CANADIAN NUCLEAR SOCIETY

Bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

JUNE 2014 JUIN VOL. 35, NO.2

- 10th CANDU Maintenance Conference
- 2014 Canada-China Advanced Reactor Development
- CNS Annual General Meeting
- Incoming President's Address

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A New (Old) Government for Ontario

The Liberals have won a striking majority in this June's election. Will things change?

In their previous majority position that began in 2003 and lasted until 2011, the Liberals introduced the bid process for New Nuclear at the Darlington Site while also introducing their so-called Green Energy Act. Just prior to the June election they were in a minority position, and to maintain parliamentary power they needed the support of the New Democrats (NDP). The NDP is opposed to nuclear (whether new build or refurbishing old plants) while supporting wind and solar. To sustain NDP support the Liberals cancelled New Nuclear and introduced the Long Term Energy Plan that was a compromise of refurbishing old nuclear and increasing wind and solar.

The introduction of wind and solar came at a very high cost to rate-payers through a system of Feed-In-Tariff (FIT) that guaranteed very high payments to the private power generators. With an angry public enraged over skyrocketing electricity prices the Liberals took shots at the government owned utilities, Hydro One and Ontario Power Generation in order to divert the public's rage away from the Liberal's electricity screw-ups. They claimed that these utilities were paying their employees excessive wages and pensions and that was the reason hydro bills are so high. However, politicians are not good at math - OPG is paid about 5.2 cents per kWh compared to 11 cents per kWh for the privately owned gas (needed to support wind and solar), 13.5 cents per kWh for wind and 50 cents per kWh for solar.

Not only are politicians poor at math, they are much worse at engineering. In order to accommodate wind and solar (to appease the NDP) significant investments had to be made in order to keep the power grid stable!

The Progressive Conservatives, for their part, were highly critical of the Liberal government's Green Energy Act and vowed to terminate the lucrative FIT payments to private power generators. Furthermore the Ontario PC party has historically supported nuclear power. They also vowed to stop interfering with engineering the electricity system, and let engineers do what they are qualified to do. Unfortunately the PC leader was as poor at math (or worse) than the Liberals. In my opinion, the PC party simply blew it with the voters with a platform that did not add up.

When the Liberals held a majority they began the process of new build nuclear. While in a minority they cancelled new build. However, they could not ignore the success of the Bruce Power refurbishment project because it was that refurbishment, and not added wind and solar, that facilitated the Liberal promise to phase out coal.

Now the Liberals have a majority again and no longer need the support of the anti-nuclear NDP. Will things change?

In This Issue

There were two recent conferences that are reported in this issue: the 10th International CANDU Maintenance Conference and the 2014 Canada-China Conference on Advanced Reactor Development. Both were a technical success in exchanging knowledge, which will benefit the nuclear industry. Three technical papers from the CANDU Maintenance Conference are presented in this edition of the Bulletin.

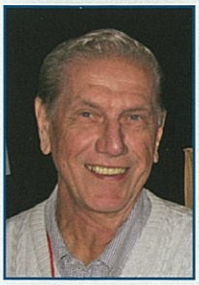
We also have an article by CNS Member Hans Tammemagi who shares his thoughts about public communication using nuclear waste disposal as an example.

With our recent Annual General Meeting we have a new Executive with incoming president Jacques Plourde. There is a report on the meeting as well as the new president's Incoming Address.

As usual we have a number of interesting news item, both of industry and of the CNS, and an updated calendar of events. Jeremy Whitlock, in his Endpoint article, offers some very interesting facts about nuclear, intended to evoke that "Wow" response when shared with bowling buddies and neighbours.

As always, your comments and letters are always welcome!

Well, it was a winter to forget. Really! It was over budget and behind schedule. Nature, it seems, decided to save lost time by skipping spring altogether and sliding straight into summer, for which we are thankful! Enjoy your summer and play safe!



Society

April and May this year saw three important CNS activities- the *Canada – China Conference on Advanced Reactor Development*; the *Annual General Meeting* and the *10th International Conference on CANDU Maintenance.* There are reports on all three in this issue of the CNS Bulletin.

The Annual General Meeting was held slightly earlier than usual and in conjunction with the CANDU Maintenance Conference instead of an Annual Conference. When the Society was awarded the right to host the large international *19th Pacific Basin Nuclear Conference* in Vancouver in late August this year CNS Council decided to forego an Annual Conference.

The two Society conferences held since the last issue, the Canada – China Conference and the CANDU Maintenance Conference, were both quite successful in terms of information exchange and personal contacts. Their chairs, Laurence Leung and Vinod Chugh, respectively, deserve congratulations for assembling teams that made their respective events a positive experience for all participants.

However, the financial outcomes for the Society were different. The Canada – China event was not planned to make money, in fact the CNS contributed to this important international exchange. Previous CANDU Maintenance Conferences (except the immediate previous one) had been significant financial contributors to the Society. This one was not. Until last year conferences had been the major source of income for the Society, far outweighing that from memberships.

This 10th version of CMC had excellent participation by senior industry people but the financial contributions through sponsorships were appreciably less than predicted. Given the current state of our nuclear power program, perhaps that should have been anticipated. As a result the Society is expected to end 2014 with another significant deficit. Fortunately, over the previous decade or so the Society had positive incomes. While there is no danger of bankruptcy the past two Councils have taken the hard decisions necessary to bring the Society operating budget into balance and the newly elected one will undoubtedly continue that approach. If any member has thoughts on how the Society can increase its income while continuing to fulfill its mandate please communicate with the President or local member of Council.

One approach is to hold new conferences or other activities. An excellent example is the planned *1s Technical Meeting on Fire Safety and Emergenc Preparedness for the Nuclear Industry* to be held i Mississauga, ON, June 17 – 19, 2015. The proposal fo this new conference came from one of the younges members of Council, Tracy Pearce of AECL- CRL.

Of a different scale financially but important i meeting one of the objectives of the Society - *to ac as a forum for the exchange of information relating t nuclear science and technology* – are the courses CN offered such as one on CANDU Fuel Technology to b held this October.

The Canadian Nuclear Scene

Given that much of the Canadian nuclear activity i in Ontario, the recent provincial elections were impor tant. Unfortunately the outcome leaves the nuclea program still in a state of uncertainty. The winnin party is the same one that gave us the Green Energ Act, which has badly crippled the electricity system and cancelled any new nuclear units.

Nationally, the federal government is proceedin with its plan to turn the Chalk River Laboratory ove to a consortium of mostly private corporations. Whil this is touted as improving the operation of CRL it ha been clear since the beginning of this exercise that th federal government expects this exercise will reduc the cost to the federal treasury. That ignores the expe rience in the USA where the national laboratories stil obtain the vast majority of their funding from th national government but from many different depar ments instead of the former arrangement where it al came from the Department of Energy.

Then there is the public opinion fiasco of the Dee Geologic Repository at the Bruce site. The objec tions to the technical plan are all superficial but hav received great media coverage, mostly negative. An now even the state of Illinois is getting into the act.

It is difficult to understand why such a project wa ever proposed for **low and intermediate** radioactiv waste. That has been handled safely for decades. Th DGR proposal leaves the strong implication that eve that material is extremely dangerous.

To close on a positive note, the Canadian Nuclea Safety Commission and, especially, its presiden Michael Binder, deserve praise for challenging th ruling of a Federal Court in May this year. Tha Court dismissed the decision of a joint CNSC – CEA hearing of 2012 that approved site preparations fo the then planned (but unspecified) new units at th Darlington site. *(See General News for more details).*

Contents

~ Cover Photo ~

Optimized tight fitting annulus spacer installed on a pressure tube. See paper "Detection and Repositioning of Tight Fitting Annulus Spacers" in this issue.

Photo courtesy of AECL.

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Le Bulletin SNC *est l'organe d'information de la Société Nucléaire Canadienne.*

CNS provides Canadians interested in nuclear energy with a forum for technical discussion. For membership information, contact the CNS office, a member of the Council, or local branch executive. Membership fee for new members is $82.40 per calendar year, $48.41 for retirees, free to qualified students.

