

# COGNIZANT

VOLUME 21  
ISSUE 2  
FALL 2016



**Ready, set, GO!**  
*The industry prepared.  
Now it's execution for  
Darlington Refurbishment*

**Building Resiliency**  
*From safety culture  
to human behaviour:  
Making plants safer*

**Nuclear American Style**  
*COG hears from a Washington  
lobbyist spreading the  
nuclear message*

**KHNPP's EVP Cheong-ro Yoon**  
*-- Training for Excellence*





A message from CANDU Owners Group  
President Fred Dermarkar

# If ever a time for collaboration

## *An industry SWOT analysis makes the case for working together*

Competitive spirit is a fairly universal cultural norm.

As I write this, the American Trump-Clinton presidential race is in full swing, Major League Baseball is in the World Series and, in South Korea, about 70 people recently took part in the Space Out Competition – literally competing to see who is best at doing nothing.

Competition is what we know and that can be a good thing. When things go right, it reduces poor performance and drives innovation and excellence.

But today, converging factors serve as an urgent reminder that while we need some competition, **collaboration** is also critical to the health of our companies, our industry and the world.

The fact nuclear is not even a consideration in many countries when deciding generation technologies has always mattered to the industry.

Today, it matters for the earth and its inhabitants. The fact is a negative perception of nuclear prevents many countries, in need of a large-scale, carbon-free generation source to meet even modest greenhouse gas reduction targets, from considering nuclear.

With nuclear plants shutting prematurely or simply not being built because of safety and cost perceptions, we don't have time to work in silos. If we look at our shared strengths and opportunities, and especially our weaknesses and threats, it is easy to identify the converging areas where combined efforts will exponentially improve outcomes. And, as always in the age of communication, our industry is as strong as the weakest link in every area of performance.

This is where I find greatest satisfaction as president of CANDU Owners Group (COG). It is a role that is premised on

building collaborative models.

In the April, 2016 issue of COGnizant, you may have read about our collaboration agreement with the International Atomic Energy Agency (IAEA). Since then, we have signed two more collaboration agreements, one with Atomic Energy Canada Limited (AECL) and one with the Organization for Canadian Nuclear Industries (OCI).

While the agreements have different areas of focus, the common thread is a commitment to share information and initiatives to improve outcomes in nuclear safety, reliability, affordability and human performance as well as innovation for better performance tomorrow. This is good for our collective organizations and members, good for nuclear and good for a healthy planet.

Others in the industry are making similar collaboration efforts. Bruce Power's new President & CEO Mike Rencheck has echoed OPG President & CEO Jeff Lyash's commitment to collaboration between their respective utilities, especially on refurbishment, a legacy issue for the industry in the decade ahead. We look forward to hearing more about the new Bruce Power CEO's vision and insights at COG's December General Business Meeting where he will be our keynote speaker.

A couple of recent COG initiatives also aim to increase collaboration of our members. We have recently published an event guide in PDF format (available on COGonline or from your COG contacts). It will serve as an at-a-glance planning tool for all upcoming COG events. It will be updated six times annually with highlights and new events as they are added.

One of those events is COG Collaboration Week, with several workshops combined into a single week. It is an idea adopted from similar initiatives at EPRI. The goal is to encourage more international participation, thereby allowing more collaboration and opportunities for shared learning by reducing travel costs and time. The 2017 dates will be announced soon.

Perception drives action. And perception of nuclear begins with performance. These agreements and initiatives will help us to build on existing strengths and close gaps together, faster than any single organization could do alone. And that benefits everyone.



# Contents

- 2 President's Message
- 4 Nuclear American style
- 6 Training the trainers
- 7 COG visits the Darlington Energy Complex
- 10 Good to great through safety culture
- 12 Training for safety excellence
- 14 COG News: Around the industry
- 18 Expanding the table for nuclear safety
- 20 COG AGM spotlights reliability
- 22 Human factors for resiliency
- 25 Strategies for obsolescence
- 26 Help when it's needed: Inter-Station Assistance
- 27 The 2016 WiN Conference: COG is there
- 30 A look ahead to our Winter COGnizant

The CANDU Owners Group, COG, is a private, not-for-profit international corporation funded voluntarily by CANDU operating utilities, Canadian Nuclear Laboratories and supplier participants.

For more information, visit us at [CANDU.org](http://CANDU.org)

COGnizant is a publication of the CANDU Owners Group (COG)  
655 Bay Street, 17th Floor  
Toronto, ON M5G 2K4 Canada  
Phone: 1-416-595-1888  
Fax: 1-416-595-1022  
Email: [cog@candu.org](mailto:cog@candu.org)

Editor: Jacquie Hoornweg  
[Jacquie.Hoornweg@CANDU.org](mailto:Jacquie.Hoornweg@CANDU.org)

Produced by Querencia Partners Canada Ltd.

**COVER PHOTO:**  
*KHNP Executive Vice President Cheong-ro Yoon*  
*Photo courtesy of Korea Hydro & Nuclear Power*  
**ABOVE:**  
*COG employees at the Darlington Training Facility*

# A look across the continent at the COG GBM

*The COG General Business Meeting, held Sept. 20 in Cambridge, Ontario gave members and supplier participants a chance to share information on their own operations and to take a higher-level view of the state of the industry across North America.*



*Don Hoffman, past president of the American Nuclear Society (middle) along with John Barrett, current president of the Canadian Nuclear Association, above with COG president Fred Dermarkar, shared thoughts on the North American nuclear outlook at the COG GBM in September.*

**K**eynote speakers Don Hoffman, past American Nuclear Society president and John Barrett, current Canadian Nuclear Association president, shared a vision for nuclear as a powerful contributor to the energy mix, the environment and the economy of both countries.

Afterward, the meeting continued with a tour of the BWXT Canada's Cambridge, Ontario facility.

In the first of a three-part series, below is a look at the state of nuclear in the US through the eyes of Hoffman, an active participant in the politics of nuclear, south of the border. In our Winter 2017 edition of COGnizant, we will feature the two other meeting highlights:

**Part 2:** A Canadian outlook from John Barrett's perspective; and

**Part 3:** A tour of the BWXT Canada facility.

## Nuclear American Style

The future for nuclear in the United States is, in a word, complicated. And Donald R. Hoffman is determined to make it clear.

If you've met Hoffman you may have ascertained he's a man who does what he sets his mind to, and quickly. With a brain that moves at the speed of light, followed in close step by his tongue, Hoffman has spent a good part of his career unpacking myths and trying to inject reality into policy and regulation for the American nuclear industry.

Hoffman formed his Rockville, Maryland-based regulatory and engineering resolution consultancy in 1985. Today, the past president of the American Nuclear Society is leading the nuclear charge on Capitol Hill and across the US through his not-for-profit organization, Sensible Energy Matters to America (SEMA). He's working with legislators to achieve a level-playing field for nuclear operators who, he says, are feeling economic pain as a result of political policy decisions that have been starving even the most efficiently-operated nuclear plants. With several high-performing plants already in decommissioning and many others on a deathwatch, Hoffman is working against the clock to get meaningful change that will allow the assets to reach their potential and continue to serve a valuable role in the US energy mix.

"Despite how well our nuclear plants are operating at the highest levels of safety and in highest levels of performance; 92-94 per cent capacity factors and delivering on the nuclear promise... despite all that these plants are unable to compete in the market," Hoffman says, describing the subsidies for renewables and other

mission. A fervent believer in the holistic benefit of nuclear as a valuable contributor to sustainability, Hoffman has ensured the two presidential candidates have the facts on the nuclear industry and definitive policy details to create a level energy-playing field.

"Our electricity market is severely flawed. It favours subsidized wind and solar... the message we've been sending is the unique value of nuclear is predicated on energy, the economy and the environment" in supplying a predictable and stable grid with 24/7 electricity that runs when needed, that "contributes to fuel and technology diversity" while benefitting the climate change mitigation strategy and helping the economy, Hoffman says.

"One nuclear plant in New York State creates half a billion dollars in sales of goods and services," says Hoffman, noting that is based on a one-unit plant, with exponential outcomes for multi-unit operations. His economic message is the plants contribute to above-average salaries, strong house prices and have a positive impact on local taxes, which in turn strengthens the economy and local infrastructure; all of which means a higher standard of life and well being for the American people.

It is not a new message for the nuclear industry, shared often and backed by data in many jurisdictions worldwide. To bring it home to US legislators, the American Nuclear Society Special Committee on Nuclear in the States, co-chaired by Hoffman, issued The US Without Nuclear Energy, A Report on the Public Impact of Plant Closures (see bottom of article for link). The widely shared document provides the proof points on the detriment to the country on a state-by-state basis should the US continue with the status quo energy policy. "It paints a pretty bleak picture if you have no nuclear," notes Hoffman.

The message is gaining traction. In New York State, which gets about 30 per cent of its electricity from nuclear, the state was under threat of losing several units due to non-viable economics. This summer, it adopted a zero-emission credit for nuclear similar to the incentives provided to wind and solar as well as an additional market price top up, all included in New York's Clean Energy Standard.

In approving the measures, New York Public Service Commission Chair Audrey Zibelman said, "If these plants close abruptly, they in all likelihood will be replaced by the attributes of expanded fossil fuel base generation. This will impair our ability to achieve our environmental goals."

In addition to hammering home the message, state by state, Hoffman and the American nuclear industry hope to achieve federal changes as well. Hoffman has been working to have "national assets legislation" passed, which would include measures,

conditions favourable to other energy sources that have placed the American nuclear fleets in peril.

"(We are) having difficulties being able to explain to our policy and law makers the unique value of nuclear science and technology... and to ensure that nuclear stays in our mix."

And so, Hoffman has his

similar to those brought in by New York but implemented US-wide.

Hoffman says he has more than 20 governors now informed on the "unique value" of nuclear in the energy mix. His hope is the facts on nuclear's contribution, shared by the industry for years, about a strong energy mix, the environmental benefits and a vibrant economy will finally become as apparent to legislators as it has been to those working in the industry all along.

## Sources:

This article is based on a presentation by Donald Hoffman, past president of the American Nuclear Society and co-chair of an ANS special committee on nuclear in the states at the CANDU Owners Group General Business Meeting, Sept. 20, 2016.

