was clearly on his mind, Lyash started his new job's priority list with safety, an over-arching theme he returned to throughout the discussion.

"My first priority is safety; nothing is more important than that and in making sure that's not just something we talk about but that's something we operationalize and that's something we build into every behaviour, every day," he said.

It starts, he added, with personal safety "because it is the discipline in observing personal safety from which everything else falls out," including great nuclear performance.

"It's respect for the rules; it's understanding the situation; it's following process and procedures; it's training and qualifications; it's all the things that make an operation successful."

Continued...

Refurbishment: Securing a nuclear future for Ontario

Of course on everyone's mind, including the man now ultimately accountable for its success, is the project set to roll into execution this fall.

Like anyone with lengthy experience in the industry, Lyash has seen the consequence of projects that succeed and of those that fail. He has worked at Duke Energy, Florida Power, Progress Energy, Pennsylvania Power & Light, Tennessee Valley Authority and has had various roles with the U.S. Nuclear Regulatory Commission, all sufficient to give him the combination of confidence and self-deprecating humility that comes across as he speaks about the road ahead.

Perhaps, as important, is the diversity of his experience. From July 2013 until joining OPG last summer, Lyash served as president of the power division of the EPC, Chicago Bridge and Iron (CBI) at its Charlotte, North Carolina location.

“What we're really trying to do is stand up suppliers... (who have) a discipline that will guarantee results, or at least assure the results at a very high level and have a safety culture built into that. If you're really in it for the long term, I want our organization partnering with you and helping you to get where we need to get.”

He has seen many facets of the nuclear sector and of big projects from both sides of the supplier-operator dynamic, the public and private sector, and from the project and operations angles; all directly relevant experience for the Darlington project and all with experiences that would make him appropriately respectful of the challenges the refurbishment team will face.

“My priority is to make sure we are well-prepared and we deliver Darlington refurbishment on-time/on-schedule, on budget, at the level of quality required at a nuclear facility, and safely, period. That's what we must deliver.

“I think this is not just important to OPG. It's important to Ontario, it's important to Canada, it's important to the nuclear industry... That's

what I am here to help the team deliver.”

Lyash's hand-off from previous OPG President Tom Mitchell came at a time when the Darlington project was poised to move from planning to execution; a good time for the baton to shift. After three months of intrusive examination of the preparation the company did before his arrival, he has concluded it is at the right state of preparedness. Now, he said, it's time to focus on execution excellence.

“A great plan is useless without great execution... when you think about execution you have to think about the refurb itself, which is not running a plant.” He recognizes the inherent tension when you have a project running in tandem with operation on the same site. The project mentality, he said, is about agility to course correct as necessary whereas in operation, the focus must be about maintaining procedure and consistency. “Those two approaches don't go terribly well together and they conflict at all the interface points.” But, as with any problem, defining it is the key to the solution.

Pickering: A veteran ready for continued tour of duty

In 2010, following a business-case analysis, OPG announced the decision not to proceed with the Pickering refurbishment. The decision followed successful safety and environmental assessments that favoured refurbishment but the business case did not provide the right economics. At the time, OPG announced a 2020 closure based on the government's long-term energy forecast of the day. In 2016, the need has changed, Lyash said, and so has the plan.

The date of 2020 “is not a technical date,” he said. “There's not a safety basis for that date; that was a placeholder date in the policy document. Another of my priorities is to determine what the real lifetime of Pickering should be and to make sure we, and the various stakeholders in this process, are ready to support whatever that right lifetime is.” Pickering can provide a low cost per megawatt, CO2-free energy, which “seems to be pretty important value we can deliver,” he added.

In fact, OPG has stated, the company's technical work shows Pickering can be safely operated to 2024 and that doing so will save Ontario electricity customers up to \$600 million and avoid eight-million tonnes of greenhouse gas emissions. Lyash has committed to work closely with community partners through the process, which will include approval from the Canadian Nuclear Safety Commission (CNSC). OPG has started work on a licence application for CNSC approval in 2018.

Continued...



OPG President and CEO Jeff Lyash, in conversation with CANDU Owners Group President Fred Dermarkar and other industry members this past December. Lyash shared his insights into the nuclear industry and the role of operators and suppliers in achieving project and operational success.

The role of suppliers in safety and performance

Lyash's former employer, CBI, was the first EPC company to win the Green Cross for Safety medal so perhaps it's not surprising Lyash brings a cultural expectation that suppliers play an important role in nuclear safety.

Quick to state he understands the conflicting pressures suppliers' experience, Lyash noted how important it is suppliers find a way to provide quality assurance.

The industry needs "a supplier community that shares lessons learned, that drives for continuous improvement, that sets standards at a level that exceeds what the owners and the customers need and that builds safety cultures," Lyash said. The work and the parts the suppliers contribute are embedded in the stations and therefore must withstand the rigours of production, not just the day the outage is complete but for the years the plant is expected to operate.

"What we're really trying to do is stand up suppliers, who with a full recognition of 50 years of nuclear experience behind them, understand how important traceability of material is; qualification of workforce; demonstration of weld procedures; inspection criteria... and they implement it with a discipline that will guarantee results, or at least assure the results at a very high level and have a safety culture built into that. If you're really in it for the long term, I want our organization partnering with you and helping you to get where we need to get," he said. Those not committed for the long term need not apply.

Suppliers have not always found it as easy to share OPEX as operators. Lyash gets the constraints of commercial sensitivity but insists that cannot get in the way of building safety culture and sharing critical safety information.