La SNC procure aux Canadiens intéressés à l'énergie nucléaire un forum où ils peuvent participer à des discussions de nature technique. Pour tous renseignements concernant les inscriptions, veuillez bien entrer en contact avec le bureau de la SNC, les membres du Conseil ou les responsables locaux. Les frais d'adhésion par année de calendrier pour nouveaux membres sont 82.40$, et 48.41$ pour retraités.

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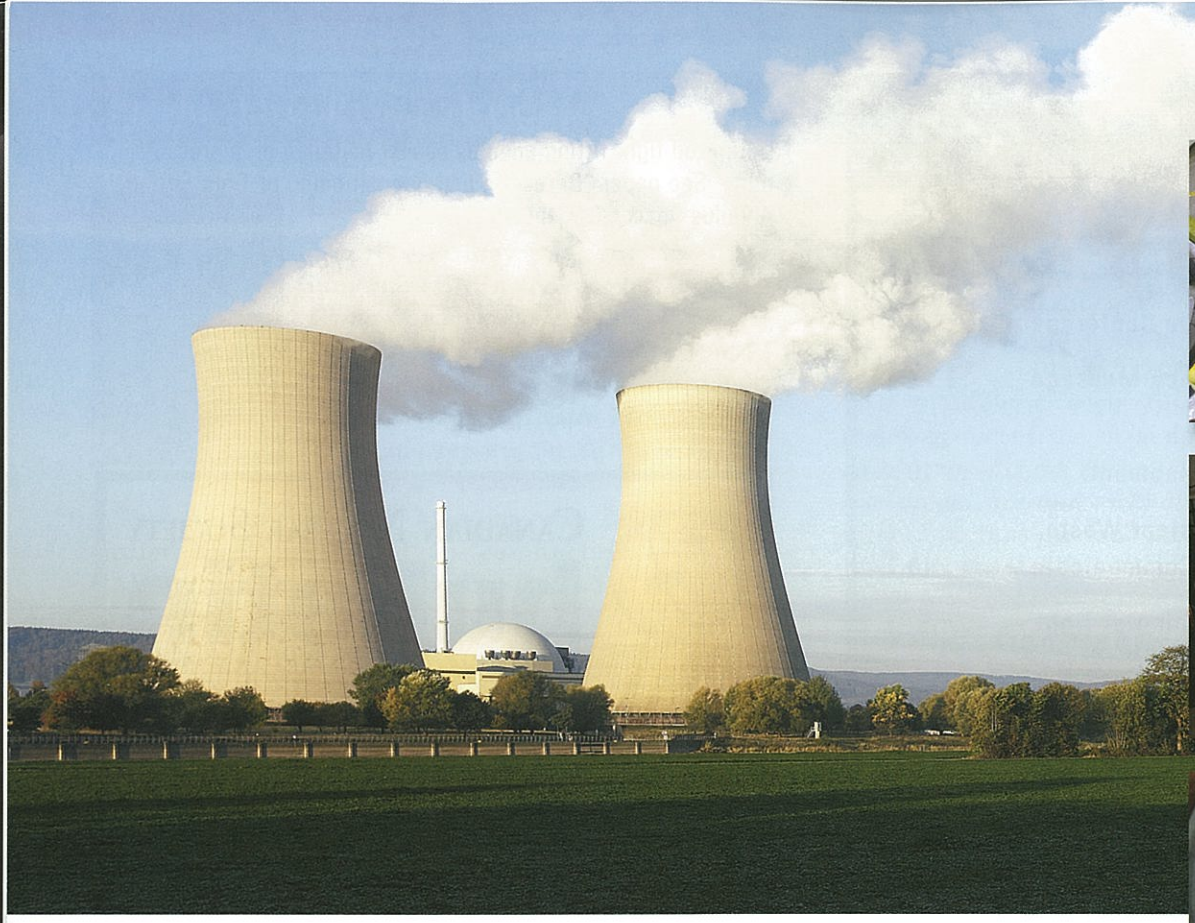

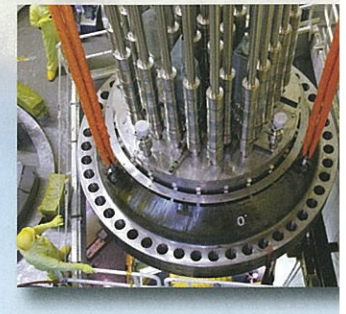

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10th CANDU Maintenance Conference

Revised conference format expands scope

by FRED BOYD

The *10th International Conference on CANDU Maintenance* held in Toronto, May 25-27, 2014, expanded the scope of subjects to include policies, people, planning and more. This attracted and involved many senior level representatives from the nuclear operating utilities among the approximately 300 attendees.

A sub-theme of the conference was *Revamping the Technical Strength of Our Industry,*

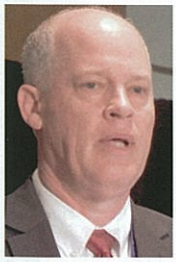
There were concise plenary sessions both morning and afternoon of the two day meeting, followed by break-out technical sessions. The latter had four parallel sessions, broadly following on the theme of the preceding plenary one.

As for the past several conferences in this series, this 10th version was held in the Metro Toronto Conference Centre adjacent to the CN Tower.

Preceding the conference were two events on the Sunday: an all-day *CANDU Configuration Overview Course* and a NAYGN (North America Young Generation Nuclear) *Professional Development Day*. Both were well attended.

An opening reception was held on the Sunday evening in the Trade Show area, where 34 companies and organizations displayed their products or services.

In opening the conference on the Monday morning, **Vinod Chugh**, Conference General Chair, began by thanking the nuclear utilities for the good performance of their nuclear units, and expressed appreciation to them for the participation of senior people in the conference. He urged collaboration between the utilities and with contractors to solve problems.



Chugh then turned the microphone over to **Margaret Russett**, Executive Assistant to the Executive Vice-President and Chief Nuclear Officer of Bruce Power, **Len Clewett**, to chair the opening plenary session titled *"Policy and Vision"*. She then introduced Clewett, the only plenary speaker. .

Clewett titled his remarks: *Establishing Building Blocks for Equipment Excellence.*

Unplanned equipment failures have caused the forced loss rates of Bruce units to exceed industry averages, he noted. Critical factors for success, he said, included: proactive engineering; preventative and predictive maintenance; successful work management; use of operating experience and benchmarking.

He noted that the industry faces challenges, such as an aging workforce and obsolescence of equipment. On the latter he invited suppliers to help.

As part of a two year initiative still in an early stage, Bruce Power wants to set a new "norm" which will include: intolerance of unplanned failures; rapid learning; fact finding; sharing experience; pride of ownership. A basic question, he said, is "Are we making things better?"

The first set of Technical Sessions began after a networking break, under the same broad title of *Policy and Vision*. There were four Technical Sessions each with four presentations. That pattern continued in the afternoon and for the second day.

Following lunch the newly elected President of the Canadian Nuclear Society, **Jacques Plourde**, added his welcome to the attendees. A challenge for the industry and the Society, he said, is to convince politicians of the value and importance of the nuclear industry.

He then opened the second Plenary Session which was titled *Processes and Tools* and introduced **Alnoor Bhaloo**, Chief Nuclear Engineer, New Brunswick Power.

Under the title *Navigating for Excellence* Point Lepreau is focussing on plant reliability, he said, with the objective of achieving world class performance. The key objective is to achieve excellence in five areas: 1. Safety; 2. Operation; 3. Leadership; 4, Process; 5. Equipment. The goal, he stated, is to achieve top quartile performance and make Point Lepreau the best plant in North America, as it had been in the early 1990s.

Plourde then introduced **Mark Knutson**, Director of Fukushima Support, Ontario Power Generation, who spoke on *Canadian Nuclear Power Principles for Beyond Design Basis Events.*

He began by noting that following the accident at Fukushima, Japan on March 11, 2011, the three Canadian nuclear utilities worked together to develop principles for a common approach to deal with

extreme events. The objective of the exercise was to practically eliminate the potential for societal disruption due to a nuclear incident by maintaining multiple and flexible barriers to severe event progression.