It includes additional information from the following sources:

### ANS: The US without Nuclear Energy

<http://cdn.ans.org/pi/publicpolicy/docs/the-us-without-nuclear-energy-report.pdf>

### E&E Publishing: Campaign 2016: Meet Trump's 'token nuke guy'

<http://www.eenews.net/stories/1060044016>

### Hoffman, D.: June 2016. Presenting the nuclear narrative, Chicago, Ill.

[https://www.eiseverywhere.com/file\\_uploads/6dbd-da911158b325edf7c550af95072\\_00-DonHoffman-PresentingtheNuclearNarrative\\_Revised.pdf](https://www.eiseverywhere.com/file_uploads/6dbd-da911158b325edf7c550af95072_00-DonHoffman-PresentingtheNuclearNarrative_Revised.pdf)

### RTO Insider: August 2016. New York clean energy standard nuclear subsidy

<https://www.rtoinsider.com/new-york-clean-energy-standard-nuclear-subsidy-29816/>

## IN COGNIZANT WINTER 2017

In our first issue of 2017, COGNIZANT will feature more highlights of the September General Business Meeting including Canadian Nuclear Association President John Barrett's views on the state of nuclear in Canada as well as a tour of BWXT Canada's Cambridge facility.



# Training the trainers

63 operator trainers converge to share OPEX and learn from industry leaders



CANDU operating training staff from Canada and Romania had an opportunity to connect, share information and take lessons learned back home early this past summer at the COG Operator Training Workshop, June 28-29.

The event featured keynote speaker Glenn Jager, President of Ontario Power Generation (OPG) Nuclear and Chief Nuclear Officer.

Jager welcomed both the international flavour and diversity of industry participants, giving recognition to the value of bringing diverse perspectives together in learning and collaboration.

"Operational Excellence is achieved through continuous learning and a drive for continuous improvement," Jager said. "It also involves recognizing the importance of operating experience and the need to incorporate of lessons learned to avoid mistakes of the past."

"Forums such as this Trainer Workshop enable you to collaborate with your peers in the Training field. Here you can share your experience, your initiatives and your innovations that will become the tools and best practices needed to driving excellence in Operator Training across the CANDU fleet."

As well, Jager provided an overview of OPG's new strategic direction – **Power with a Purpose**, and explained in detail how operator training dovetails into the four imperatives: Operational Excellence, Project Excellence, Financial Strength, and Social Licence.

Training topics included nuclear refurbishment, non-licensed operator training, simulator and fuel handling training and the certification exams. Each of the participant organizations provided an update on their activities.

The Canadian Nuclear Safety Commission provided the regulator's perspective on operator training including upcoming changes to the regulatory framework.

The workshop also provided participants an opportunity to share the techniques they are using and new technologies being employed at their stations.

At OPG, for example, operators use robotics to perform activities such as radiation surveys, leak searches and equipment repairs in high dose areas to eliminate operator exposure.

In addition to the presentation and workshops, the two-day event also included tours of the Darlington and Pickering simulators and the Non-Licensed Operator Training Facility. At the facility, operators learn to perform hands-on activities that develop their human performance skills including use of event-free tools.

COG will host the biannual event again in 2018.



*Photos: TOP: Lorne Cunliffe explains the capabilities of the upgraded Fuel Handling panels in the Pickering 14 simulator.*

*Middle: George Cocossis explains the hands-on operator training capabilities at the 890 Brock Road training facility.*

*Bottom: President OPG Nuclear & CNO Glenn Jager speaks to participants about his own experience in operations.*

*COG's Rick Manners along with OPG's Kevin Lemkay and Andy Moeck made the event possible.*





## COG GOES TO THE DARLINGTON ENERGY COMPLEX

This summer, as Ontario Power Generation was ramping up for the beginning of the Darlington refurbishment execution phase, the CANDU Owners Group staff went out for a look at the training facility and project campus where thousands of contractors and OPG staff were preparing for the work ahead.

COG has an important role helping the industry collaborate and prepare for the refurbishments at both OPG and Bruce Power.

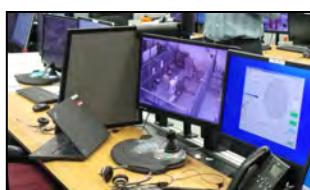
As the first unit came down for refurbishment at Darlington, Oct. 14, COG, the utilities and project vendor partners were **ready, set, go...**



Photos: Jacqueline Hoornweg



# *Ready, Set, GO!*



**Photos this page:** The Darlington Training Facility allows the OPG refurbishment project team contractors and staff to train and test tools and processes in replica conditions before they head into the plant, saving time and cost where it counts most.

## **DARLINGTON REFURBISHMENT Enters Execution Phase**

It's a project the Conference Board of Canada anticipates will create more than a half million person years of employment.

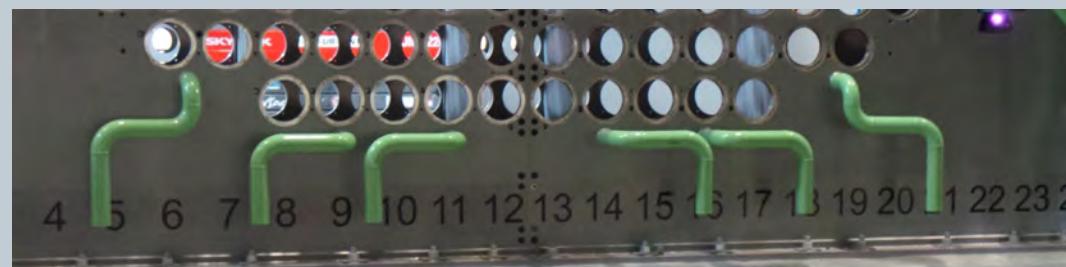
The \$12.8 Billion infrastructure investment in Darlington comes with exponential economic impact for the local area, province and country. Here's a look at the project as it transitions from preparation phase to execution.

**First unit offline:** Unit 2: A 40-month project

**Total project:** Four units over 10 years

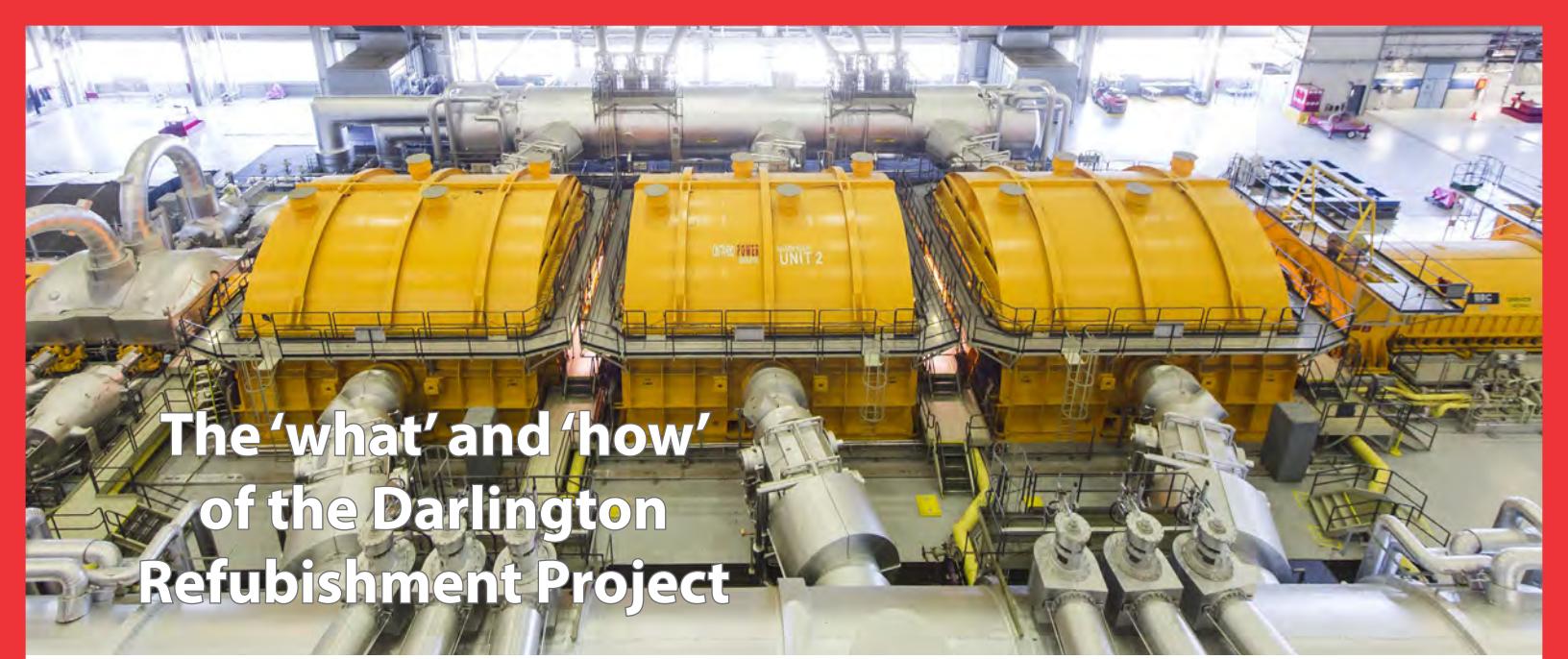
**Historical electricity output:** About 20 per cent of Ontario's power

*Source: Ontario Power Generation*



*Photos: Jacquie Hoornweg*

CANDU OWNERS GROUP



# The 'what' and 'how' of the Darlington Refurbishment Project

## Four pillars of refurbishment success:

As of August, 2016:

**Safety:** 2,372 days without a lost-time accident

**Quality:** 722 work packages developed with 75,000 tasks scheduled: No significant quality events in the reporting period

**Schedule:** Refurbishment execution phase began with Unit 2 on schedule this October, 2016.

**Cost:** Tracking to meet is \$12.8 Billion budget with \$2.6 Billion spent to date.

## Campus Plan:

- 18 new buildings to support refurbishment and continued operation
- 12 completed, 6 in-progress and on track



## Execution Phase:

**Re-tube and feeder replacement:** Removal and replacement of fuel channels, calandria tubes and feeders inside each reactor

**Turbine generators:** Inspections and repairs on the four turbine generator sets and replacement of analog systems with digital systems

**Defueling of the reactor:** Remove of used fuel and refurbishment of fuel handling equipment

**Steam generators:** Mechanical cleaning, water lancing, inspection and maintenance work

**Balance of plant:** Many smaller projects to replace and repair components on both the nuclear and conventional (e.g. electrical system, piping and valves) side of the plant



*Above: Construction central: Darlington Nuclear has made a multi-million dollar investment in site improvements to support refurbishment and continued operation with 18 new buildings.*

*Top of page: Turbine generator sets will undergo inspection and repair during refurb execution.*

# *From GOOD to GREAT*

## **COG workshop emphasizes a common approach for nuclear safety culture amongst operators and suppliers**

Ontario Power Generation's Darlington Refurbishment has entered execution phase and Bruce Power is further into preparation mode for its own Major Components Replacement project, including the recent opening of its Centre for Project Excellence.