"No judgments implied -- of course suppliers have to be mindful of commercial sensitivity. It is different for a supplier versus an owner but... we tend to hide behind (commercial sensitivity) more than we need to. With more careful thinking and a better parsing of what it is we're sharing and what it is we're not, there is a lot of ground to share that does not, really, impact commercial interest."

In fact, many suppliers and industry members have recognized the same thing. At COG, initiatives are already underway to help suppliers connect with the operators and with each other to share operating experience and develop processes. Just days prior to the Lyash visit, COG and the Organization of Canadian Nuclear Industries (OCI) held a joint workshop that brought owner representatives, regulators and suppliers together on the subject of supply chain security. There, several suppliers openly shared their own processes for prevention and protection methods.

"Just imagine if we open the breaker in October and we finish the Darlington refurb ahead of schedule and under budget and put the plant back in service and it runs like it should. What does that say about OPG and what does that say about the Canadian nuclear industry? It says a lot."

The role for COG

The history of COG and OPG (and OPG's predecessor Ontario Hydro) is inextricably linked. COG's research and development including fuel channel life management, joint projects undertaken with OPG and other members, the information exchanges and sharing of operating experience have all significantly benefited OPG, and conversely, OPG's participation has benefited COG's other members.

Even after a few months on the job, Lyash sees the value COG brings.

JEFF LYASH IN CONVERSATION

In December, Ontario Power Generation's new president, Jeff Lyash joined CANDU Owners Group members and supplier participants for a candid conversation on the state of the industry and his vision for OPG.

Below are some excerpts from his interview with COG President Fred Dermarkar.

1. [Why the nuclear industry matters](#)
2. [Safety](#)
3. [OPG's refurbishment](#)
4. [A role for COG in refurbishment](#)
5. [Supplier quality control](#)
6. [Opportunities come with success](#)

"I was very pleased to see the health of an organization like COG because at the heart of this industry has to be sharing lessons learned, helping others learn from each of our experiences, collaborating where there are technical issues to be solved or where there are opportunities to strengthen nuclear safety performance, lower cost, extend asset lives. To make that happen, an institution like this has to be in place... I really think about COG more like I think about EPRI for example in the way this institution and the members support the industry. So far I have been very impressed."

Going forward, he said, "There may be things with making this refurbishment process more efficient, more effective that can be identified where COG can have a role." Noting the Darlington refurbishment will go into 2026 and the Bruce Power refurbishment will be about a decade in duration starting in 2020, he added, "If there are ways to shorten those outages (such as) tooling, equipment, techniques; if there are ways to improve productivity and materials; you've got a big base here just in Ontario and I expect behind that is the international fleet because we want them to be as successful as the plants here in Ontario."

From success opportunity is born

While Lyash comes across as confident as he is experienced; his comments and tone reflect an awareness of fate's fickle nature when it comes to big projects. He is careful, even modest. Yet, he allows himself to imagine the potential the Darlington project could have to thrust OPG forward, and the industry along with it, should the company hold true to its promise of refurbishment success.

"If we're successful... where does that position OPG and where does that position the nuclear industry in Canada? And how do we take advantage of that five years from now? Just imagine if we open the breaker in October and we finish the Darlington refurb ahead of schedule and under budget and put the plant back in service and it runs like it should.

"What does that say about OPG and what does that say about the Canadian nuclear industry? It says a lot. It says you can deliver complex, long-term mega projects and meet what you promised to do."

If OPG does that, and Bruce Power does the same, Lyash said, he sees a renewed discussion about an even bigger role for nuclear in Canada's future. ☘

Spotlight on SUPPLIERS

A supply chain, accustomed to competition over collaboration, is developing new business norms as it assumes a leading role.

As the Canadian nuclear industry prepares for one of its biggest turns on the national stage yet – 15 years of continuous refurbishment execution at Ontario Power Generation and Bruce Power – the spotlight has never been more focussed on its performance and the stakes never higher.

And, as the industry shifts from straight operation to balancing generation with a project mentality, so too it must shift from its traditional utility-led framework to one with a shared leading role for suppliers. More accustomed to quieter supporting roles, suppliers' performance in many facets of the refurbishment could be the difference between critical acclaim and an early close to the show.

“The Tier-1 suppliers understand OPEX (operating experience), safety and the need to deliver on time and on budget,” says Ian Trotman, COG’s point person for coordinating refurbishment readiness industry-wide. “They understand the concepts and many have robust processes in place already.” But although awareness of the need is growing, many suppliers are struggling with the balance of competitive advantage versus a collective need for the highest calibre in safety and performance industrywide and in some cases, finding the manpower to participate in collaborative efforts, he says.

A recent utility-supplier workshop, with more than 70 participants, organized by Trotman for COG and supported by the Organization of Canadian Nuclear Industries (OCI), provided an opportunity for suppliers to get a deeper understanding of the new expectations more traditionally saved for the utilities.

“The industry (specifically utilities) has known for a long time it does not compete on safety,” says Trotman. With watershed events starting with Three Mile Island in 1979, the utilities quickly learned that as goes one plant anywhere worldwide, so goes the industry. “We share each others successes, and more so, suffer collectively for individual failures.”

An increasing awareness of the impact of suppliers on safety and



Dave Dennier, AMEC Foster Wheeler’s director of major component engineering and chair of the CANDU Owners Group supplier participant program.

overall performance is not confined to the CANDU fleet. A key speaker at the COG workshop was Institution of Nuclear Power Operations (INPO), Program Manager Undrenia Burnside, who told participants strengthening supplier performance is part of an industry-wide strategy for improvement. The goals, she said, include ensuring there are no significant events created by suppliers; maintaining appropriate nuclear standards; and developing a culture of continuous improvement and commitment to excellence. This needs to occur throughout supply chain, just in the same way the utilities have learned to strive for these same outcomes. Specific guidance is laid out in INPO-14-005, Principles for Excellence in Nuclear Supplier Performance.