Knutson said nine principles were adopted: 1. Event Progression Defences; 2. Multiple Barriers; 3, Early fuel cooling; 4, Maintain containment integrity; 5. Filtered venting; 6. Equipment integrity; 7. Spent fuel cooling; 8. Readily deployed emergency mitigating equipment; 9. Meet frequently and maintain common philosophy.

Following a networking break in the exhibit area, the afternoon technical sessions were held, again under the same theme of *Processes and Tools.*

That evening there was a networking reception followed by a dinner served buffet style with foods representative of all the countries with CANDU units.

Tuesday morning began with another Plenary Session, this time with three presentations, under the theme *Plant Equipment and Reliability.* It was chaired by **Polad Zahedi** of OPG who introduced the first speaker, **Mark Elliott**, Chief Nuclear Engineer, Ontario Power Generation.

Elliott began with a tale about a period of his career at the Pickering station. In 2003 there were more than 3,000 Work Orders outstanding. He took the entire staff to a local theatre to rally them to clear the backlog. It took five years but the task was completed.

He referred to the ERI – Equipment Reliability Index – that had been developed in the USA. COG (CANDU Owners Group) developed an ERI specific to CANDU. The CANDU index was less than 70 compared to a USA index of 90. It is still low, he stated. "We need to pull up our socks on maintenance", he stated bluntly.

An improved approach to maintenance is needed, he asserted, and challenged engineers and suppliers to stop equipment from breaking. "Let's get down to work", he urged in closing.

Next was **Brad Dennis**, Manager, Performance Engineering, Ontario Power Generation, Under the title *Overall Pickering Reliability* he spoke of the unique challenge facing the Pickering station. With less than six years left in its commercial life its reliability needs to be enhanced as Darlington units begin refurbishment. Over the past three years there have been over 3500 work orders. A critical failure review identified those with the highest priority. At the top of the list was fuel handling projects.

System Health Teams have been created with cross-functional members. A major factor, he said, was human performance.

The third Plenary speaker was **Kristy Mohan**, section Manager, Equipment Reliability, Darlington, OPG, who titled her presentation *Reducing Incoming Corrective maintenance Work Orders.*

Corrective maintenance tends to increase as plants age. Components often fail in unexpected ways resulting in challenges to maintenance staff. At Darlington a proactive and analytic approach has managed to reduce the number of corrective maintenance work orders. This process identifies trends and resolves equipment issues before they become wide spread. The number of corrective maintenance orders at Darlington has decreased by 35 per cent since January 2013 and further improvement is projected. She closed with the statement that "we need better equipment rather than repairs".

The three presentations evoked a lively open question period.

Following lunch the fourth and last plenary session was held under the theme *People and Skills*, chaired by Jacques Plourde. This session had five concise presentations

The first was by **George Bereznai**, of the University of Ontario Institute of Technology (UOIT), with the long title *Positioning Undergraduates and Graduates for Success in an Ever-changing Nuclear Industry.*

Bereznai reviewed the history of UOIT since its beginning in 2001. It now provides a number of programs related to the nuclear program, Degree programs offered include: B.A.Sc. in nuclear power; B.Sc. health physics; M.Eng. and M.A.Sc. in nuclear engineering; Ph.D. in nuclear engineering. Special training can be provided, he said, but if new requirements are needed the university needs a two-year warning to prepare the program.

Next, **Neil Mitchell**, Vice-President, Refurbishment Engineering, Darlington Refurbishment, OPG, spoke on *Succession Planning and Knowledge Transfer Opportunities in a Large Refurbishment Project.*

He summarized the broad timetable for the Darlington refurbishment as : 2007 -2009 Project Definition; 2010 – 2015 Executive Preparation; 2015 – 2025 Program. A full scale mock-up reactor was completed in February 2014 to test fuel channel replacement techniques. Actual retubing is scheduled to begin in October 2016.

Currently teams are being built along with planning for succession of personnel. Staffing will be from both internal and external sources. "Refurbishment is a smart investment" he stated in closing.

Jim Rippon. President AMEC NSS Ltd. followed with an outline of the role of a major consulting organization, which he titled *Maintaining a Knowledge and Experience Base as a Service Provider.*

He began by noting that the genesis of his firm was the transfer of 158 staff of the former nuclear analysis division of Ontario Power Generation. The

complement now is over 400. In addition, he said, they make use of individual contractors. AMEC NSS has an extensive program for evaluating employees, he commented, and has a graduate training program.

A view from the distaff segment was provided by **Colleen Sidford**, President of Women in Nuclear Canada, under the title: *Challenges and Opportunities for Women Involved in Nuclear – Demographics spanning the Entire Career Timeline.*

Although nuclear is largely a man's world, she said, there are many opportunities for women in the industry. Not all of the roles will be technical, she acknowledged, but important in the operation of large organizations. She noted that WiN International started in Europe after the Chernobyl accident. There are now WiN groups in 93 countries, involved in a range of nuclear-related activities. WiN Canada has 1300 members, second only to WiN USA, which has almost 7,000 members.

The final speaker in this elongated plenary session was **Fred Dermarker**, president, CANDU Owners Group, who titled his presentation: *Uniting the Nuclear Community (Utilities, Service Providers, Institutions, Organizations) to preserve our CANDU Expertise.*

COG's role is to help the nuclear utilities in areas such as: maintaining a strong supply of skilled workers, assisting in keeping refurbishments on-time and on-budget; and providing advice on long-term management. He mentioned a recent COG publication – *Steam Generator Textbook – Operating Experience.*

COG oversees a $40 million per year R and D program related to safety and licensing issues, he noted and closed with COG's motto "CANDU Excellence through Collaboration".

The balance of the afternoon was filled with a slightly shorter further set of four technical sessions, again following the theme *People and Skills*. Attendance remained strong until the end of the conference.

The conference was organized by a sizable team under General Conference Chair Vinod Chugh. Other major members were: Peter Angell; Mohinder Grover; Kris Mohan; Masih Balouch; Polad Zahedi; Ashutosh Bhanwaj; Margaret Russett; Gord Kozak; Janice Keating; Ron Oberth; Graham MacDonald. The NAYGN program was organized by Revi Kizhatil; Ray Mutiger; Rahim Lakhani; and Andrew Ali. Administration was handled by Elizabeth Muckle-Jeff's company The Professional Edge.

All the technical papers and some of the plenary presentations will be available through the CNS website.

Scenes from The Conference

CMC 2014 Post-Conference Message

CMC 2014 has been held under a challenging time for our industry. Yet nearly 300 people came together to share different perspectives that con- tributed significantly to the overall success of the confer- ence and to our objective of *Revamping the Technical Strength of Our Industry.*

I was particularly pleased to welcome those from our international CANDU® family repre- senting Argentina, Romania and the Republic of Korea, as well as many from the United States.

I am honoured to have served as Conference General Chair, overseeing the event from concept to execution with an outstanding Organizing Team of volunteers representing our industry. Our utility engagement team has been a great success in promoting the concept of Needs and Interests of Operating Utilities (NIOU).

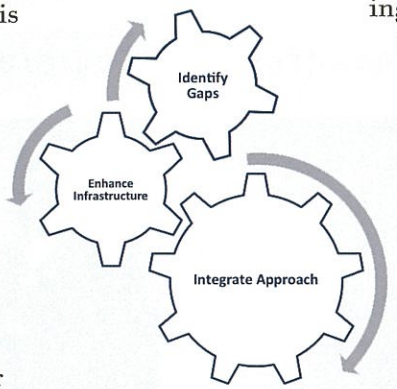
The Operating Utilities have made many accomplishments since the last CANDU Maintenance Conference in 2011. Darlington sustained excellent perfor- mance, Bruce Power is operating the largest nuclear generating station in North America with all 8 units operational following the Unit 1 & 2 restarts, Point Lepreau has restarted with improved reliability & higher power output and Pickering has continued to improve performance as a 6 Unit Station.