But if there is one priority overriding schedules, costs and facilities in the minds of the utilities' leaders, it is safety culture excellence. At a time when collaboration between utilities and suppliers is more critical to project and operation success than ever before, they are hoping to inculcate a safety culture mentality in both their own organizations and industry-wide.

"We see it time and again: companies that place emphasis on safety and quality are also the most cost effective," says CANDU Owners Group (COG) president Fred Dermarkar. "More than ever we need the highest standard of both safety and quality in our work. There is just so much riding on it, both for the people who rely on clean electricity produced safely and for the sustainability of the industry."

To help achieve a standard of excellence in safety culture industry-wide, COG is facilitating efforts with the supplier community to help the industry develop the systems, mindset and behaviours for alignment and achievement.

One of these initiatives, the **COG Refurbishment Forum, Nuclear Safety Culture Workshop** was held at the Darlington Energy Complex in July. Participants included representatives from COG, OPG, Bruce Power, CNL, the Organization of Canadian Nuclear Industries (OCI) and participants from the

supplier community including large companies such as BWXT, Hatch and Kinetics and smaller members of the supply chain such as Promation Nuclear and Topax Protektive Packaging.

"It is not enough to know what safety culture is or even to understand how it works," says Dermarkar. "There is a depth of leadership and internalization required across every organization, from every leader and ultimately with every worker who is part of refurbishment, operation or supply chain. Our success with the refurbishment projects and into continued operation depends upon that industry-wide commitment," says Dermarkar.

Among speakers at the conference were Bruce Power Chief Nuclear Officer Len Clewett, and OPG Deputy Chief Nuclear Officer Sean Granville who each shared their own insights. Senior managers from both operators as well as Westinghouse Electric shared operating experience and Dr. Mark Fleming the CN Professor of Safety Culture also provided insights from the experiences of other industries including shipping and oil and gas.

"Safety culture is not a concept unique to the nuclear industry though as operators, we have embraced and developed it for a long time," says COG Project Manager Ian Trotman, who facilitates the collaboration between the operators and suppliers.

"There is no such thing as done when it comes to safety culture. With these workshops and other activities, we are continuing to cultivate the expectation and expertise to achieve



*Speakers at the COG Refurbishment Safety Culture workshop provided a diversity of perspectives and advice for building safety culture within organizations.*

*FRONT ROW L-R: Bill Owens, Aileen Sullivan, Tim Teather and Len Clewett*

*BACK ROW L-R: Kathryn Harrison, Ed Wills, Mark Fleming and Ian Trotman*

excellence and we are taking the knowledge deeper into the nuclear community.”

Trotman adds, “The supplier community also has a valuable perspective of its own to share. The point of these workshops is to foster an understanding of expectations, share experience and learn from each other.” 

## Nuclear Safety Culture Defined

The core values and behaviours resulting from a collective commitment by leaders and individuals to emphasize safety over competing goals to ensure protection of people and the environment.

*INPO, Traits of a healthy safety culture*

# Seen and heard at the COG Refurbishment Safety Culture Workshop

## Sean Granville

Deputy Chief Nuclear Officer, OPG

### Advice for all workers:

#### Recognize:

- You work in a nuclear power plant: your work and the technology is special and unique;
- You must follow procedures and plans to do your job safely;
- You need to stand by the quality of your work;
- We want you to bring your concerns forward and ask your supervisor for help;
- Take care of yourself and your co-workers;
- Use your event-free tools to help you through difficult situations.

## Len Clewett,

EVP and CNO, Bruce Power

### Expectations for suppliers:

- Commitment to safety;
- Excellent quality management;
- Robust human performance program and ownership;
- Healthy safety culture;
- Learning organization.

## Aileen Sullivan

Director Fleet Performance Improvement, OPG:

### Everyone can impact nuclear safety.

Experience has shown that leaders in organizations foster a healthy safety culture by:

- Reinforcing it;
- Measuring it frequently;
- Communicating what it looks like and helping people understand their own role in contributing to it;
- Recognizing safety culture is not all or nothing: it moves along a continuum that allows room for discussion, questions and reporting of errors and mistakes to allow learning.

## Ed Wills

Director Global Nuclear Safety,  
Westinghouse Electric

### Nuclear Safety Culture Message – Is it simple and is it relatable?

#### What we will change:

- Demand integrity in the workplace
- Lead with safety
- Treat all workers with respect

#### How we will change:

- Leadership alignment
- Common approach
- Relentless implementation

## Tim Teather

Performance Improvement Manager, Bruce Power

### Four managed defences for nuclear safety:

- **Cultural:** Values and beliefs;
- **Engineered:** Physical barriers;
- **Administrative:** Procedures, training, processes and policies that keep activities safe and predictable;
- **Oversight:** Assessing team performance and consistently addressing problems and vulnerabilities.

## Mark Fleming

CN Professor of Safety Culture,  
St. Mary's University

### Safety requires communication.

- A safety management system is not effective unless it is accompanied by a good safety culture;
- Stay alert to potential risk factors that could increase the risk of major disaster;
- You need to win hearts and minds to improve safety;
- A proactive approach involves self assessment and feedback on the less visible elements of the safety management system.

# Training for *safety* Excellence



KHNTP Executive Vice President, Quality & Safety Division Cheong-ro Yoon was executive sponsor for a safety culture training course delivered by COG for KHNTP staff at various levels of the organization.

The culture of the nuclear industry is continuous learning. It is what the World Association of Nuclear Operators (WANO) was premised upon at its inception. In an industry with high consequence risks and a challenge with public perception, it is also a business necessity.

In 2013, Korea Hydro and Nuclear Power (KHNTP), recognized that safety culture was an area it needed to strengthen to ensure public and employee safety and to earn community and broader public support. And, as the utility's Executive Vice President of Quality & Safety, Cheong-ro Yoon says, "Quality is safety and safety is quality."

The company's plan for improvement in its safety culture is a long game. KHNTP management recognizes true change, especially culture change, does not occur overnight. Its goal is not simply heightened awareness of its corporate staff. It wants to drive change through the organization and, eventually, it wants to become an industry leader.

"Ensuring safety and reliability is the most important aspect of our operations," Yoon says. "It should be supported by a strong safety culture across all areas such as design, con-

struction and operation of a nuclear power plant. Unless safety culture is firmly established and embedded in our operations, we can neither expect sustainable development nor win trust of the public."

KHNTP developed a stepped plan for its safety improvement that takes the company from its journey beginnings in 2013 to its end date in 2022. The mid-to-long term plan includes:

- Annual execution plans;
- Safety culture training tailored to each position;
- Assessments to measure safety culture progress;
- Adoption of eight safety culture principles with 32 specific items; and
- Research & Development on safety culture.

As part of its training plan, KHNTP looked to COG to deliver presentations and mentoring that would help it both inculcate safety culture and manage good safety performance.

The training, which occurred over a five-day period in July, 2016 at a KHNTP office building in Gyeongju-si, Korea, was delivered in three parts: a two-day workshop for engineering



COG's John Froats (bottom, third from left) and John Sowagi (bottom, second from right), spent five days training three different KHNTP employee groups on safety culture. The training is part of KHNTP's vision to become industry safety leaders through a decade-long plan. KHNTP EVP Cheong-Ro Yoon, (third from right, bottom) is the training sponsor.

staff from four of the KHPN sites; another two-day program for managers and then a one-day program for KHPN executives at the director and VP level.

The COG trainers were John Froats and John Sowagi. Froats is a nuclear engineering professor at the University of Ontario Institute of Technology (UOIT) -- a Canadian university, with a deep specialty in nuclear technology, and particularly CANDU.

Prior to becoming a professor, Froats had a lengthy career as a nuclear engineer including his work as Chief Nuclear Engineer at Ontario Power Generation and he is a past president of COG.

Sowagi, has spent his career developing human potential through leadership and industrial training. His work includes the development of COG's **Nuclear Professionals Development Seminar** program, which trains high-potential individuals leadership skills in preparation for the rigors of senior management.

Like the COG leadership seminars, the COG safety culture course KHPN attended was kept to small groups to allow meaningful dialogue; it used an industry leader (Froats) as a mentor and advisor to the class; and used case studies and real problems that would be encountered in the field.

The formula clicked for the participants who rated the program 4.8/5 on their feedback evaluations.

Yoon says the training gave KHPN a better understanding of

safety culture and ways to apply it in concrete ways.

"The COG safety culture training was very helpful in establishing the culture where pre-job briefing and pre-job safety training are conducted in a better way. Work is put on hold immediately and prompt action is taken if a safety-related issue is found," he says.

**"The COG training helped us better understand the concept of safety culture and laid a foundation for applying safety culture from the textbook into our operations. We did this through analysis of the gap between management's commitment to safety and procedure compliance in the field."**

The training served as a reminder of the importance of the 'zero safety accident' policy and, reinforced that "safe operation cannot be emphasized enough," says Yoon. "I look forward to continued support and cooperation not only from COG but also from other organizations such as PWROG, FROG, WANO and INPO and hope to continue exchanges with other licensees worldwide to improve safety culture."

Today, KHPN participants are students, committed to continuous improvement. One day, they intend to be industry leaders.



COG Project Manager KiSang Jang (left) talks safety culture with COG seminar executive sponsor, KHPN EVP Cheong-ro Yoon.

#### **Learnings on safety culture from the COG seminar**

"I think we need to urgently resolve our current issues of ignoring risks by focusing on schedule and confucian culture, which can make it difficult for safety concerns to be raised by employees.

As EVP of the Quality & Safety Division, I realized again the importance of top management's attention to safety culture, leading by example, and creating an atmosphere where safety is considered as an overriding priority when conducting training and performing work."

#### **A THREE-PHASED SAFETY CULTURE PLAN**

**Phase 1 (2013-2015): Establish the foundation for safety culture.**

**Phase 2 (2016-2018): Enhance safety culture.**

**Phase 3 (2019-2022): Lead a global safety culture.**



# COG NEWS

*Dispatches from COG, its members,  
stakeholders and supplier community*

## Positive outcome for Pickering Nuclear's IAEA-OSART team visit

PICKERING -- A global panel of nuclear experts recently gave Ontario Power Generation's Pickering Nuclear one of the most thorough safety reviews a nuclear plant can undergo.