Dave Dennier, AMEC Foster Wheeler’s director of major component engineering, chairs the COG supplier participant program. He says there has been a lot of talk in the industry supply community around the idea of collaboration and the need for it. However, he says, the emphasis now needs to move to execution. Sharing is improving he says but it is not there yet.

A framework for collaboration is really just the beginning of the work suppliers have ahead of them. There are a myriad of focus areas the suppliers will need to address in the coming months and years including the challenging logistical issues that come with any mega project. In the past, issues such as timing for parts ordering and delivery has put a monkey wrench into the on-time, on-budget mantra.

This time, as the world watches, the suppliers will own part of the success, and part of any failure, in a whole new way. 🌟



From left to right: Presenters Dietmar Reiner (OPG), Sean Toohey (OPG), Dan Playfair (Bruce Power) and Chris McConnell (OPG) spoke to the importance of a shared safety culture and understanding by all suppliers and contractors.

Understanding fuel bundle behaviour

Research on temperature impact reaches a milestone

A major milestone was reached with the completion of experiments on high temperature fuel bundle deformation behaviour. This multi-year project, conducted under the COG Safety and Licensing R&D program (WP 20306), measured fuel bundle deformation under high temperature conditions.

The experimental results will allow the industry to address outstanding industry and regulatory concerns regarding fuel bundle deformation behaviour during certain Anticipated Operational Occurrences (AOOs) and Design Basis Accident (DBA) conditions.

The work, which began in 2007, is funded by Bruce Power, Canadian Nuclear Laboratories (CNL), Ontario Power Generation, New Brunswick Power, Societatea Nationala Nuclearelectrica and Korea Hydro and Nuclear Power. The experiments were conducted by CNL.

Analysis of the data continues.



For more details on this and other research, see the COG Research and Development April 2016 Update on COGonline.

Highlights of progress in the High-Temperature Fuel Bundle Behaviour Experiments (WP 20306)

- Tests with externally heated 37-element fuel bundles were completed in July 2014. This test achieved 800°C sheath temperature at an average heatup rate of ~0.5°C/s. The measured displacement of the elements at the bottom of the bundle was small and insufficient to touch the quartz tube supporting the bundle.
- Seven element testing was carried out in mid-November over a temperature range of 600°C to 1200°C at a heat up rate of ~18°C/s. Good data was obtained.
- Data analysis is ongoing. Post-test examination of fuel-element simulator bundle to follow.
- The final report on 7-element tests released in March 2016.
- Experiments are complete. Most of the work package objectives were met.
- Enough data is now available for the development of a deformation model for AOO and some types of loss of Coolant Accident (LOCA).
- Another work package at Stern Laboratories measured deformation in a 7-element bundle at to investigate the deformation patterns of a CANDU fuel bundle under simulated Large Break Loss of Coolant Accident (LBLOCA) conditions. The test includes a fast transient, when high power is applied to raise the sheath temperature to above 1000 °C at a heat-up rate of 50-100 °C/s.

The CNL project lead Dr. Catherine Thiriet said, “Designing the test apparatus and measuring deformation, from a heated fuel bundle non-intrusively using high-tech lasers, was the most challenging experience in my time at CNL.”

Steam generators get a textbook solution

COG joint project is a 25-chapter book with CANDU expertise from soup to nuts on generators

A new 25-chapter textbook, a year in the making and featuring chapters by CANDU industry experts, examines all of the CANDU steam generators, comparing them to PWR steam generators and showing the similarities.

The book illustrates how CANDU plants can both learn from PWR experience, and how CANDU steam generator technology has been applied in PWR plants, says its principal author, James C. Smith co-owner and manager of Business Development, Northern Nuclear Industries Inc.

The COG collaborative project covers the basic definition of what a steam generator is and what it is required to do in the plant, how the design is developed, key parts of the equipment, manufacturing and operational aspects of the equipment. Tube materials and corro-

sion, and inspections and testing are described in detail, as well as a growingly important topic of steam generator replacement. Future trends and risks to steam generator health are described and future steam generator research is proposed. The book is in excess of 500 pages and available on the COG website to the joint project-member employees.

The book project manager was COG’s John Sowagi. It is collaboration between Ontario Power Generation (OPG), Societatea Nationala “Nuclearelectrica” – S.A., China National Nuclear Operation Company, New Brunswick Power Nuclear, Nucleoelectrica Argentina Sociedad Anonima, Kinectrics, the Canadian Nuclear Safety Commission, and the University Network of Excellence in Nuclear Engineering.

A new arrow in the quiver against aging reactor challenges

COG helps develop CSA-approved model to disposition cracking at flaws

The industry has a new CSA-approved tool to effectively disposition overload cracking at pressure tube flaws when undertaking probabilistic core assessments in support of continued operation of CANDU units.

A new model to predict the behaviour of the overload cracking at flaws has been developed through a shared initiative between the CANDU Owners Group (COG) fuel channels research and development (R&D) and Joint Project (JP) programs. The model was the result of collaboration between COG members and supplier members. COG provided co-ordination through Anna MacIntosh, Ron Fleck and Tania Rose.

The model satisfies the need for a tool to predict the cracking impacts in order to validate the safety of continued operation of pressure tubes as hydrogen equivalent concentration increases over time.