Out of the four technical themes in the conference, the theme "People and Skills" drew the most attention. In our industry we are in a situation with retiring Subject Matter Experts (SMEs) at one end and young generation of individuals on the other end of the work-life spectrum. Engaged collaboration with a motive to help each other succeed is becoming more and more important every day. It takes about five years of training and on-the-job learning before a fresh individual starts making effective contributions to the industry. Young individ- uals can be pleasantly surprised with what they can achieve, when given the opportunity to work with SMEs. There have been many success stories on new individuals excelling in the industry. We need to make this happen more often.

My vision for the Canadian Nuclear Society and our industry partners, the Canadian Nuclear Association (CNA), CANDU Owners Group (COG), North American Young Generation Nuclear (NAYGN), Women in Nuclear-Canada (WiN-Canada), Organization of Canadian Nuclear Industries (OCI) and University Network of Excellence in Nuclear Engineering (UNENE), is to re-focus energy on People & Skills with leaders of the nuclear industry to:

a) Identify gaps in the skills/trades over the next five years,
b) Enhance infrastructure for positive cultural change in men- torship, knowledge transfer and succession planning, and
c) Encourage a collaborative approach for younger generartion and foreign trained individuals to effectively work with SMEs and seamlessly merge in the industry

A continuous stream of well trained professionals to take over the responsibilities from retiring SMEs will add value to the industry's success and sustain an excellent safety culture.



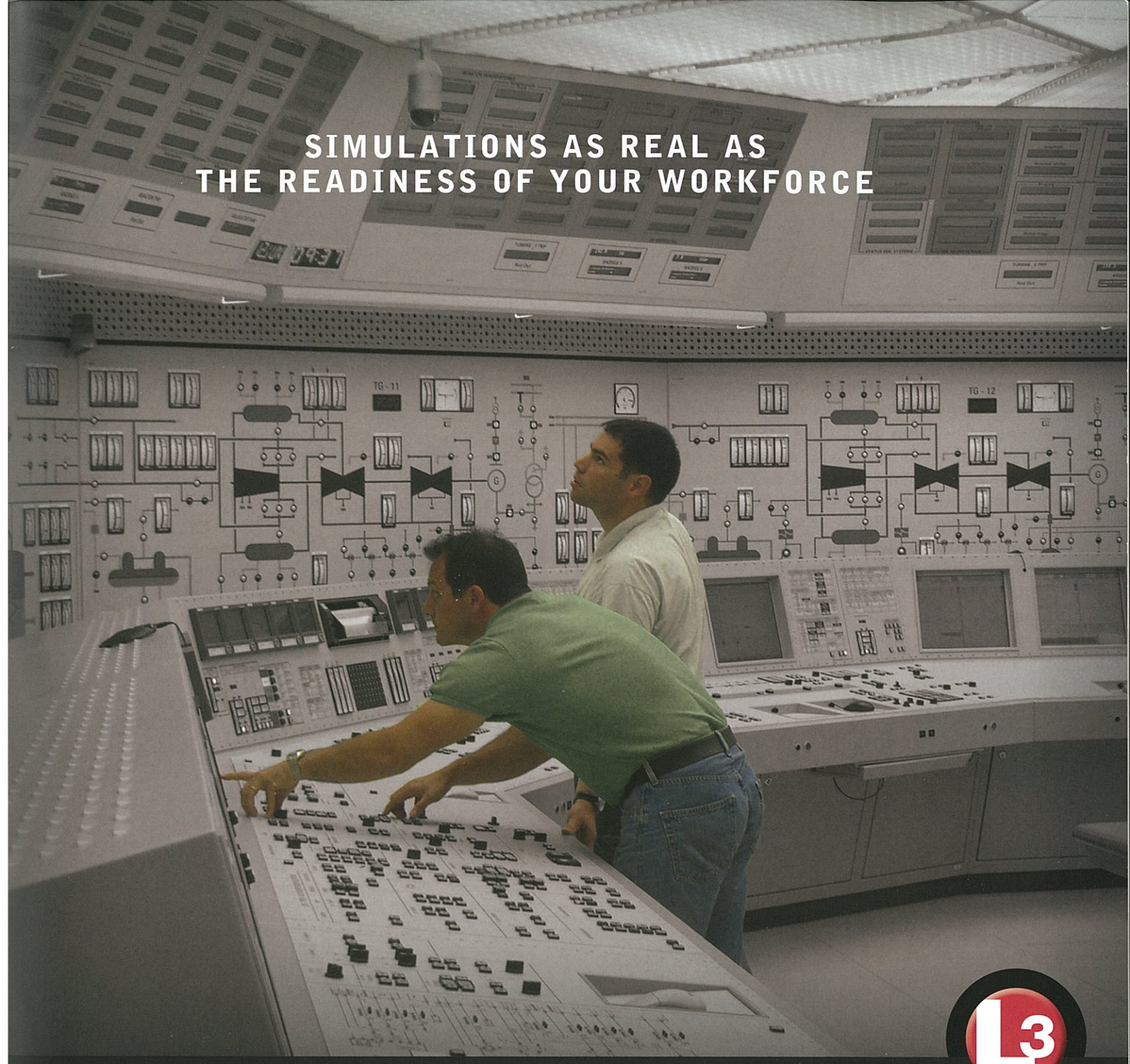
Conference Proceedings represent a beginning to look for your needs and develop mutually beneficial collaboration opportunities throughout the industry. CNS will continue to provide the platform for networking and to encourage such collaborations.

Please continue to be involved in CNS activities as a member, by becoming part of a conference Organizing Team, and by actively participating in future conferences.

I know we can count on your leadership! Wish you all the best!

Sincerely,

Vinod Chugh, P.Eng.
Conference General Chair, CMC2014 Vice President, Canadian Nuclear Society



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CCCARD-2014

Linking Canada and China in Advanced Reactor Development

by LAURENCE LEUNG

Sponsored and organized by Atomic Energy of Canada Limited (AECL) with the support of the Canadian Nuclear Society, the 2014 Canada-China Conference on Advanced Reactor Development (CCCARD-2014) was held at the Niagara Falls Marriott Fallsview Hotel & Spa April 27–30, 2014. About 80 engaged registrants attended CCCARD-2014 from utilities, industries, research organizations and academic institutions spanning both countries.

"The conference provided a direct link between Canada and China in Advanced Reactor Development," said Laurence Leung, Manager, Advanced Concepts and Collaboration, AECL. "It helped establish bridges between utilities, industries, research organizations and academic institutions from the two countries."

CCCARD-2014 evolved from the successful Canada-China Workshop on Super-Critical Water-cooled Reactors (CCSC) held in Xi'an, China in 2012. "A survey of CCSC participants indicated the desire to expand the collaboration beyond the Super-Critical Water-cooled Reactors between Canada and China," commented Leung. The four-day conference was created to provide a forum to discuss advances and issues, share information and promote future collaborations on advanced nuclear reactor development.

"Both Canada and China are pursuing advanced nuclear reactor designs with enhanced safety and improved performance," noted Leung. "Partnership will help expedite the development of key technologies while avoiding the duplication of work in both countries. Canada and China have already been collaborating in nuclear research and development to advance technologies such as advanced fuel cycle, fuel development, materials, thermalhydraulics, and reactor safety."

Conference organizers were pleased to welcome conference participants from several key Chinese nuclear companies. "We were happy to see organizations across China embrace the conference, with participants from the Third Qinshan Nuclear Power Company (TQNPC), the Nuclear Power Institute of China (NPIC), the Shanghai Nuclear Engineering Research and Design Institute (SNERDI), and the State Nuclear Power Research Institute (SNPRI) in attendance. That's an important step forward for CCCARD." Researchers from the China Institute of Atomic Energy had submitted a paper but were not able to attend.

A reception was held in the evening of April 27 for old friends and new acquaintances to meet and greet. There were many opportunities to discuss new collaborations and business partnerships.

The conference began early in the morning of April 28, 2014. Philippe Dauphin, Director General of Canmet-MATERIALS of Natural Resources Canada (NRCan), provided a warm welcome to participants from Canada and China. He highlighted the close relationship and the opportunities between Canada and China in energy and nuclear development.