At completion of the 19-day mission, the contingent said the veteran plant has strengthened safety in recent years. The Operational Safety Review Team (OSART) concluded a 19-day mission in early October. The team observed a number of good practices at Pickering that will be shared with the industry globally, according to the International Atomic Energy Agency (IAEA), OSART's governing body.

The team also provided recommendations where the operator can add scope for further improvements at the plant. OPG has invited OSART to return for a follow-up visit in 18 months to review implementation on the recommendations.

According to an IAEA press release, the team found Pickering Nuclear "has made good progress in a number of operational safety areas, for example by installing severe accident simulation software. The team also proposed further safety enhancements, including measures to ensure proper maintenance of safety-relevant equipment."

OSART missions aim to improve operational safety by objectively assessing safety performance using the IAEA's Safety Standards and proposing recommendations for improvement where appropriate.

The team leader Fuming Jiang, Senior Nuclear Safety Officer at the IAEA said,

"We observed that the plant's senior leadership team is constantly reinforcing the value of safety as the top priority."

The 18-member team comprised experts and observers from Belgium, Brazil, the People's Republic of China, the Czech Republic, France, Germany, Hungary, Romania, Russia Federation, Slovak

Republic, Sweden and the United States of America as well as the IAEA.

"OPG is supportive of independent oversight and transparency and believe reports like this further strengthen the operational safety of the Pickering Nuclear Plant. We will use the findings to continue our drive for excellence," said Brian McGee, Senior Vice President at the plant.

For the full release go to <https://www.iaea.org/newscenter/press-releases/iaea-mission-says-canadas-pickering-nuclear-plant-has-strengthened-safety-sees-scope-for-further-improvement>



*OPG's Pickering Nuclear team have worked hard to maintain plant condition to ensure the station is running at top performance right up until the last day of operation. Historically, the nuclear plant has provided about 15 per cent of Ontario's electricity each year. With refurbishment and major component projects at Darlington and Bruce Power underway over the next several years, the importance of Pickering as a safe, reliable and cost-effective source of power will increase further.*

# COG welcomes new Bruce Power CEO

## COG's Dec. 6 General Business Meeting features Mike Rencheck



TORONTO -- The new Bruce Power President and Chief Executive Officer Michael (Mike) Rencheck will take part in a fireside chat with CANDU Owners Group (COG) President Fred Dermarkar at the COG general business meeting, Dec. 6.

Rencheck joined Bruce Power in August, replacing Duncan Hawthorne. The seasoned executive in the international nuclear

industry has extensive experience in nuclear operations, major capital projects and has been a tireless advocate for the important role nuclear power plays as a safe, low-cost, clean and reliable source of electricity.

"The international experience and track record that Mike Rencheck brings to the table in operations, project execution and as a strong voice for the industry are a perfect fit as the organization embarks on a multi-year investment program to secure its role in Ontario's Long Term Energy Plan," said Don Wishart, Chair of the Bruce Power Board of Directors in his introductory remarks on Rencheck this past summer.

Over the last 33 years, Mike Rencheck has served in a number of roles and most recently was the Deputy Chief Operating Officer for AREVA overseeing its extensive Global capital portfolio of nuclear and renewable projects. In addition to his roles at Areva, Rencheck has held a range of leadership positions including Chief Nuclear Officer at American Electric Power (AEP) and Senior Vice-President Engineering, Project and Field Services for AEP's 38,000 MWs of generation assets.

## Bruce Power opens Centre for Project Excellence

**BRUCE COUNTY** -- Bruce Power has taken an important step toward its refurbishment preparations by opening the Centre for Project Excellence on the Bruce site.

The centre will be dedicated to the company's extensive planning activities to prepare for the successful execution of the first refurbishment, which begins in 2020.

"A key priority at Bruce Power is project excellence and that's why preparing for the successful execution of our refurbishment program, which will begin in 2020, is an important focus for our

organization," said Mike Rencheck, Bruce Power's President and CEO. "The opening of the Centre for Project Excellence is another important milestone as we prepare for the successful execution of future refurbishments that are important to our site, surrounding communities and the Province of Ontario."

The Centre for Project Excellence is a 60,000 sq. ft. facility of combined office and warehouse space that will house the project team for the refurbishment preparations.

## COG associate is a jolly good fellow

### Dr. Krish Krishnan's commitment to the CNS and the industry recognized

With his longstanding efforts to improve safety, further technical research and raise CANDU's stature internationally, Dr. Krish Krishnan has long been a nuclear industry leader.

And, in June, at the Canadian Nuclear Society's (CNS) 36<sup>th</sup> annual conference in Toronto, Dr. Krishnan, was inducted as a CNS fellow. The distinction recognizes his extensive contributions to the industry over a 35-year career that included 29 years at Atomic Energy Canada Limited (AECL) and more recently work with the CANDU Owners Group (COG) and McMaster University.

Since he joined the society in 1985, Dr. Krishnan has served in a multitude of leadership roles, including chair of the Nuclear Science and Engineering Division, two terms as vice-president, and as 1999-2000 CNS President. In addition, he served for four years as chair of the Honours and Awards Committee beginning in 2010.

"Dr. Krishnan has been a strong proponent of the Canadian nuclear industry and a strong supporter of the CANDU research and development community," said Dr. Laurence Leung, manager,

R&D Facilities Operations, Canadian Nuclear Laboratories. "His expertise on thermal-hydraulics and safety is recognized by national and international peers," added Leung noting Krishnan's active participation in the Canadian Nuclear Society.

At AECL, Krishnan worked at both the Whiteshell Nuclear Laboratories in Pinawa, Manitoba and the Reactor Division at Sheridan Park, Ontario. Since retiring from AECL, he has worked as a consultant with COG and with McMaster University.



CNS President Paul Thompson congratulates COG associate Krish Krishnan on recognition of his lifetime of achievement.

# Giving back to our community

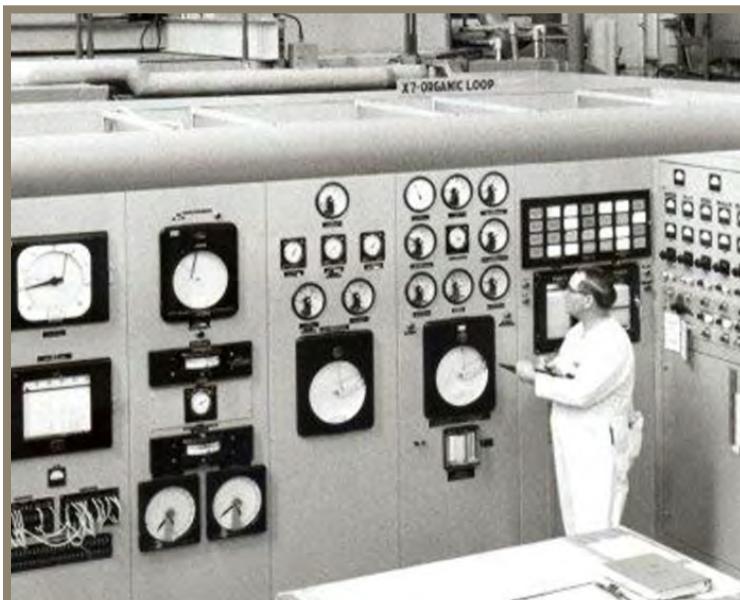


Mersedeh Safa (above) represented COG at this year's Terry Fox Run for cancer research. Safa was supported by colleagues and with their help raised \$710 dollars. She said she was so inspired by her colleagues generosity she ran 10K instead of the planned five.



## COG fires up the grill for the Red Cross

COG employees used a sunny lunch break to support a staff-chosen charity of choice this summer. The team raised \$545 for the **Red Cross** while enjoying burgers and sausages. Thanks to all the volunteers and the participants who supported this first fundraising event.



## Did you know?

The Canadian Nuclear Safety Commission and its predecessor the Atomic Energy Control Board (AECB) turns 70 in 2016?

*For a retrospective on the Canadian nuclear regulator, go to: <http://www.nuclearsafety.gc.ca/eng/resources/publications/reports/annual-reports/highlights2015/index.html>*

# NWMO gets a new leader

*Ken Nash passes the baton to OPG's Laurie Swami; a seasoned nuclear veteran with a depth of nuclear environment, regulatory and waste management experience*

Laurie Swami will take over as president of the Nuclear Waste Management Organization from out-going president Ken Nash, effective Nov. 14.

Ms. Swami joins the NWMO after a 30-year career at Ontario Power Generation (OPG), most recently as Senior Vice-President of Decommissioning and Nuclear Waste Management. Her responsibilities included implementing OPG's low- and intermediate-level nuclear waste deep geologic repository and overseeing operation of nuclear waste management facilities.

"Ms. Swami's extensive experience makes her the ideal leader for the NWMO," said Board Chair Wayne Robbins. "She brings a deep understanding and appreciation of both the technical rigour and social responsibility associated with safely managing used nuclear fuel."

Ms. Swami will lead the NWMO as it continues to implement Adaptive Phased Management, Canada's plan for the safe, long-term management of used nuclear fuel. The plan requires used fuel to be contained and isolated in a deep geological repository. The organization is currently implementing a site selection process to identify a safe location in an area with an informed and willing host.

"I have long been impressed with the calibre of the NWMO team and believe strongly in its work," said Ms. Swami. "I am excited to have the opportunity to be part of Canada's plan, and look forward to working collaboratively with the many municipal, First Nation and Métis communities involved in the site selection process, as well as the various levels of government staying abreast of the NWMO's work."

Mr. Nash announced earlier this year he was stepping down following a 42-year career in the nuclear sector, including 10 years leading the NWMO.

"Under Mr. Nash's direction, the NWMO has made tremendous progress in implementing its mandate using an approach that is widely respected in Canada and around the world," said Mr. Robbins. "The Board has every confidence this momentum will continue in the months and years to come."

Mr. Nash announced earlier this year that he was stepping down following a 42-year career in the nuclear sector, including 10 years leading the NWMO.

"Under Mr. Nash's direction, the NWMO has made tremendous progress in implementing its mandate using an approach that is widely respected in Canada and around the world," said Mr. Robbins. "The Board has every confidence this momentum will continue in the months and years to come."