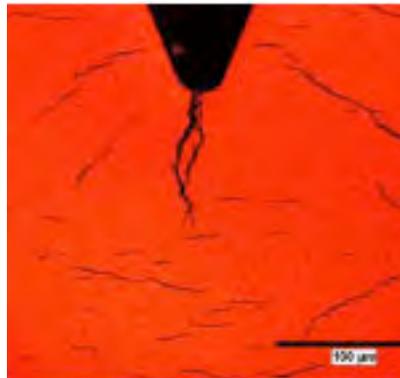
Pressure tube flaws such as those created by fretting of trapped debris between the fuel bundle and pressure tube, or fretting of the fuel bundle bearing pads against the pressure tube are known industry-wide occurrences.

A series of integrated work packages were created in R&D and JP to conduct measurement experiments on the overload cracking resistance in irradiated and non-irradiated pressure tube materials under a wide variety of test conditions. At the same time, the researchers created a theoretical model to predict overload cracking.

The end result was a Mark 1 statistical-based, engineering model that will take into account the flaw geometry, hydrogen equivalent concentration and the internal pressure loading. One key feature of the model is its ability to account for reduced internal pressure during reactor cool-down thereby eliminating unnecessary conservatism.

The development of the Mark 1 model is documented in COG-10-1014-R1. As a result of the COG research, the model was implemented into the CSA Standard N285.8 and can be used to disposition flaws and to perform probabilistic core assessments in support of continued CANDU unit operation.

Work continues to further support and improve the model. ❖



Neutron Overpower Protection methodology achieves regulatory success

The Canadian Nuclear Industry recently reached a significant milestone when Ontario Power Generation and Bruce Power received formal regulatory acceptance of the enhanced methodology for conducting Neutron Overpower Protection (NOP) system analysis. This methodology has been key to better characterizing the safety margins associated with the NOP system as CANDU plants age.

The Neutron Overpower Protection system consists of a set of flux detectors that are capable of shutting down the reactor for certain unlikely but postulated scenarios where power becomes too high anywhere in the core. Historically, the trip setpoint at which the reactor shuts down has been calculated using a methodology that takes into account random variations in the operating configuration of the reactor as well as other uncertainties in the underlying calculations.

As CANDU reactors age, the calculated safety margin in the reactor decreases somewhat due to diametral creep of the pressure tubes. In the absence of any mitigating action, this can force the need to operate the reactors at reduced power to preserve safety margin. To offset this effect of aging, Ontario Power Generation and Bruce Power have taken two major steps to regain safety margin.

One is the implementation a modified 37-element fuel bundle (37M) that improves the heat removal from the fuel under certain accident conditions. Tests of the 37M-bundle design conducted by Stern Laboratories under the COG R&D program are ongoing and have demonstrated significant improvements in safety margin.

The other major improvement is the development of a more advanced mathematical model of the NOP system, developed by staff of AMEC FW which provides a more complete characterization of the available safety margin. This methodology uses an advanced statistical modelling (often referred to as Extreme Value Statistics) which distinguishes between errors resulting from variations in the operating state of the plant (aleatory uncertainties) and errors resulting from our lack of knowledge of and the imperfections in the computer codes and the inputs that invariably propagate through the calculations (epistemic uncertainty). The EVS approach results in significant improvement in the NOP margin when compared to the traditional method of calculating the trip setpoint. The improved margin arises because of the “excess” conservatism incorporated in the traditional calculations of trip setpoint using non-EVS methods. ❖



Holly Anderson (in purple jacket) has been engineering solutions to nuclear puzzles for almost four decades. She is seen here with some of her colleagues from CANDU Owners Group, L-R: Mersedeh Safa, Sonia Qureshi, Donna Tuck, Tania Rose, Holly Anderson, Amanda Debidyal, and Ann Palen.

Celebrating Diverse Perspectives

Across nuclear, organizations used *International Women's Day, March 8* to both reflect upon and celebrate the role of women in the industry. At CANDU Owners Group, we did the same.

Reflecting on a career spanning almost four decades in the nuclear industry, Holly Anderson, program manager of safety and licensing at CANDU Owners Group (COG), attributes her longevity to a passion for the technology itself and the breadth of scope it offers. In particular, it's the pleasure she derives from solving challenging technical problems and then working as part of a team to overcome them. And, she adds, there is the pride that comes from helping to generate "a non-polluting electricity."

Anderson's reflections are probably pretty similar to what her counterparts, male and female, industrywide, find rewarding about the complex and challenging industry. And her commitment to excellence, innovation and continuous learning is reflective of a culture inculcated as foundational practice. So, when people's curiosity about her work jumps from interest in what she does, to the fact she is a woman doing it, she admits to a little frustration.

This year, as we celebrate International Women's Day, there is a new optimism about women's roles in the workforce and in positions of leadership. This is the first year Canadian women can celebrate seeing themselves equally represented in their federal government's cabinet. It is also a time when there is a call for more gender diversity everywhere from the boardroom to the shop floor partly because "it is 2015" or more accurately now, 2016, but also because it is economically-smart. Gender diversity in workplace decision-making is proving to be good for business, according to multiple academic and private sector think tanks.

And yet, in 2015, the World Economic Forum pushed back the date we will reach gender parity from 2095 to 2133, more than a century away. It is a reminder there is still a long way to go.

A recent study by the US Department of Commerce estimates only

about 25 per cent of professionals in science, technology, engineering and mathematic (STEM) fields are women. In nuclear, the number is lower still.

However, for those who buck the odds, the work is rewarding and the trendline is changing.