Philippe Dauphin


Rick Didsbury

The conference featured a Plenary Session with speakers from AECL, NPIC, Candu Energy Inc., Institute of Nuclear Energy Safety Technology (INEST), Canadian Nuclear Safety Commission (CNSC) and Academia Sinica. AECL R&D Operations General Manager, Rick Didsbury, provides an inspiring presentation on energy supply and demand for future generations. He highlighted the need of nuclear energy as a prudent component in the energy supply mix. Dr. Danrong Song of NPIC introduced the organization and new reactor concepts (such as the ACP100) currently being worked on. Dr. Sermet Kuran of Candu Energy provided the highlight on the natural uranium equivalent (NUE) and the Advanced Fuel Cycle Reactor (AFCR) programs. Dr. Qunying Huang of INEST presented the R&D activities on advance nuclear reactor development in their institute. Dr. Robert Rulko of CNSC introduced the new regulatory guidelines for advanced reactor design. Dr. Frank Shu of Academia Sinica of Taiwan presented a new application using the molten-salt reactor.

After the plenary presentations, all participants were anxious to start the technical sessions. A total of 55 papers were presented with focuses on Reactor Designs; Materials, Chemistry and Corrosion; Thermalhydraulics and Safety Design; Reactor Physics and Fuel. The program was separated into 14 sessions, each

Danrong Song (NPIC)

with four presentations on a specific technical subject. All presenters were well-prepared and well-equipped with colourful presentations to convey their subject knowledge to the attendees. The attendees were equally ready to absorb the new information and advanced technology, and fully engaged in the discussion. Overall, all participants were satisfied with the information exchanged at each session.

Following the conference, 17 participants participated in a full-day technical tour of the Liburdi Engineering site, NRCan's Material Technology Laboratory, and McMaster Research Reactor. The visitors were given guided access to these facilities.

"Ultimately, Canada and China are working towards the same goals," concluded Leung. "This collaboration will move innovation forward in developing advanced reactors and shape the future of nuclear technology for both countries."

Group photo

The CCCARD-2014 successfully brought experts and newcomers from the industry and the academic community closer together to advance nuclear technology with a common goal. All participants enjoyed the opportunity to exchange information, share ideas, and build friendships across the Pacific Ocean. To continue providing a forum for discussion, the next conference (CCCARD-2016) has been planned for 2016 in China.

There is no substitute for experience

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Decades of Delay in Nuclear Waste Disposal — A Failure to Communicate

By HANS TAMMEMAGI

Nuclear waste disposal in Canada has been stalled for three long decades, and a central reason is the inability to communicate with the public. This article explores the nuclear industry's communication program and suggests methods for improvement. Although the focus of this article is communication in waste management, the lessons learned apply to the overall nuclear industry, as well as many other industries that struggle with public acceptance.

Lack of progress

AECL initiated a dedicated nuclear waste disposal program in 1975 (I was the first full-time hire). Over the next years the team made good progress; we proposed a concept for deep disposal of high-level nuclear wastes (spent fuel) in geologic formations known as plutons. We also developed designs of the repository and methods for encapsulating and burying the waste. A safety-analyses methodology based on pathways analyses was formulated.

In more than three decades since then, virtually no further progress has been made. No disposal site has been selected. No wastes have been disposed.

I left AECL in 1981 and since have been an outsider looking in at the nuclear industry. For the past fifteen years I have been a writer, getting quite a different perspective on the nuclear industry's difficulties. This article summarizes my thoughts and concludes that the industry needs a major change in its communications strategy.

The Canadian Environmental Assessment hearings of the nuclear waste disposal concept, aka the Seaborn Review, was a debacle that lasted from 1989 to 1998, an incredible ten years. Even more astonishing, a concept rather than a site-specific project was assessed. It was a huge waste of taxpayers' money, but it summed up the public sentiment and showed that politicians will stall and avoid making any decisions that might be unpopular with voters.

Sadly, nothing has changed. Although the Nuclear Waste Management Organization was created, its program to find a volunteer site for a spent-fuel disposal site is, in my opinion, destined to fail. There's a sense of déjà vu, for the Siting Task Force of the Low Level Radioactive Waste Management Office [of AECL] sought all over Ontario from 1987 to 1995 to find a volunteer community to host a waste disposal facility. The program was very well designed, operated and incorporated intensive public consultation and communication. Yet it failed. So will the current NWMO program.

Nuclear is Feared

The main problem is that the public is frightened, very frightened, by radiation, nuclear power and nuclear wastes. And fear trumps reason. There are, of course, some valid reasons for fearing nuclear. The nuclear bomb is capable of destroying our world. That's certainly scary. And nuclear reactors are very complex, costly and, furthermore, have had accidents, such as at Chernobyl and Fukushima. Nevertheless, nuclear also has many positive aspects.

Because nuclear wastes are always considered in isolation, the public's fear has become highly exaggerated. It is natural for the human mind to fear the unknown, and when matters are presented without any yardstick, fear expands rapidly. A myth has developed that nuclear wastes are incredibly toxic and incredibly difficult to dispose of safely.

Furthermore, nuclear has become a symbol for what many people dislike about our crowded, overly complex, technological world. If you don't hate nuclear, you don't fit in. Thus, nuclear communications must overcome not only a huge obstacle of fear, but one which has become deeply ingrained in society.

The Public Divide

A major division exists in society: there are people with an arts background, the right brainers, who rely largely on emotions and feeling. And there are those with a scientific or technical background, the left brainers, who rely on analyses and reason. Journalists, the people who drive the media, and politicians who make the decisions, are generally artsies. The nuclear industry is composed almost entirely of techies. An effective nuclear public-relations program must bridge this huge chasm between the two groups.

How to Communicate?

Here are four principles for communicating with the public in a persuasive and convincing manner.

a) Speak simply. People, especially the right brainers, are more influenced by narratives told through metaphor and figures of speech than by technical data. Thus, one should avoid speaking in technical jargon, instead, communicating using metaphors, comparisons and examples.

b) Stress that radiation is natural. Radiation is all around us and always has been. All life has evolved in a sea of radioactivity. It is essential to dispel the public's impression that radiation is unique and extremely dangerous.

c) Place nuclear wastes into perspective. It is imperative that nuclear wastes not be dealt with in isolation, and instead are placed into context by making comparisons to non-nuclear wastes and situations with which people are familiar.

d) Bring nuclear medicine into the conversation, often.

Here are some examples of how to apply these principles.

It should be pointed out that radiation is an entirely natural phenomenon and is everywhere around us and even inside us. In fact, the world wouldn't exist as we know it without nuclear power, which powers the sun and provides all life.

Having evolved in radiation since life began, humans, and all living things, have adapted to it. A comparison: Every major disease-causing bacterium has developed strains that resist the antibiotics used to treat them. Scientists estimate that bacteria become resistant to new antibiotics in a period of 5 to 10 years. Mosquitoes and other nuisance insects become immune within a few decades to lethal pesticides that have been specifically engineered to eradicate them. Humans follow the same evolutionary rules and have, over millennia, developed immunity to radiation.

The public should be far more concerned about the many synthetic chemicals and substances such as PCB, DDT and dioxin that have only come into existence in recent decades. Produced in enormous quantities and dispersed throughout the environment, these chemicals are so recent that humans have not had time to develop immunity and are, thus, vulnerable to their damaging effects.

Every home in Canada generates wastes. Some, such as motor oil, batteries, paint thinner, weed killers, pharmaceuticals and nail polish remover are hazardous. These wastes, which are comparable to low-level radioactive wastes in toxicity, are placed into municipal landfills, of which thousands are scattered across the country. The public accepts this. However, low-level nuclear waste is being dealt by far safer methods than other wastes of comparable risk.

Industry produces many chemicals of higher toxicity such as selenium compounds, potassium cyanide, copper, arsenic and strychnine, which will last forever. These toxic wastes, which are comparable to high-level nuclear waste (spent fuel), go to Swan Hills Treatment Centre for treatment and burial in an engineered, shallow landfill.