## China and SNC-Lavalin team up on Advanced Fuel CANDU technology

**SNC-Lavalin signed an "agreement in principle" in September for a joint venture with China National Nuclear Corp. (CNNC) and Shanghai Electric Company**

The joint venture would develop, market and build Advanced Fuel CANDU Reactors (AFCR), according to SNC-Lavalin. The new company is expected to be registered in 2017 with two design centres -- one in Canada and one in China -- to complete the technology and potentially lead to construction of the first two AFCR units in China. Calling it a 'game changer,' SNC-Lavalin said in a news release that each new build will benefit Canada and the Canadian nuclear industry. It says one AFCR would provide enough power for four million Chinese homes.

## Have your say on Ontario's Long-Term Energy Plan consultation until Dec. 16

Do you have a perspective to share on Ontario's Long Term Energy Plan?

The provincial government is currently updating the plan as it does every three years and it welcomes perspectives from Ontario citizens and industry members alike.

If you have a valuable view to share or would just like more information on the process, visit the Ministry website at <http://www.energy.gov.on.ca/en/ltep/>.

On the website, you can read the discussion guide, find dates for consultation sessions near you and provide input through the [LTEP Online Comment Registry](#). You can also contribute to surveys on a series of topics at [Energy Talks](#).

Bruce Power and Ontario Power Generation employees can also get more information through their company websites.

The Ministry intends to release the next version of the LTP in 2017. **The consultation process ends Dec. 16.**



# Expanding the table

Working together and sharing expertise is a must in the nuclear industry, particularly in light of the safety issues raised by its biggest disasters. As Jacquie Hoornweg discusses, CANDU Owners Group is reaching out to all parties in a drive to foster collaboration for the betterment of all.

**F**ollowing the events of Chernobyl, 30 years ago, the nuclear industry focussed on strengthening safety culture at utilities.

Five years ago, after Fukushima – an event IAEA Director General Yukiya Amano called “the worst accident at a nuclear plant since the Chernobyl disaster” – regulators scrutinised their role in strengthening the framework for safety culture.

Today, in an increasingly complex and globalised industry and an evolving business model domestically, the Canadian industry is looking at the role suppliers, contractors and other stakeholders play in ensuring greater safety on projects and in operations.

“There is increasing recognition that safety culture requires the involvement of all stakeholders,” says Fred Dermarkar, president of the CANDU Owners Group (COG), the member organisation for CANDU operators worldwide. He adds: “It must be a collaboration and it must be embedded into the industry’s culture in an authentic way.”

Over the past year and a half, COG has worked with an increasing number of CANDU suppliers to create a forum for sharing operating experience (OPEX). The goal of the Supplier Participant Program is to create both a better knowledge base and a stronger framework for sharing amongst suppliers. It uses similar models to the ones utilities have used to share OPEX over the past three decades.

In Canada, the need for this kind of supplier interaction is fairly new. Up until a few years ago Canadian utilities relied heavily on in-house services and original equipment manufacturers (OEMs) for project and maintenance work. At that time the framework primarily existed within the individual utility processes. But in recent years utilities have evolved to use more contractors, resulting in a greater number of suppliers entering the Canadian market.

“The industry has undergone organic change in the past ten to 15 years,” says Dave Dennier, director of major component engineering for Amec Foster Wheeler and chair of the COG Supplier Participant Program, established in early 2015. “In the past three years in particular, there are a lot more competitors in the marketplace.”

The work drawing the new entries to the Canadian market includes major refurbishment projects at Ontario Power Generation’s four-unit Darlington plant and life extension and refurbishment on six units at the Bruce Power plant. There is pressure to deliver on time and budget, while maintaining the high standard of safety that is table stakes in the nuclear industry.

Fukushima was a reminder that the actions of one part of the industry, good or bad, has a ripple effect on the rest. Within a single project or jurisdiction that is even truer. As suppliers realise their success is dependent on the performance of other suppliers as well

as their own, and as they have experienced the benefits of collaboration, there has been a cultural shift. “As independent for-profit businesses, we’re focussed on winning work and executing to the client’s satisfaction,” says Dennier who notes the initial steps into the collaborative process were tentative and mostly focussed on physical safety. But, he says, there is a growing recognition that self-interest can be achieved through the collective improvement that comes from shared experience. And, there is an increasing recognition your success may depend on your competitor’s success.

Initially not everyone was willing to share information, especially of a technical nature. It was also felt that only companies participating would be given access. Fast-forward to today and a wide range of technical details are being shared between organisations. There is enthusiastic and open discussion of materials and sharing of specific examples. There are also plans to create databases and other systems to share OPEX with all utilities and suppliers, not just programme participants.

Dennier believes with each issue the suppliers resolve, their perception of the programme’s value increases. “You get something out of it. We’ve seen a realisation ‘this OPEX is really useful to me. I can take it back to my mechanical engineers or my electrical team.’ That is the first objective.” He adds there is also a realisation that on the

job site, contractors are working side by side. The performance of others has a direct impact on you.

Additionally, he says: "This is going to be a vehicle where we can address issues... as a supplier community working with the utility community. That works to everyone's benefit. If we can share (issues) with that common voice, every supplier will benefit as will the utilities."

Back at COG, Dermarkar believes there is a parallel for the nuclear industry to be found in the American aviation industry. There, significant gains were made in fatality reduction over a decade when industry stakeholders worked collectively toward this common goal. The airline industry had a good track record but really gained ground when airlines, contractors, labour and the regulator joined together.

Kathleen Heppell-Masys, director general of safety management at the Canadian Nuclear Safety Commission, says the regulator must maintain its independence to effectively provide impartial nuclear safety oversight to the industry. However, she adds, the regulator can be part of "intelligent dialogue" of safety culture. "We don't want to compromise that independence but we want informed dialogue. That's a challenging balance but it is important."

While being clear the responsibility for nuclear safety sits with the operator, Heppell-Masys says: "We have asked for years for the licences to foster safety culture. And the regulator has a role to play too." The CNSC is active in research and consultation activities to promote an understanding of the role of human and organisational factors including reaching out to many stakeholders.

In fact, Heppell-Masys says one key observation of the 2015 IAEA Fukushima report is that stakeholder impacts do not end with those who supply parts, touch the equipment or even oversee operations. The strength of the relationships and

### An approach to sharing operating experience

The use of independent external suppliers in the Canadian nuclear industry is growing. Since the CANDU Owners Group supplier participants began the initiative to share operating experience in the past year and a half, they've take a number of steps to build trust and benefits amongst both supplier participants and utilities.

There are regular meetings and interactions between a growing group of suppliers where operating experience on physical safety, as well as technical information, can be exchanged. Written reports are produced on templates adapted from utilities including event descriptions, details of applicable and significant issues and lessons learned. There are exchanges between suppliers and utilities including a recent day-long supplier/utility workshop hosted by CANDU Owners Group, which also included a speaker from INPO on the role of suppliers in nuclear safety.

communication across an eco-system that includes universities, work unions, standards organisations, government ministries, media, lobby groups and others, all contribute to a healthy nuclear plant support system. Each also has a unique perspective and those views can provide meaningful contributions that reduce blind spots. When the eco-system is in good balance it can contribute to nuclear safety in a similar way to other defence-in-depth mechanisms.

As nuclear strives to become safer and through safety, more viable, the number of settings at the table for on-going and meaningful dialogue is likely to grow.

### Defining safety culture

The International Atomic Energy Agency (IAEA) defines a strong safety culture as 'the assembly of characteristics and attitudes in organisations and individuals which establishes that, as an overriding priority, protection and safety issues receive the attention warranted by their significance.'

By contrast, challenges to safety culture identified by the IAEA include attitudes and beliefs that lead to behaviours such as communication of good news only; a sense 'it can't happen here' and acceptance of poor conditions or poor compliance.

In the IAEA Director General Post-Fukushima report released on the 31st August 2015, a contributing factor to the accident included the pressure felt by operators to minimise safety drills due to potential public perceptions. This, coupled with a belief that an event of that magnitude could not occur, provided a false sense of security.

A strong safety culture is supported when senior management establishes and promotes decision-making and "safety conscious behaviour." The IAEA suggests the list below as a set of principles used in some organisations to promote safety culture:

- Everyone has an impact on safety.
- Managers and leaders must demonstrate their commitment to safety.
- Trust and open communication permeate the organisation.
- Decision making reflects putting safety first.
- Nuclear technology is recognised as having unique safety implications.
- A questioning attitude is fostered.
- Organisational learning is encouraged.
- Training of personnel is encouraged.
- A proactive approach to safety is taken.
- Safety is constantly under review.

An understanding and use of the principles can strengthen safety culture both by creating a common understanding of safety culture factors within the organisation and as a tool to evaluate the strengths and weaknesses through self-assessment and external review, according to the IAEA.

At the February, 2016 IAEA International Conference on Human and Organisational Aspects of Assuring Nuclear Safety – Exploring 30 Years of Safety Culture, one area of discussion was the confluence of human and technical factors including external stakeholders and other influences on safety culture. ■



**CANDU Owners Group (COG)** recently held a supplier-utility one-day workshop where utilities and suppliers shared safety expectations and practices from procurement through to operations and major project work. Representatives from Canadian utilities, suppliers and the Institute of Nuclear Operations (INPO) (pictured above) shared their perspectives with more than 80 people in attendance. The COG's Supplier Participant Program has created an on-going venue for suppliers to share technical and safety information creating collaboration within a competitive environment.

### References

Further discussion on this topic can be found at: <http://www-pub.iaea.org/iaeameetings/50800/> International-Conference-on-Human-and-Organizational-Aspects-of-Assuring-Nuclear-Safety-Exploring-30-Years-of-Safety-Culture

This article was originally published in the June 2016 issue of Nuclear Engineering International.

Request your FREE sample digital edition at: <http://www.neimagazine.com/onlineform/NEISubscription.htm>

## LOOKING BACK ON 2015-16

# *Taking the industry pulse at the* **COG ANNUAL GENERAL MEETING**

### **June meeting reflected COG culture of sharing, listening and collaborating to achieve excellence**

Annual General Meetings (AGM) provide an opportunity for organizations to report out their results of the past year and look ahead to what comes next.

For the CANDU Owners Group, the June event was also an opportunity to listen and to collaborate with members, suppliers and industry stakeholders.