Anna MacIntosh is part of a newer generation of women joining the industry. About 13 years in, she says the industry has offered her

"When I had my discussions with management and was trying to decide if I wanted to come here, I never felt being a woman was a hindrance. They were really looking for the most qualified person. And that's evident if you look around... the executive here is looking for whoever's most qualified."

rewarding and varied work with projects that stretch her technically and also help build the critical interpersonal skills required to work in an industry that at its core is a people business. Having worked most of her career in a progressive succession of jobs at Kinetrics and Bruce Power, she moved to COG in 2015 to work as a program manager on fuel channel life management; a critical deliverable for the industry.

The ability to build a strong cross-function network of supportive colleagues is something she says she learned early on, in the major components group at Bruce Power. She was working as an intern with the people who would actually apply the designs she engineers.

Continued...

MacIntosh says for women, and men, “street credibility” comes from respecting people’s input and applying it into your work to make it better and more reflective of the stakeholders’ needs.

“That was one of my biggest learnings -- valuing their experience and what they can help you learn from the practical side of the application of engineering... It was probably one of my early data points that I will carry with me to the end of my career, being able to develop those relationships in a 360 perspective,” she says.

Rachna Clavero, COG’s program manager for research and development, began her career at Atomic Energy Canada Limited (AECL) in the 1990s following graduation from the University of Toronto engineering program. She says she has seen a change in the face of nuclear as more women have joined the industry and more have taken on roles with greater responsibility. She points to women like Katherine Moshonas Cole, general manager at Candesco, Laurie Swami, senior vice president of decommissioning at Ontario Power Generation and Basma Shalaby, now the president of the University Network of Excellence in Nuclear Engineering, who previously served as chief engineer at Atomic Energy Canada Limited.

“That was one of my biggest learnings -- valuing their experience and what they can help you learn from the practical side of the application of engineering...”

“There is definitely momentum in the industry overall,” she says, but notes, “These are the women who have helped pave the way but we still need to widen that path and bring more women into these roles.”

Clavero says nurturing the next generation of young girls and women will be critical to continue the flow of women into STEM. Many mentorship programs, including those led by Women in Nuclear, are now well established in universities and even primary and secondary schools and it is the women in the industry themselves who are volunteering to make them work. Some utilities and suppliers have also made concerted efforts and investments in encouraging young women to pursue STEM and nuclear careers.

At COG, with women like Carmen Trandafir and Anderson who



Rachna Clavero, COG’s program manager for research and development (left) and Anna MacIntosh, program manager on fuel channel life management are both newer faces at COG. But they’ll be familiar to many people across the industry for their engineering work at member and stakeholder organizations. Between them, they’ve been part of the teams at Atomic Energy Canada Ltd., Bruce Power, Kinetrics, Candesco and the Ontario Ministry of Energy.

have many years in the industry, and a new generation of women now in senior roles, Clavero says the organization is well placed to set the right tone.

“When I had my discussions with management and was trying to decide if I wanted to come here, I never felt being a woman was a hindrance. They were really looking for the most qualified person. And that’s evident if you look around... the executive here is looking for whoever’s most qualified.”

While Clavero, is excited to see the emergence of women in senior roles, she is quick to qualify this is not about creating an ‘us versus them’ mentality.

“I don’t think it’s about trying to break the boys’ club... It’s about trying to build relationships and connections in the industry that are outside of it that can help the industry grow.”

In fact, both Clavero and MacIntosh cite male colleagues as important mentors.

Anderson sees a definable positive shift in the male-female dynamic. While it may be a while yet before gender is not a point of conversation, there is progress. In the 1970s, she says, sometimes there was a perception that, despite extensive qualifications, she was hired “because I was a woman.” She says, “I think the situation has changed significantly in the workplace in that regard: this comment is not likely to be made in today’s world.” ❁

Indian nuclear plant recovering from small LOCA

Friday, March 11, the Kakrapar nuclear plant in India experienced a small Loss of Coolant Accident (LOCA) in Unit 1. There was no public danger and no abnormal release of radiation to the public. Kakrapar is a two unit Pressurized Heavy Water Reactor (PHWR) designed in India. Each unit is rated at 220 MWe. The two units entered commercial service in 1993 and 1995.

We are receiving OPEX updates on this event from India from the Nuclear Power Company of India (NPCIL) and Atomic Energy Regulatory Body (AERB) web sites, and also through our telephone contacts. From the OPEX, we know that as a result of the breach of the heat transport

system, both shutdown systems responded as designed, the emergency core cooling system was activated and the reactor was safely shut down.

Over the next few days the affected channel was defueled and isolated to stop the leak. No damage was observed in the removed fuel bundles.

At this time, plans are being prepared for in-situ channel inspection prior to removal of the pressure tube, which will be sent for inspection to determine the cause of the leak.

The event was provisionally rated on the International Nuclear Event Scale (INES) as Level 1. The INES scale rates nuclear incidents and accidents on a seven-point scale with seven being the most severe. ❁



Romania



China



Pakistan



S. Korea

COG on the road



India

Recent site visits to Cernavoda and Point Lepreau start off planned visits by the COG management team

If you want to get an understanding of operational successes and challenges, there is no substitute for seeing a nuclear plant firsthand and talking to people on their home turf.

The CANDU Owners Group (COG) kicked off the year with site visits to Cernavoda, Point Lepreau and Argentina (NASA) nuclear plants and there are plans for visits to Korea and China later this spring.

COG President Fred Dermarkar also recently attended a World Association of Nuclear Operators (WANO) post-Fukushima conference in Tokyo. There, he was able to meet face-to-face with COG's international members to discuss trending issues and opportunities in addition to discussions on continuing post-Fukushima strategies.