Communications programs should compare nuclear waste disposal to non-nuclear waste disposal in society. The conclusion is simple and obvious. The nuclear industry is developing disposal technologies that are far more advanced. These methods could be adapted for non-nuclear wastes, and, thus, benefit society.

Nuclear technology has profoundly transformed the practice of medicine, and one of three Canadians has undergone a nuclear procedure of some kind. The public knows and accepts nuclear medicine. Nuclear medicine should be introduced as frequently as possible. The benefits should be extolled and it should be noted that just like the nuclear industry transformed medicine, so could it transform waste disposal.

Ultimately, the problem is not technology, but the people behind it. Because knives have killed hundreds and thousands of people doesn't mean we should ban knives or steel. Knives are also used to cut a family's bread, perform brain surgery and create fine carvings. It's the same with nuclear technology. If used carefully and responsibly, nuclear has much to offer. Sound regulations and operations need to be in place. In Canada, this is the case, and Canadians have benefited from nuclear medicine and electricity without greenhouse gases. We can also benefit from advanced waste disposal.

As CEAA's Seaborn panel concluded, the nuclear waste disposal program lacks public acceptance. As outlined above, significant changes are required in communications if this situation is to change.

[Ed. Note: Hans Tammemagi, B.Sc. and M.Sc. (geophysics), University of Toronto; Ph.D. (geophysics), Australian National University. Hans worked at AECL in Whiteshell from 1975 to 1981 in the nuclear waste disposal program, and then turned to consulting in the environmental field until 2005. Since retirement he has turned to writing and photography and has authored 10 non-fiction books, including one national best seller and ***Half Lives - A guide to nuclear technology in Canada*** *(with David Jackson). Hans is a long-standing member of the CNS.]*

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Detection and Repositioning of Tight Fitting Annulus Spacers in CANDU® Fuel Channels

by GREG HERSAK[1], ANDREW KITTMER[1], JAREK GOSZCZYNSKI[2], DENNIS KAZIMER[3]

[Ed. Note: The following paper was presented at the 10th International Conference on CANDU® Maintenance in Toronto, Ontario, Canada, May 25-27, 2014.]

Abstract

The latest generation of CANDU® reactors has been constructed with tight-fitting annulus spacers to maintain the annular gap between the inner pressure tubes and the outer calandria tubes. These spacers cannot be detected and repositioned with the existing Spacer Location and Repositioning (SLAR) process, which is designed to work with loose-fitting annulus spacers.

There is currently no established technology to detect and reposition tight-fitting annulus spacers. Atomic Energy of Canada Limited has been performing research and development to locate and move tight-fitting annulus spacers using Modal Detection and Repositioning (MODAR™) technology since 2005 and is currently working in collaboration with Candu Energy and Bruce Power on a production system to be deployed for an in-reactor demonstration in the next year. The MODAR technology uses controlled vibrations on a short, isolated length of pressure tube to locate and reposition tight-fitting annulus spacers. MODAR technology will allow the utilities to demonstrate fuel channel integrity to the regulator and obtain approval for additional years of reactor operation. This paper briefly describes the technology and provides an overview of the tool testing and development.

1. Introduction

In a CANDU reactor, annulus spacers are used to maintain the annular gap between the primary heat transport system pressure tubes (PTs), and the cool calandria tubes (CTs). Typically, four annulus spacers support the PT, while transferring minimal heat to the CT. Contact between the two tubes could result in the formation of hydride blisters in the Zr-2.5Nb PT material.

To preclude PT-CT contact until the end of fuel channel life, it is important that the annulus spacers remain near the as-installed locations. Significant movement of spacers from the optimal design locations could result in PT-CT contact. Both loose fitting and, more recently, tight fitting annulus spacers have been installed in CANDU reactors. The tight fitting spacer design was adopted due to the tendency of the loose fitting spacers to move from their as-installed locations.

To mitigate the issue of loose fitting annulus spacer mobility, the Spacer Locating And Relocating (SLAR) system was developed. The SLAR process relies on the continuous electrical circuit created by the loose fitting spacer's welded girdle wire, to first locate and then relocate spacers as needed. The tight fitting spacer design features a girdle wire with overlapping, rather than welded, ends. Once in service, the overlapped girdle wire oxidizes and does not provide a continuous circuit, so the SLAR process cannot be used.

Existing methods of detecting tight fitting annulus spacers are indirect, based on PT deformation measurements, and are not reliable until a fuel channel has reached approximately 100 000 Effective Full Power Hours. There are no existing methods of repositioning tight fitting annulus spacers.

Atomic Energy of Canada Limited (AECL) has developed a new vibration-based technology termed Modal Detection and Repositioning (MODAR) for the detection and repositioning of tight-fitting annulus spacers (United States Patent Application 20100284505).

2. Modar Applications

There are two tight-fitting annulus spacer designs in use today: the "Bruce 8", and "optimized" designs. In response to the loose fitting spacer mobility issue, tight fitting spacers (Bruce 8 design) were installed during the construction of Bruce Power's Unit 8 reactor. In subsequent new builds, single fuel channel replacements, and retube projects, optimized tight fitting spacers have been used. Both designs feature a closely coiled, square cross-section wire, through which a central girdle wire is passed; however, the optimized design features a lighter wire and larger coil pitch. In both cases, the ends of the coiled wire are hooked together to generate a snug fit on the outside of the PT as shown in Figure 1. The MODAR process is applicable to both tight fitting spacer designs; how-

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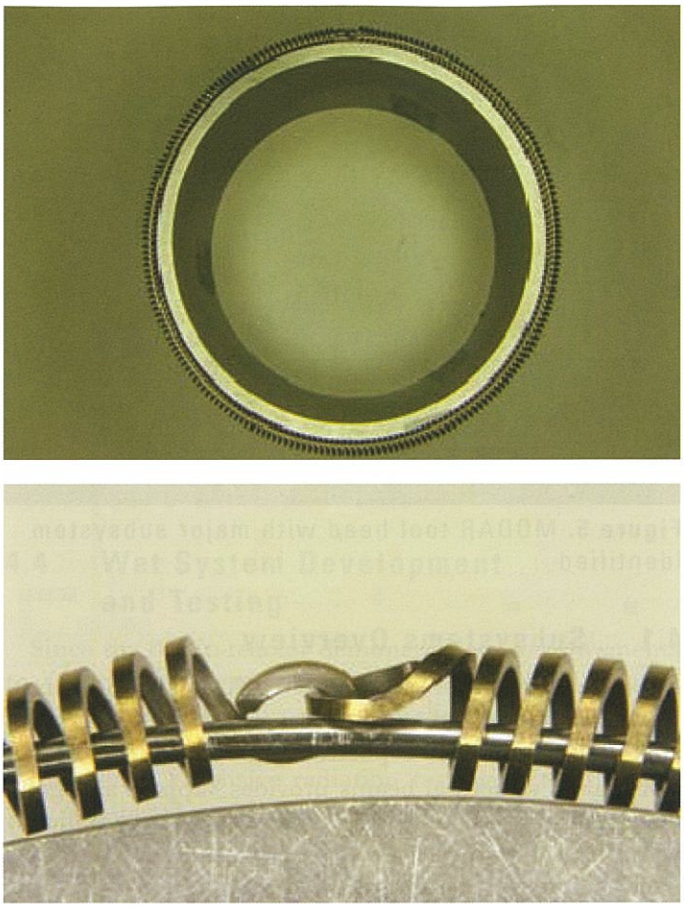

Figure 1. Optimized tight fitting annulus spacer installed on a pressure tube

ever, the integrity of optimized spacers has not been fully analyzed or confirmed to date.

Although tight fitting annulus spacers are designed not to move, there may be scenarios where spacer detection and possible repositioning are desirable. Fuel channel deformation models have been used to identify spacer locations that would extend the fuel channels' service life.