"The day gave us a snapshot of what is on the minds of our members and industry partners in real-time," says COG President Fred Dermarkar. "We came away with a clear direction of what is important now for the CANDU industry on a range of issues. And, we gained insights we can use to focus our research and collaboration efforts, and to further strengthen COG programs."

During a day-long round table, members, suppliers and the industry participants tackled equipment reliability and other key industry issues.

The day began with a focus on equipment reliability and presentations from EPRI's Ken Canavan, INPO's equipment reliability working group utility chair Jane Antoine (from Entergy), and COG's equipment reliability peer group chair Alnoor Bhaloo (from OPG). The presentations were followed by a panel discussion that also included Bruce Power's Steve Miller and New Brunswick Power's Andrew Whipple.

As well, the day included insights from Chief Nuclear Officers (CNOs) of Bruce Power, Canadian Nuclear Laboratories, New Brunswick Power and Ontario Power Generation on industry direction and the needs of their organizations. International members were also in attendance including representatives from CNNO, China and the Pakistan Atomic Energy Commission.

As the 2015-16 business year concludes, COG has more supplier participants than ever before and more international partnerships and projects. The result for members and industry partners is greater opportunity to gain a breadth of operating experience and to further leverage collaboration to achieve excellence in all aspects of nuclear research, projects and operations.

See the next page for some of the topics coming out of COG's AGM.



**Top:** COG President Fred Dermarkar and outgoing COG Chairman Paul Spekkens share a reflective moment following the June 2016 AGM. Spekkens retired from OPG and from his position on the COG Board, which he joined in 2011. **At bottom,** Sean Granville, Jordan Chou and Liansheng Wang catch up during a break from the day's round table and panel discussions.

**Find more information on COG 2015-16 initiatives in the Annual Report available on COGonline.**

# HOT TOPICS AT THE AGM

## Equipment Reliability

Equipment reliability has been a COG working group focus area for the past few years. The cross-functional approach and other strategies implemented by the group are showing measurable results.

Aspects impacting reliability discussed at the AGM included:

- Improved wrench time
- Risk analysis on equipment criticality
- Long-term asset management strategies
- Wireless technology to strengthen communication systems
- Other contemporary communications for better OPEX sharing
- Integrated life-cycle management
- Standardized task evaluation and process streamlining
- Turbine generator research
- Scram reduction through vulnerability assessment of behaviours and processes
- The role of culture in achieving reliability
- Utilization of industry standard tools and products
- Including sensor technology in replacement parts to improve maintenance capabilities
- Fulfilling the nuclear promise

## Knowledge Transfer

Whether it is capturing knowledge from the continued stream of baby boomers leaving the workforce or evolving communication methods to effectively train a new generation of employees, understanding and leveraging technology and communication cultural shifts is essential to human performance.

Challenges have been identified but so have strategies including video capture and new ways of cataloguing information for a generation raised on the Internet.

## Cyber Security

With increasing reliance on communication technology comes increased threat from malicious hackers and even unintended events caused by connectivity. Cyber security is as important as the physical barriers traditionally used in nuclear protection.

## Obsolescence Management

Plants in the latter half or quarter of their life such as Point Lepreau, Wolsong (Korea), Pickering Nuclear and the refurbished units at Bruce Power are striving to hit safety, reliability and cost performance targets equal to or better than those achieved in the first half of the plant life cycle. Several COG peer teams and research projects are part of the collaborative effort to positively impact long-term plant performance. A critical component of achieving sustained performance as plants age is managing for obsolescence of parts, equipment and even skill sets amongst the utility and supplier workforce. Amongst strategies discussed at the AGM were:

- Managing obsolescence through maintenance versus replacement;
- Connecting the financial side of the business with the technical side;
- Addressing supply chain transparency, commercial grade dedication and change management for greater security and quality control of replacement parts.

(Read COGnizant Spring 2016 and the COG 2015-16 Annual Report for more information on COG efforts to date.)

## Leveraging Data

The consensus is the CANDU industry has a wealth of data and means for collecting it. The challenge in front of the industry is to mine and leverage the data to provide right place – right time use of the data where and when it is needed to impact on performance and avoid unnecessary repeat events. Whether it is to impact preventative maintenance or human performance, collectively the industry sees this as an area of further exploration and development.

## Change of guard on the COG Board of Directors

### *COG says farewell to COG Board Chair Paul Spekkens*

Ontario Power Generation's **Paul Spekkens** retired from the COG Board of Directors this year as he did the same at OPG. Paul served on the COG Board for five years beginning in 2011. A tireless volunteer, Paul has also served on many other boards, committees and took part in industry activities. In particular, he has given a great deal of his time and passion for training the next generation.

"Paul was more than just the chair of the board," says COG President **Fred Dermarkar**. "He was fully committed to the COG collaboration model, and was an outstanding mentor to my staff and me in helping us to find ways for our members to realize the full potential of collaboration. He is truly a very special person, and I will miss him," Dermarkar adds.

Bruce Power's Vice President and Chief Nuclear Engineer **Gary Newman** replaces Paul as Board Chair while OPG's Senior Vice President, Nuclear Engineering and Chief Nuclear Engineer **Steve Woods** replaces Paul as the OPG representative on the Board.

# Human Factors in Nuclear Resiliency

## Getting to acceptance *Through human performance & collaboration*

**C**limate change and the resulting need for low carbon generation options has created one of the most compelling cases for the use of nuclear power in the history of the technology. Increasingly, continuous improvement of operating methods and equipment management is improving its safety and economics.

Yet, especially in western countries, the use of nuclear for electricity generation continues to decline in both current operation and in future planning scenarios.

There are several factors impacting on nuclear's competitive position. But when they are boiled down, the concern remains one of public and political confidence in the safety and the cost. The negative perceptions are, in part, based on lack of understanding of a complex technology and on global events like Chernobyl and Fukushima, which due to their scale, remain in the public consciousness. But even small performance events at generally strong performing plants can erode public confidence in their jurisdiction, creating additional legislative and regulatory hurdles to both continued operation and new nuclear builds.

In September, CANDU Owners Group President Fred Dermarkar spoke at the *International Atomic Energy Agency's (IAEA) technical meeting on Strengthening Resiliency in Nuclear Power Plant Operations in the Face of Current and Future Challenges*. The meeting brought together global nuclear leaders to consider how the industry can improve its collective performance. and in doing so, improve the likelihood the world will see nuclear technology as a solution to the planet's carbon challenge and a way to meet its increasing need for environmentally-sustainable, affordable and safe electricity.

In two sessions, Dermarkar shared COG's experience and his own observations on both human and technical aspects of nuclear practices.

In Part 1 of a two-part series, we feature highlights of Dermarkar's presentation on human aspects in nuclear resiliency. Part 2, highlighting technical aspects, will appear in the Winter 2017 edition of COGnizant.

### Highlights

#### COG President Fred Dermarkar on Human Aspects contributing to Nuclear Resiliency IAEA, Vienna, September 2016

**S**eventy per cent of nuclear plant significant events can be traced back to human error. And, if you consider the times the event pre-conditions were caused by human aspects (latent conditions that could have been averted with the correct preventative behaviours), it is likely much higher.

At the two plants impacted by the tsunami in Fukushima – Daini and Daiichi -- there were two very different outcomes. Daini's was positive because in the face of extraordinary external challenges, the team managed to avert three core meltdowns. At Daiichi, we know, it was a devastatingly negative outcome. Both relate back to human and organizational factors.

And, it is not just a nuclear phenomenon.

The 2013 train crash in Lac Mégantic, Quebec that killed 47 people and led to the destruction of all but three of the more than 60 buildings in the downtown region is recognized as having its roots in human and organizational factors, extending systemically to both the operator and the regulator.

It is true as well of the event that caused injury to eight sailors on the USS Dwight D. Eisenhower in March 2016. In this event, a plane failed to slow in its landing on the aircraft carrier, after a cable snapped. At first blush it might seem like equipment failure. But the investigation revealed missed steps during troubleshooting by workers as the cause, pointing more fundamentally at human and organizational factors.



## Human Factors Continued

### Creating a system for success

These events may appear to be faulty individual actions, just in the way counterfeit parts finding their way into airplanes or nuclear plants may seem like random acts of corruption.

But in each case, when you review the root causes, you can find system-related issues that allowed precursor conditions to these events. For example, in the case of the aircraft carrier, the precursor to the failed troubleshooting has been identified as insufficient training.

These are human aspects over which we almost always have control.

By contrast, pilot, Chester B. Sullenberger and his crew, were lauded as heroes for split-second decision-making that resulted in their plane's safe landing in the Hudson River following engine failure caused by geese striking the plane. Just as with the Fukushima Daini plant that managed to avert disaster, we should learn from these successes and ask ourselves:

- What leadership, culture and learned behaviours allowed these crews to make the decisions required;
- What underpinning cultural factors provided the respective leaders the support from their team in that deciding moment?

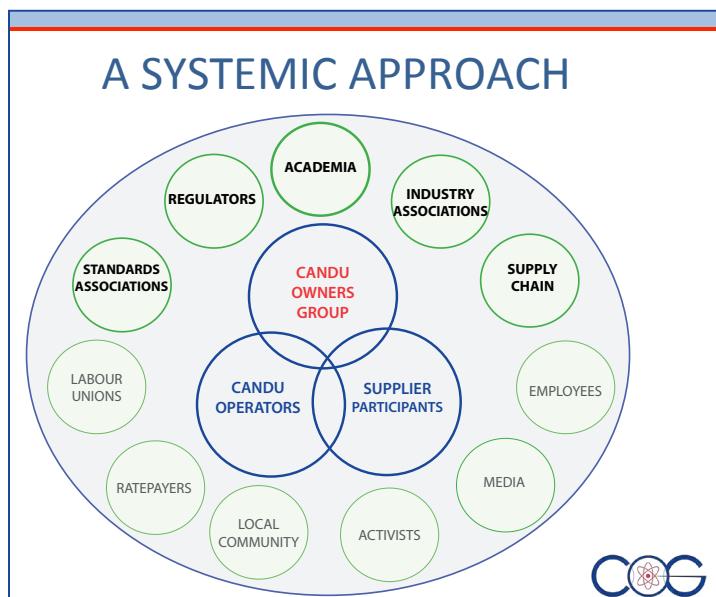
### Influencing Human Factors

If we consider human aspects systematically, we can think of it as leadership directing and enabling culture throughout the company and in the plant. In turn, this sets the tone for the individual behaviours, communication systems and processes people call upon in their work every day – the things that either drive or undermine safety, reliability and cost. And, in those rare but high impact events, the internalized culture drives instinct.