At Point Lepreau, it was an opportunity to meet with new Site Vice President and Chief Nuclear Officer Brett Plummer and senior staff, says COG's Martin Reid.

"On our visits we do a value report for each site that provides the management team insight into what COG is contributing to their operations," says Reid.

Some plant employees may access COG resources on a weekly or even daily basis or participate on COG peer teams and in workshops and in research projects, but the senior managers may not have the same regular connection. The visits give the leaders a chance to see what COG is providing, to give input on it, and to better leverage COG services to maximize the value for their operations, Reid says.

And, he adds, it works both ways. The visits also give the COG management team a chance to get better acquainted with the senior managers, a better understanding of their needs and a chance to learn from their experience. 🌟

Nuclear's role in climate change

With both scientific study and world weather events illustrating the realities of climate change, this past December's COP21 meeting in Paris became a focal point for intense global discussion on potential policies to help attain country-level targets and commitments

Just weeks prior to the conference, Canada saw major change in both party and politics of its federal government. The country appointed a new Liberal government and with it, a new approach to energy policy that puts unprecedented priority on climate change action. The focus is so defining for the new government, it changed the name of its environment ministry from *Environment Canada* to *Environment and Climate Change Canada*. Both COP21 and the new domestic direction dovetailed into the Canadian Nuclear Association's annual February conference already slated for a climate change theme.

Nuclear industry participants returned from the conference with a renewed sense of optimism about their work and the value nuclear can contribute, not just to generating electricity – a commodity

necessary to sustain a high standard of living – but maybe even as a solution for a world looking to reduce its carbon footprint as fast as world politics and logistics allow.

In March, that optimism was tempered with remembrance of the events five years ago in Fukushima. The World Association of Nuclear Operators held its post-Fukushima conference in Tokyo, a sobering reminder of the falibility of the technology and the humans that operate it. Yet, actions since the accident provide hope for what the industry can accomplish through collaboration and its commitment to continuous improvement.

In the next few years, it will be up to the nuclear industry to demonstrate it has moved past Fukushima and other watershed events to provide a viable and trustworthy strategy in pulling back the effects of climate change.

The discussion continues. 🌟



Graduates of the UNENE M.Eng program pose for a photo with UNENE president, Dr. Basma Shalaby and program director Dr. Victor Snell. From left to right: Joseph Downey, Ben Rouben, Pamela McDermid, Victor Snell, Ishan Roy, Abuzafar Ali, Basma Shalaby, Agnes Moisin and David Watts.

UNENE Builds Nuclear Knowledge

The nuclear industry, like other industries, seeks continual improvement in the skill of its workforce to improve plant safety, operation and economics.

The University Network of Excellence in Nuclear Engineering (UNENE) has developed accredited programs for nuclear professionals that aim to transfer the design and licensing basis of CANDU technology to young professionals in the industry to enhance their expertise in today's increasingly demanding industry.

UNENE has created two options for nuclear professionals who are looking to further develop their nuclear expertise: The UNENE Masters of Engineering (M.Eng) in Nuclear Engineering program and a more recent addition, the UNENE Diploma in Nuclear Engineering. The Ontario Universities Council on Quality Assurance accredits both.

"The whole intent is to enable the young professionals that are joining the industry to continue enhancing their knowledge of the nuclear technology," says UNENE President Basma Shalaby. "It does two things: it transfers the knowledge of the CANDU technology in terms of its design and safety basis and at the same time it enhances the ability to troubleshoot in their area of core competencies through lateral thinking and knowledge of all aspects of the plant configuration," she adds.

Dr. Victor Snell has been the UNENE program director since 2008 and has done significant outreach to potential staff in many industry organizations.

"The program gives students a fundamental knowledge of nuclear technology, so that they both understand what normally happens and are also prepared for the unusual," he says. "Students invariably tell us how their degree has broadened their capabilities."

The M.Eng. in Nuclear Engineering program began in 2004 and has since seen over 90 graduates with a total of 120 participants. The 10-course M.Eng (or eight with a project) are targeted to those who are working full time. The courses are offered over a four-week period on alternate weekends with online distance learning available for remote students.

"I would recommend it to anybody in the nuclear industry or anybody thinking about the nuclear industry. I found the courses I've taken so far to be extremely relevant," says current student and Ontario Power Generation (OPG) reactor safety manager, Stewart Wilson. Students have up to five years to complete the necessary course requirements but many are able to finish in three to four years. In some cases, employers will contribute to and/or cover the cost of the courses for their employees.

"I would recommend it to anybody in the nuclear industry or anybody thinking about the nuclear industry. I found the courses I've taken so far to be extremely relevant."

Emily Cornthwaite, senior technical engineer/officer in the Refurbishment Chemistry Technical department, graduated from the masters program in November 2015. After joining OPG about six years ago, she took the company's training program, which, she says, provided her a great foundation to the industry. Still, as she gained experience in the job, she felt she was ready to learn more.

Continued...

UNENE (Continued from previous page)

“I was looking at masters programs that I could use to help further my career and this was the one that I thought stood out the most,” she says. “It allows you to learn a lot about the broad spectrum and not necessarily focus in on one area like a research masters would.”

The Diploma in Nuclear Engineering was created to cater to those wishing to expand their knowledge of the nuclear industry without having to commit to the full master’s program. This option is a new addition to UNENE and began in April of 2015. Those taking the diploma route are given the same selection of courses as the master’s program but are only required to complete four courses instead of 10. At any point if those in the diploma program decide they would like to complete the master’s program or vice versa, they can transfer their credits upon approval as long as they have not yet graduated.