Fuel channels are inspected for sag and PT-CT gap, and this information is used in fuel channel deformation models to predict when PT-CT contact may occur. Included in the key inputs for this type of assessment is spacer location. If fuel channel life is limited by PT-CT contact, there may be cases where spacer repositioning could be used to delay or prevent such contact.

MODAR technology could also be used to supplement routine fuel channel inspections. In cases where the indirect spacer detection methods cannot strongly identify a spacer location, the MODAR process may be used to provide this information.

3. Research Activities

AECL has performed research and development work on methods of detecting and repositioning tight fitting annulus spacers for the past several years [1]. This

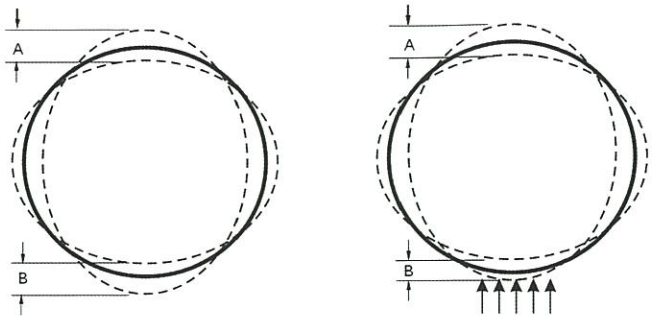

Figure 2. PT mode shape asymmetry resulting from a loaded spacer

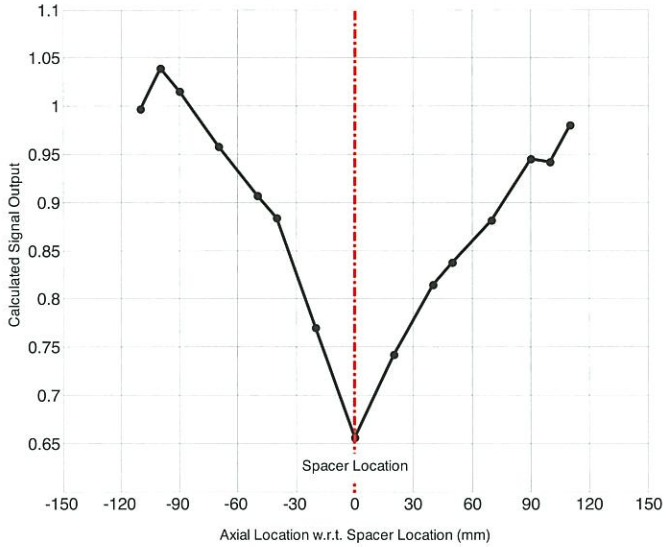

Figure 3. Typical MODAR system response to a loaded spacer

research advanced MODAR technology to the point of tool design and testing for in-reactor implementation.

3.1 Principle of Spacer Detection

The MODAR detection technique examines asymmetry between the PT top and bottom surfaces' acceleration, in the vicinity of a loaded spacer, when subjected to vibrations. An isolated length of PT is excited with random vibrations, and the top and bottom surfaces' acceleration is measured by sensor pairs. The amplitude ratio (AR) between the PT bottom and top surfaces' acceleration reaches a local minimum at the location of a loaded spacer. As shown in Figure 2, the added stiffness from a loaded spacer alters the local circumferential deflection of the PT wall. Figure 3 shows a typical set of AR data obtained with the MODAR system. The AR technique is only one of the methods used to analyse PT acceleration data to determine spacer position. The other techniques include the calculation of the relative phase between the bottom and top sensors and

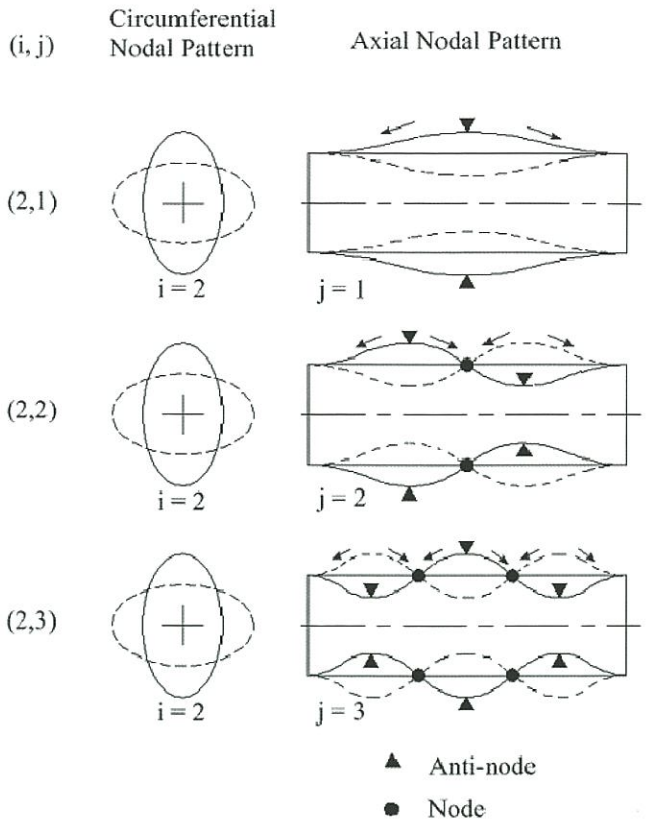

Figure 4. PT shell mode shapes and resulting spacer motion

the calculation the standard deviation of the frequency response function between the bottom and the top accelerometers over a certain frequency range.

3.2 Principle of Spacer Repositioning

The MODAR repositioning technique excites shell mode vibrations in an isolated length of PT. To move a spacer, the isolated length of PT is excited to vibrate at a specific shell mode frequency. A spacer located between a node and an antinode will move away from the antinode towards the node. Figure 4 shows the first three shell mode shapes, which are used for repositioning. The mode shape designations (2,1), (2,2) and (2,3) refer to the (i,j) indices, where "i" is the circumferential mode number and "j" is the axial mode number. The arrows indicate the direction of spacer motion produced, depending on start location.

4. Tool Development

Following AECL research and development activities, development of a MODAR system for reactor deployment commenced in 2008, under commercial contract with Bruce Power.

Development continues today in collaboration with Candu Energy and Bruce Power.

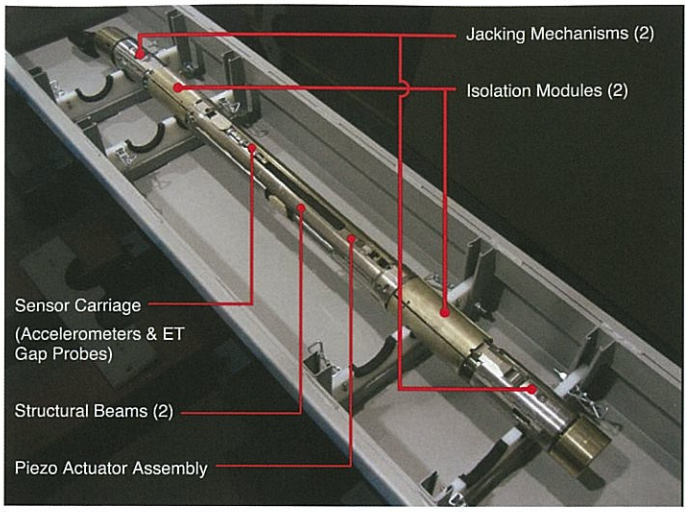

Figure 5. MODAR tool head with major subsystem identified

4.1 Subsystems Overview

As shown in Figure 5, the MODAR tool is comprised of a number of subsystems to perform the tasks of spacer detection and repositioning.

A pair of structural beams provides support and guidance for various tool subsystems. Two hydraulically actuated isolation modules clamp onto the PT to create fixed boundary conditions, and isolate PT vibrations within the working span of the tool. To generate vibrations for both detection and repositioning operations, a piezo actuator assembly is driven outwards into contact with the PT and then supplied with a specified voltage signal. A movable sensor carriage includes two pairs of accelerometers positioned at 12 and 6 o'clock, and two eddy current (ET) gap probes also positioned at 12 and 6 o'clock. Accelerometers are used both for spacer detection, and frequency determination for spacer repositioning. The ET gap probes are used in conjunction with two hydraulic jacking mechanisms, which are based on existing SLAR technology. The jacking mechanisms may be used to apply an upward bending moment to the PT, allowing a spacer to be unloaded for repositioning. Conversely, the tool may be inverted and a downward bending moment applied to load a spacer for detection.