### Human Aspect Trends

There are a number of human aspect issues chief nuclear officers are flagging in their work environments including:

- Demographic shifts, which continue at a high rate as they have for more than a decade;



**Today nuclear operators have a host of external factors to consider when contemplating the factors that affect their operations. They must break down silos both inside and outside of the plant. Above, a slide from COG President Fred Dermarkar's presentation at the IAEA Nuclear Resiliency Technical Committee Meeting in September 2016.**

- The impact on the plant of public and regulatory expectations and perceptions. More than ever, we see safety and economic regulatory expectations that take a systemic approach: They place increased value on societal expectations with input from multiple stakeholders including labour unions, neighbouring communities, suppliers, standards organizations, academia, activists, and others;

- And within the plant we wrestle with human inclination to create silos and tribes – the instinct to throw work over the departmental fence or to secret it away to avoid the challenge of criticism. There are complex reasons for this behaviour and unravelling them to create a culture of transparency is equally complex.

It requires deep work in building leadership, building teams, building trust and understanding of human dynamics. Here, too, we need to take a systemic approach of involving many internal stakeholders.

Collaboration models are needed to provide a sense of safe space and mutual accountability; one that rewards people for working together; that values team outcomes rather than individual superstars.

And finally, we need to integrate decision-making competencies into our processes and our training. We need to develop systems that provide people the skills and resilience to make decisions in extreme situations: the ability to make decisions and execute in those moments when paralysis is the worst choice of all.

### A Systemic Approach

Many stakeholders influence the operation of nuclear power plants. Addressing the human aspects that influence plant operation requires consideration of the complex interactions between these stakeholders. At COG, our focus has been primarily on operators, and it has recently expanded to include supplier participants. To better support our members, the CANDU operators, we are playing an increasingly prominent role in interactions and collaborations involving academia, industry associations, the supply chain, standards associations and regulators.

### COG's Role: Strengthening Resiliency

The low-hanging fruit is found in our reverse pyramid of leadership, culture and personal behaviours.

In 2014, COG began a training program for leadership development, which has grown significantly, including with our international members. In China, CNNO put 140 of its management team through this three-week program and continues to enroll its team in the course.

Similarly, COG offers a safety culture course that was recently delivered to KHNPP in Korea. The course was divided into three sessions, targeted at executives, managers and then engineers. Courses like these help to set up the systems required to make and sustain deep changes in leadership and culture.

### Training the next generation

COG provides its member the ability to transfer knowledge from one generation to another.

Through a number of joint projects, we have been able to capture knowledge and operating experience through textbooks and other documents from a generation of nuclear professionals who have, or are about to, retire. It is not an exaggeration to say we have an encyclopedia set worth of data and knowledge captured to share. And, we continue to look for the best ways to share this knowledge through updates to our web-based systems, through improvements to our workshops, through new training opportunities

## **Human Factors Continued**

and peer teams, and through extended international collaborations across organizations and with our partners and at forums such as this one across organizations. And, we are currently looking at how we can improve this by better understanding the communication patterns of millennials coming into the workforce.

We also seek out experts beyond our own industry. Human and organizational factors that apply to nuclear are often the same ones that have been studied and implemented elsewhere. For example, managing counterfeit parts in the nuclear industry has similarities to the approach in aviation. Similarly, safe behaviors in a nuclear plant have the same roots as safety in rail management or infectious disease control.

### **Suppliers and operators working together**

An initiative that has provided a lot of excitement at COG in the past couple of years is our supplier participant program. We continue to have new suppliers joining and even more interacting with COG and its members as the role and significance of suppliers' behaviour in outcomes becomes further understood.

Through bi-monthly meetings facilitated by COG, leaders in the supplier community are stepping up and sharing operating experience from their projects. One year ago, they would have viewed this information as contributing to their competitive advantage and would not have been open to sharing. Now, they see the linkages between their work and the success of the operators, and the need to ensure that the lessons learned from a mistake made by one supplier are shared within the supplier community to prevent repeat event by another supplier. Importantly, they are taking ownership for their role in the success of the industry.

COG is very appreciative of the strong working relationship we have been able to forge with the *Organization of Canadian Nuclear Industries* in these efforts. As well, we have built on the work of INPO, IAEA and others. This initiative is a case study in the value of collaboration.

### **COG's international reach**

As mentioned earlier, actions taken far away reverberate around the globe. There may be no other sector that underscores how small our world has become in the same way nuclear does. What happens in a plant in Japan or India; in New York or Ontario is felt across Europe, North America, Asia and Africa in varying degrees.

So, we see it as a real strength that COG's reach is increasingly international with strong support and partnership flowing between our Canadian members and our international members. COG also works to be a conduit between our members and other organizations like EPRI, WANO and IAEA, to help them get the most from this knowledge network by channeling the knowledge and information most relevant to them into tangible activities and work programs.

COG wants to make the world smaller, in a positive way, by bringing lessons learned from multiple settings with all the nuances different cultural norms bring to the workplace. We can learn from each other's diverse experiences: both the successes and the failures. We can adopt ideas into our own operations, including those that would not have been inherent to our own societal norms.

For a couple of years now COG has been helping our CANDU-6 fleet members connect in a more formal way with periodic meetings and other peer opportunities. For the people who run this subset of CANDU technology, the commonalities they share combined with the diversity of perspectives they bring, offers tremendous learning opportunities.

### **The human in equipment reliability**

Equipment reliability seems to be a technical issue. After all, how can you get more technically focused than equipment condition?

And yet, COG members have seen excellent progress through the equipment reliability peer teams whose focus has been very

***"COG is appreciative of the strong working relationship we have been able to forge with the Organization of Canadian Nuclear Industries in these efforts. As well, we have built on the work of INPO, IAEA and others. This initiative is a case study in the value of collaboration."***

much on culture change and human performance. They have moved the bar by changing how people work with each other across teams and functions. New requirements for more-fulsome, more-frequent communications with more analysis of what worked and what didn't, has created a quarter-over-quarter improvement between 2013, when the initiative was launched, and today.

### **Excellence through Collaboration**

I feel fortunate to be president of COG because so much of what we do relates to harnessing the positive side of human performance and to working with CANDU operator and supplier leaders in this area.

The work of these colleagues brings to mind the value of risk sharing in relation to operators and suppliers. I will expand it here to internal plant stakeholders and departments.

Successful risk sharing requires a systemic approach that includes:

- Oversight of quality assurance and control;
- Leadership through human performance program oversight; and
- A culture of partnering and alignment.

Through these three steps we can achieve the personal behaviours necessary to reduce the frequency of events and minimize the severity of events. It is in our control.

These are the details of the work that must be observed day over day to achieve that simple, yet large, goal of excellence through collaboration, which is COG's vision.

The outcome of living this day-over-day is the opportunity it affords for us to demonstrate our safety and affordability in a way persuasive to governments, regulators, financers and the public. It builds trust.

We can do this. Not only for ourselves, but also for the millions of people who rely on us to provide them power that is safe, clean and affordable... and that is an excellent tool in fighting one of the planet's toughest challenges today – the impacts of climate change.

*The COGnizant Winter 2017 Edition will feature Part 2 of this article: Nuclear Resiliency through Technical Factors based on Fred Dermarkar's second presentation to the IAEA Technical Committee in Vienna this past September, 2016.*

# Making obsolescence issues feel almost... obsolete



*David Mueller, Vice President Strategic Programs, Argo Turbo and Saadia Malik, Senior Design Engineer, OPG chat at the ATC Nuclear booth during the workshop.*

## *Year 2 of the COG Obsolescence Workshop offered more opportunities for collaboration to address challenges and find solutions to an aging problem*

Obsolescence is a complex issue, which can have serious ramifications for nuclear utilities if it is not managed well.

As many of the nuclear power plants around the world aged, and with limited new build activity in the west, the business drivers that would incent equipment vendors to maintain their nuclear qualifications waned.

Managing obsolescence in isolation is costly, inefficient and nearly impossible. In recognition of these challenges, COG member utilities had a strong desire to collaborate and in 2015, COG held its first Obsolescence Management workshop. Our goal was to provide a forum where the industry players can share knowledge, experiences and ideas on how to manage this complex and multi-faceted problem.

This year, COG held the event again in Toronto on Sept. 15-16 with an excellent turn out of about 55 people representing virtually all of the CANDU utilities (OPG, BPLP, NBP, CNNO NPP3, KHNP, SNN), Canadian Nuclear Laboratories (CNL) and 18 vendor companies, says COG Project Manager, Joint Projects & Service and event

organizer Nidhi Gaudani, who noted about 90 per cent of the 2015 participants returned this year in addition to new participants.

The direction and strong support of the COG Procurement Engineering Peer Group (PEPG) significantly contributed to the success of the workshop, organized to meet the following objectives:

- Bring together representatives from CANDU stations around the globe so that they could learn from each other's successes and share problems;
- Stay current on industry activities and initiatives;
- Provide a forum for vendors to showcase their expertise and engineering capabilities in response to the needs expressed by CANDU utilities; and
- Provide a networking opportunity with industry peers to make connections and build trust towards developing synergistic relationships for collaboration.

Together, COG members and suppliers are improving operators' ability to sustain healthy plant life longer.

## The Obsolescence Workshop

**Day 1** started with a speed networking session followed by utility presentations highlighting recent success stories.

The theme of the afternoon session was industry collaboration under which Nuclear Utility Obsolescence Group (NUOG) and COG representatives presented.

**Day 2** began with vendor presentations on engineering capabilities and solutions they can offer to CANDU utilities for the resolution of their obsolescence issues. Participants provided very positive feedback and confirmed the two COG joint projects -- Shared Obsolescence Solutions and Equivalency Uploads via CMIS Lite Integration -- are directionally correct.

The workshop proceedings are available to COG utility members and COG supplier participants on COGonline.



*Participants started Day 1 with a speed networking session. With representation across virtually all of the CANDU utilities, it was an opportunity to make new connections.*

# The rescue network

## COG's Inter-Station Assistance -- A different kind of lifesaver

Association presidents get many letters in a given day but back in late July, when COG President Fred Dermarkar opened one particular note from Wolsong NPP1's Director General, he knew it was a good day.