UNENE was established in 2002 as a not-for-profit corporation and is a partnership between industry and 12 Canadian universities. Its mission is to bridge the gap between those entering the industry and those retiring from it. They wish to preserve the knowledge and lessons learned throughout the nuclear community and these two programs are doing just that. ❁

Interested in finding out more about the programs? Visit the UNENE website at:

<https://www.unene.ca/education>

For more information on the application process for the M.Eng in Nuclear Engineering, visit:

<https://www.unene.ca/education/m-eng>

For more information on the application process for the Diploma in Nuclear Engineering, visit:

<https://www.unene.ca/education/diploma>

A new look for COGNIZANT

Tell us how you like it...

Over the past few issues, we have been evolving COGnizant to provide more industry information for our members. Enhancements include more feature-oriented stories and photos as well as the magazine-style format introduced in this issue.

These changes are in keeping with COG’s commitment to share knowledge across the CANDU industry and to respond to member feedback. You have asked us to update our communication processes and we are working, in many ways, to serve you better.

The change you see in COGnizant is just one example of many COG communication enhancements you will notice over the coming year. COG is creating more ways to connect and access information through enhanced programs, content and digital platform upgrades.

In the coming months we will be back in touch to get your feedback on our progress.

In the meantime, if you have feedback you would like to provide on this issue of COGnizant, click on the link to complete a one-minute survey:

[**Feedback Survey**](#)



Communicators visit Cernavoda

In an industry where public acceptance and education is critical to industry success, communicators are as much in need of ongoing professional development as their technical counterparts.

The Public Information Materials Exchange (PIME), sponsored in part by the International Atomic Energy Agency (IAEA) and the European Nuclear Society is the only forum of its kind specifically geared to nuclear communicators internationally.

There was a COG connection to PIME’s 2016 conference. Held in Bucharest, Romania in February it featured a technical tour of the only CANDU nuclear plant in Europe – Cernavoda. As well, Marc Drolet, lead for social media and digital product development at the Canadian Nuclear Safety Commission shared the Canadian regulator’s experience in building its social media presence with delegates.

CANDU operators devise strategies for parts



In the late afternoon of Sept. 8, 1989, 50 shipping company employees took off in a chartered plane from Oslo, Norway on a pleasure trip to Germany. Less than half an hour after takeoff, the flight disappeared from radar. All the passengers, along with five crewmembers, were killed when the plane crashed into the sea.

The accident report identified “abnormal wear and tear on parts that were not manufactured in accordance with the aircraft specifications supplied by the manufacturer,” as a primary cause of the plane’s demise. Among the parts blamed were a set of incorrect bolts unable to hold the plane’s vibration.

Counterfeit, fraudulent and suspect items (CFSI) have been an issue across all industries probably as long as humans have engaged in trade. Today, the issue is prevalent in everything from electronics to cosmetics. While it is not a new issue for the nuclear industry, its prevalence has increased in recent years due to culminating factors including:

- A global marketplace with rapidly-spreading manufacturing technology, which enables quick and easy creation of counterfeit products difficult to distinguish from the genuine product;
- The loss over time of original equipment and component manufacturers (OEM and OCMs) and a smaller pool of qualified manufacturers for nuclear-grade components;
- An increased complexity and length of supply chains;
- A resurgence in demand for nuclear-grade parts due to increased maintenance as nuclear operators invest in technologies and strategies to improve safety and reliability in older plants;
- Increased cost and schedule pressures.

Fred Dermarkar, President of CANDU Owners Group (COG), a member association for CANDU operators worldwide, says COG utilities have been proactive on the issue, implementing various strategies in their plants to combat potential CFSI-part infiltration. This includes participation on committees developed specifically for information sharing and collaboration such as NUPIC (Nuclear Utility Procurement Issue Committee) and a CANDU-technology dedicated group CANPAC (CANDU Procurement Advisory Committee). COG’s supplier participants, mostly Tier 1 CANDU suppliers, have also been building CFSI programs within their organizations.

“Our members recognize the risks CFSI parts represent to their plants,” says Dermarkar. “A robust safety culture needs to include awareness and prevention programs to combat CFSI. Increasingly, utilities as well as their large suppliers are strengthening their quality assurance programs and supply management processes to address this,” he says. But Dermarkar says his members also recognize their efforts and those of the largest suppliers cannot combat CFSI alone. It will take a concerted effort throughout the supply chain to address the issue effectively.

In increasingly long, complex and global supply chains, there have been reports of incidents worldwide, where even reputable distributors were inadvertent vendors of CFSI parts.

To get to the issue within the CANDU supply chain, COG teamed up with the Organization of Canadian Nuclear Industries (OCI), a supplier-member organization. In December 2015, COG and OCI sponsored a workshop that brought suppliers, utilities and regulators into the same room to talk about expectations and strategies.

“Safety is the overriding priority for nuclear plant operators and it is important for them to have confidence that only quality parts enter their plants,” says OCI President Ron Oberth.

He says suppliers face an ongoing tension between the need to meet the cost and schedule demands of the customer while finding the time and budget to implement safeguards against CFSI parts, some of which may be mixed in with legitimate parts. When you are talking about bolts, small electronic components and other low-cost, high-volume items, it can be a daunting task for small to medium-sized business (SMEs), the companies that primarily comprise OCI membership.

“The COG/OCI sponsored CFSI workshop provided a unique forum for the sharing of experience with a variety of CFSI incidents and for an open discussion of CFSI detection and prevention tools that have been successfully deployed in Canada, the USA and in some offshore CANDU countries,” says Oberth. “The workshop was an excellent example of co-operation on the sharing of best practices among the CANDU operators and both large and smaller suppliers in dealing with this threat.”

Lawrence Colligan, an engineer, independent nuclear industry consultant and previously, 30-year veteran with Canada’s nuclear regulator, the Canadian Nuclear Safety Commission (CNSC), says a US incident raised his awareness of the issue about a decade ago.

“There was an issue throughout the States when there were counterfeit Grade 8 bolts which were actually Grade 5 bolts... Because of the strength profile of those bolts, if you put them in a pressure boundary system, they had an increased likelihood of failing, resulting in a major problem,” he says.

The CNSC is working to strengthen and build awareness of the issue industry-wide. The regulator has updated its regulatory documents to include a unique reporting requirement for suspect parts, in addition to counterfeit and fraudulent items.

Among regulators worldwide, the CNSC is not alone in revisiting the issue. The International Atomic Energy Agency (IAEA) is currently updating its guidelines with the input of regulators across the globe. At the heart of the regulations is the requirement for robust quality assurance and supply management processes. Being knowledgeable and setting clear expectations for the entire supply chain is key to having an effective

Continued...

CONCFSI detection and mitigation process.

Dermarkar says quality assurance includes a procurement and product acceptance process; source inspection, receipt inspection and testing programs; as well as review, testing and dedication of commercial-grade products. COG has developed a shared audit system for major suppliers and sub-suppliers to the CANDU operators that will increase process efficiency and consistency.

But, he adds, quality assurance must be accompanied by a more holistic approach to safety overall.

“Mitigation of residual risk relies on people. It is achieved through a healthy nuclear safety culture with an individual commitment to safety including all the things we talk about in many nuclear safety contexts; things like a questioning attitude and effective safety communication.

“It also requires a commitment to safety leadership by the senior team and management systems like continuous learning, problem identification and resolution processes,” he says. “It needs a safe environment for raising concerns and requires well-established work processes. These are

easy things to say but they require a commitment to implementation and execution every day.”

Established nuclear organizations including the Institute of Nuclear Power Operations (INPO) and the Electric Power Research Institute (EPRI) have developed principles and guidance for both utilities and suppliers.

Colligan says utilities have an expectation that suppliers are following these industry best practices.

“The first line of defence is trained, knowledgeable people who have an engrained understanding of safety culture, not only in our utilities but throughout the supply chain,” he says, adding, “All participants in the supply chain: distributors, suppliers, manufacturers and utilities have responsibility to protect the integrity of the supply chain.”

Harkening back to the lessons learned by the aviation industry in that 1989 crash, Colligan adds, “If you think verifying for CFSI is expensive, try missing something.”

An industry response

The Canadian nuclear industry, like its counterparts worldwide, has been working to address counterfeit, fraudulent and suspect parts in the supply chain. Later this year updates to the standard, CSA N299, which is an updated set of quality assurance program requirements for suppliers to the nuclear utilities, is expected to be issued. Contributors to the review process have included utilities, suppliers, the Canadian regulator and members of the public.

While there is still work to be done, implementation of some actions has already started:

- ✓ Use of the EPRI self-assessment tool checklist (See links below)
- ✓ Review supply chain programs against industry best practices
- ✓ Development of computer-assisted training courses
- ✓ Review of supplier disclosure letters
- ✓ Utility - supplier workshops through the CANDU Owners Group and the Organization of Canadian Nuclear Industries (OCI)

EPRI resources:

2010, EPRI document 1021493, “CFSI Self-Assessment checklist”:

<http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=00000000001021493>

July 2014 EPRI 3002002276 “Counterfeit and Fraudulent Items” (Rev 1 of 1019163):

<http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002002276>.

April 2015: The updated NUPIC audit checklist uses performance based audit techniques with updates in Commercial Grade Dedication guidance based on new EPRI guide 3002002982; available here:

<http://www.epri.com/abstracts/Pages/ProductAbstract.aspx?ProductId=000000003002002982>

Regulatory Action:

In September 2014 the Canadian regulator, the Canadian Nuclear Safety Commission (CNSC), updated its Reporting Requirements for Nuclear Power Plants (REGDOC-3.1.1) to specifically include a requirement of reporting for counterfeit, fraudulent and suspect parts. This specificity within reporting requirements, and the inclusion of suspect parts, is an evolution in regulatory approach on the issue.

Pierre Lahaie, Director, Management Systems Division of the CNSC’s Directorate of Safety Management, says expectations are also provided to the utilities through licence conditions related to management system requirements including quality assurance in procurement.

The CNSC is also contributing to the Canadian nuclear industry’s own work on updating the Canadian Standards Association (CSA) standard on quality assurance program requirements for suppliers to utilities, which is incorporating requirements and guidance on safety culture for suppliers (CSA N299).

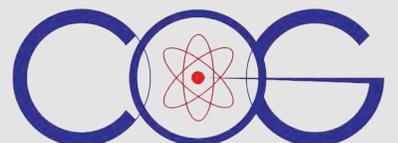
The CNSC will be supporting and encouraging utilities efforts to adhere to the CSA standard when it is released later this year, says Lahaie.

CFSI is an international issue and the Canadian regulator is also working with its counterparts worldwide to contribute to the IAEA’s update of its technical guidance document (IAEA TECDOC – 1169).

CFSI came into sharp focus in the past five years with some high profile events as well as a more general awareness industry-wide, says Lahaie. Today there is evidence that utilities, suppliers and regulators have taken heed and are addressing it.

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