The Wolsong DG, Jongha Jeon, was writing with gratitude for the quick save COG was able to help orchestrate for the Korea Hydro and Nuclear Power (KHNP) plant with procurement of a spare part from another part of the CANDU network. The ability to retrieve the part in a timely way reduced outage time on the recently refurbished Wolsong unit.

"I really appreciate your energetic cooperation for the spare parts procurement... please send my gratitude to all of the COG office and fleet members. I especially want to thank Dr.



COG Program Manager Paul Lafreniere

KiSang Jang and Ms. Nidhi Gaudani," the letter read, adding, "Thank you for your help to secure spare parts through NB Power, OPG and Fisher. Thanks to your consideration, Wolsong could secure the spare parts smoothly."

Like many nuclear operators worldwide, KHNP is working to achieve

operational excellence in the mid-to-late life stage of its nuclear plants. While technology and experience makes it possible to run older plants with as good or better performance than in the first half of their life, it's widely acknowledged that equipment obsolescence and a lack of spare parts – especially in a quick turnaround – can be a challenge.

To address this, COG created the Inter-Station Assistance (ISA) Program. It has four components:

- Emergency spare parts;
- Obsolescence Support;
- Benchmarking Forum and Staff Exchange; and
- Circuit Card Failure Mitigation Peer Group.

KHNP has had reason to use the Emergency Spare Parts program three times this year and each time the international network of operators and suppliers set up through COG has come through.

Program Manager Paul Lafreniere says the ISA program is as strong as the sum of its parts: the people at the sites who go all out to meet the need as quickly as possible. In this last event, he says, someone at New Brunswick Power came in from her vacation to get the part where it needed to go.

Lafreniere says the Inter-Station Assistance program has the potential to positively impact plants into the millions of dollars. "When you factor in the impact of lost generation and having workers sitting waiting for parts to get out of an outage, you can see how easily the time and money can add up."

## COG signs partnership agreements with OCI and AECL

In Oct. 2016, COG signed a partnership agreement with the Organization of Canadian Nuclear Industries, the organization representing 215 CANDU suppliers. The memorandum of understanding (MOU) is "to further a collaborative relationship for the overall benefit of the CANDU nuclear supply community and to enhance communications and information exchange in these common interest areas."

As well, in September, COG and Atomic Energy Canada Limited signed an MOU to "further a cooperative relationship to promote and enhance science and technology initiatives that are mutually beneficial and are of a common interest to both COG and AECL, and to enhance communications and information exchange in these common interest areas."

Together, we are tackling industry challenges and strengthening communication between operators and suppliers. Through these initiatives we will prepare for major component replacement projects and refurbishment.

These MOUs are similar in intent to one signed earlier this year between COG and the International Atomic Energy Agency (IAEA). "Through collaboration with many partners both here in Canada and internationally, the CANDU Owners Group and its members are strengthening nuclear safety, improving reliability and reducing costs both in operations and projects," said COG President Fred Dermarkar. "We are committed to excellence and there is no better way to achieve that than working together."



Above, L-R: OCI President Ron Oberth and COG President Fred Dermarkar share a laugh while signing an MOU on a partnership agreement to collaborate in areas of common interest for their members.

# Strengthening the core



CANDU Owners Group program manager Sonia Qureshi is vice chair of the WiN Canada Golden Horseshoe West Chapter. She is also part of the organizing team for the upcoming WiN Canada conference, Nov. 7, with tours of GHW Chapter organizations on Nov. 8. (Photo: BWXT Canada)

The 13th WiN Canada conference, Nov. 7-8, provides a chance to pause and focus on the core skills and knowledge that build the safe, reliable and affordable nuclear plants people can trust to power their lives.

## **CANDU Owners Group is there.**

With two multi-unit refurbishments underway, continued operations and efforts to innovate and strengthen waste management and decommissioning practices, the 60,000+ workers in Canada's nuclear industry could be forgiven for focusing on immediate needs.

So, organizers of the 13th Annual WiN-Canada Conference hope the event serves as an opportunity to reflect on actions past and present across the industry. And, through that, to plan and shape the future with this year's theme:

### ***Strengthening the Core.***

Taking place on Monday, Nov. 7, this year's conference is hosted by the Golden Horseshoe West (GHW) chapter at Lionhead Golf and Conference Centre in Brampton, Ont. Facility tours will follow the next day, Nov. 8.

GHW Chapter WiN members and their respective companies play an important role in Canada's nuclear industry

despite the absence of nuclear plants in the GHW Chapter's proximity. Covering a large area from Scarborough to Hamilton, its members come from diverse companies such as Amec Foster Wheeler, Candesco, CANDU Owners Group (COG), SNC-Lavalin, Kinetrics, Nuclear Safety Solutions, the Nuclear Waste Management Organization and Ontario Power Generation's corporate offices.

The facility tours include visits to McMaster's research reactor, SNC-Lavalin's CANDU 6 control room mockup and BWXT Canada's Cambridge facility. As well, there will be an opening reception at Hatch and breakout sessions and speakers highlighting innovation in:

- Personal Leadership;
- Career Development;
- Science and Technology; and
- Industry Best Practices.

## Why WiN?

Formed in 2004, WiN-Canada helps members gain the confidence and knowledge to become ambassadors for nuclear energy and technology.

Although many members of WiN-Canada are employed in the nuclear energy sector, members come from diverse industries that use nuclear and radiation technologies, such as hospitals and medical facilities, mining, academic and research institutions. The wider electricity sector, and their suppliers are welcome.

All members have one thing in common: they want the general public to have a better understanding of nuclear and radiation issues.

At the same time, the organization provides women an opportunity to succeed at work through initiatives such as mentoring, networking and personal development opportunities.

Sonia Qureshi, a program manager with COG's Information Exchange department currently serves as vice chair of the GHW WiN chapter. Qureshi, first became involved when she attended the Global Conference in 2006.

"I was inspired by the high caliber of women providing their insight and experience in the global nuclear industry," she says. "I knew I wanted to be a part of the association and hopefully inspire other young women to continue their professional development within the largely male-dominated nuclear industry."

The industry offers both high-skill jobs and a chance to make a difference in people's lives through safe and affordable



COG's Sonia Qureshi and BWXT Canada communication manager Natalie Cutler, do a facility walk down in preparation for the WIN-Canada tour, Nov. 8. (Photo: Emma Nicholls.)

electricity with almost no greenhouse gas emissions.

Helping women gain knowledge and tools to achieve their personal goals while contributing to more sustainable nuclear energy is what WiN, and the conference, is all about.

**Anyone interested in participating in the conference can find more information at <http://www.wincanada.org/eventdetails.php?id=379>.**

## COG's Women in Nuclear Varied Skills, Combined Strength

CANDU Owners Group takes its strength from diversity of its employees and contractors. Below are three of several WiN women on the COG team who, with their colleagues, are making a difference for the industry.



### Sonia Qureshi

The WiN Golden Horseshoe West chapter vice-chair began her career in nuclear at Atomic Energy Canada Ltd. after graduating from the University of Toronto with a Bachelor of Science (Honours) degree in chemical engineering.

Approaching 20 years in the nuclear industry, she has worked in a wide range of capacities, demonstrating her strong technical background in combination with commercial, business and marketing experience. In 2016, Qureshi moved to her role at COG.



## Ann Palen

As COG's Business Services Manager – Finance, Ann Palen combines her technical and business experience in the nuclear industry. She launched her career at Ontario Hydro after graduating from engineering. Early on, Palen worked at Bruce commissioning nuclear safety systems.

She spent several years in the Nuclear Studies and Safety Department working on the safety design of the Darlington Nuclear Generating Station. This was followed by a stint in Generation Planning and Development, where she earned her MBA studying part-time.

Palen was one of the founding members of Women in Science and Engineering (WISE), which was created to promote the education of women in these fields and to develop women's leadership skills, confidence and involvement in research and technology.

She also worked on the Canadian Fusion Fuels Technology Project (CFFTP), which was jointly funded by the Government of Canada, the Province of Ontario and Ontario Hydro. CFFTP's mission was to extend Canada's fusion capabilities, particularly the tritium technology developed in the CANDU program. She then moved to the business side of Ontario Hydro Research Division, which became Kinectrics. Palen was pleased to join COG in 2009.



## Holly Anderson

Holly Anderson is the safety and licensing program manager for the CANDU Owners Group's Research and Development department.

Anderson began her career in flow-induced vibration research and analysis when she was hired in Ontario Hydro's Research Division right out of graduate school in 1978. She has since worked in a variety of roles, including equipment commissioning, trouble-shooting, testing, data acquisition system and analysis methodology development, as well as facility supervisor. In her current role at COG Research and Development, she is responsible for the successful facilitation and administration of research and development projects related to nuclear safety and licensing on behalf of the COG membership.

Throughout her career, Anderson has worked to encourage equality and opportunity for women in the industry.

"The number of women in the nuclear industry is rapidly growing," says Anderson, who notes women working in nuclear are still statistically under-represented. Through WiN and other industry initiatives, Anderson has actively worked for change.

# **COMING...**

# **COGnizant WINTER 2017**

## ***In our next issue:***

- Meet Bruce Power President and CEO Mike Rencheck in his fireside chat with COG President Fred Dermarkar at the December GBM;
- Take a tour of BWXT Canada with participants of the September COG GBM and learn more about the growing Cambridge company; and
- Hear from Canadian Nuclear Association President Dr. John Barrett on the state of the industry.

## **Take a look back at 2016:**

- COG events and initiatives of the past year through pictures and stories; and
- The 2016-2017 Research and Development program focus areas; and
- What the C6 Fleet Committee is accomplishing through collaboration.



**Plus industry news and more.**



ABOVE: Attendees of the COG Fall 2016 GBM had the opportunity to take a tour of BWXT Canada's Cambridge facility. In the Winter 2016 COGnizant, we'll take you inside for a tour.

LEFT: The C6 Fleet Steering Committee held a meeting in September, 2016. In our Winter edition COGnizant will look at the initiatives of the group and discover the value of information sharing and collaboration amongst this unique group of operators.



**CANDU OWNERS GROUP**

Follow us on LINKEDIN

Public website: [www.CANDU.org](http://www.CANDU.org)

Members site: [COGonline.org](http://COGonline.org)

Watch for the relaunch of the COG public website coming January 2017

**CANDU Owners Group (COG)**  
655 Bay Street, 17th Floor  
Toronto, ON M5G 2K4 Canada  
Phone: 1-416-595-1888  
Fax: 1-416-595-1022  
Email: [cog@candu.org](mailto:cog@candu.org)