4.2 Dry System Testing Overview

The MODAR system underwent extensive testing at the Chalk River Laboratories to ensure that it met the requirements of an on-reactor dry demonstration. Performance and reliability tests of all tool subsystems were performed. A full length fuel channel mock-up was used to perform detection and repositioning trials. A partial length CT was mounted to carriage that allowed a spacer to be loaded at different locations along the PT. System performance was demonstrated for both Bruce Power and CNSC representatives.

4.3 In-Reactor Dry Demonstration

In February 2011, the MODAR system underwent a demonstration on two drained fuel channels in Bruce Power's Unit 8 reactor. The tool was delivered manually, using an auxiliary cart and hydraulic cart situated on a work platform. Once installed in the target fuel channel, tool operators and analysts controlled and monitored activities from an inspection trailer situated outside the reactor vault.

Initial challenges associated with first-time deployment in a high-radiation environment were overcome, and valuable operational experience was gained. The major tool subsystems, control system and software performed as expected. Within the available time, spacer detection data was collected, but no repositioning was performed.

4.4 Wet System Development and Testing

Since the dry in-reactor demonstration, improvements to the system based on operating experience and test results have been incorporated. Preliminary tool trials in a flooded fuel channel highlighted the need for further refinements. Extensive radiation testing of tool devices was conducted in gamma cell facilities and the in the spent fuel bay at the Chalk River National Research Universal (NRU) reactor. The fuel channel mock-up at the Chalk River Laboratories was upgraded to allow testing in a flooded condition with control of channel flow and temperature. Testing on this flooded fuel channel mock-up is underway and the system will be deployed for a wet in-reactor demonstration in the coming year.

5. Conclusion

MODAR technology for detecting and repositioning tight fitting annulus spacers has been developed into a reactor-ready system.

The wealth of operational experience gained throughout the development of the MODAR dry demonstration system and preliminary wet system testing has been used to advance the wet system design, which is currently being tested and prepared for an in-reactor wet system demonstration.

6. Acknowledgments

The author would like to acknowledge the contributions of several individuals who have been instrumental in the development of the MODAR technology:

- The Mechanical Equipment Development, Inspection, Monitoring and Dynamics and Systems Engineering Branches at the AECL Chalk River Laboratories.
- The Component Integrity Branch, Field Services and Project Management team at Candu Energy
- The Plant Design Engineering and MODAR Project teams at Bruce Power

The development of this technology to a reactor-ready state has been a collaborative effort that none of us could have accomplished on their own.

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[1] Feenstra, P.A., King, J.M., Smith, B.A.W., "Development of methods for detecting and repositioning of snug-fitting annulus spacers", 8th International Conference on CANDU Maintenance, 2008.

Fuel Deposits, Chemistry and CANDU® Reactor Operation

by JOHN G. ROBERTS[1]

[Ed. Note: The following paper was presented at the 10th International Conference on CANDU® Maintenance in Toronto, Ontario, Canada, May 25-27, 2014.]

Abstract

"Hot conditioning" is a process which occurs as part of commissioning and initial start-up of each CANDU® reactor, the first being the Nuclear Power Demonstration - 2 reactor (NPD). Later, understanding of the cause of the failure of the Pickering Unit 1 G16 fuel channel led to a revised approach to "hot conditioning", initially demonstrated on Bruce Unit 5. The difference being that during "hot conditioning" of CANDU® heat transport systems fuel was not in-core until Bruce Unit 5.

The "hot conditioning" processes will be briefly described along with the consequences to fuel.

1. Background

The heat transport system of a CANDU® reactor is constructed primarily of alloys of steel, carbon and stainless, and zirconium. Following construction, the

1 CANTECH Associates Ltd., Burlington, ON, Canada

heat transport system is hydrostatically pressure tested to demonstrate that the system is leaktight and will withstand design pressure. This hydrostatic test can be performed using either heavy or light water. For all units up to Bruce Unit 5 fuel was absent from core for the hydrostatic test. The fuel was manually loaded following hydrostatic test after draining the heat transport system.

The presence of carbon steel posed a problem; the problem being the possibility of pitting feeders following drain down as a result of pooled water remaining. Oxygen from air exposure, combined with low pH, from air exposure, would promote pitting. To offer protection to carbon steel against pitting the "hot conditioning" process evolved. This process involved heating alkaline water under reducing conditions at zero power hot and maintaining those conditions for ten (10) days [1]. Corrosion coupons, of all system materials, were installed into the (heat transport) system autoclaves for two reasons - the first to allow determination of the degree of corrosion during hot conditioning and the second to determine the quality of the magnetite layer formed by the hot conditioning process.

2. A New Process

During the 1960s the Russians had developed a process using disodium **e**thylene**di**amene**t**etraacetic **a**cid (EDTA) to condition carbon steel surfaces of their nuclear reactors. AECL investigated this process at the Whiteshell Nuclear Research Establishment Laboratories [2, 3]. Ontario Hydro pursued the use of EDTA for "hot conditioning" and successfully demonstrated its use at the pump test loop of the Ontario Hydro Research facility at 800 Kipling Avenue [1]. This led to Bruce Unit 4 being the first CANDU® unit to use EDTA for "hot conditioning". The chosen approach used disodium as opposed to dilithium EDTA. (Disodium EDTA was available commercially but not dilithium EDTA.) Difficulty was encountered removing the sodium at the end of hot conditioning. This was overcome by using non-lithiated ion exchange resins but consumed additional time.

Unit 6 was the next Bruce unit to be "hot conditioned" and the dilithium EDTA salt was chosen. Since commercially available dilithium EDTA of appropriate purity was unavailable the salt was prepared on site using high purity, commercially available, EDTA and pure (analytical grade) lithium hydroxide. Examination of the corrosion coupons showed the approach to be successful [4]. The heat transport system was drained and fuel, as past practice, loaded manually.

3. Regroup?

Within hours of releasing the shutdown guarantees for Bruce Unit 6 to approach first critical, the reason for the failure of the Pickering Unit 1, G16, fuel channel was understood. The failure was due to zirconium hydride blisters forming following fuel channel to calandria tube contact as a result of garter springs (spacers) having being incorrectly positioned. The result was that all the Bruce Unit 6 fuel had to be manually removed to allow garter springs to be located and, as necessary, relocated to preclude similar fuel channel degradation and failure. Unfortunately, between fuel loading and subsequent fuel removal the fuel channels had been "machined" by the fuel bundle bearing pads, generating swarf or turnings. This residual swarf led to many fuel failures from debris fretting.

The observations of swarf, and machining of fuel channels, led to the use of a shim for manual loading of fuel for each subsequent CANDU® unit. This led to the avoidance of such debris generation. Unfortunately the cleanliness, or build clean, execution for the construction/installation of many CANDU® units has been less than desirable. A notable exception is that of Cernavoda Unit 1 which involved considerable oversight by, and on behalf of, the Client [5, 6].

On inspection, few of the Bruce Unit 6 garter springs were found in their "as designed" positions. There was a suspicion that vibration from heat transport pumped fluid flow/main pump operation was causing the "loose fitting" garter springs to "walk" and shift location. It was believed that the mass of the fuel bundles would cause the fuel channels to sag into contact with and trap, at least, the centre two garter springs thereby holding them in place. Subsequently a demonstration was performed on Unit 5 with ten channels being manually fuelled, each with 12 bundles. The position 13 (inlet) bundle location was occupied by a strainer, as had occurred for Unit 6. Following "hot conditioning" of Unit 5 the ten channels were manually defueled and it was determined that the centre two garter springs had indeed not shifted location but the outer garter springs had, as predicted, moved.

This successful demonstration of the approach to use fuel to prevent garter spring movement led to Unit 7 fuel being loaded with fuel prior to the hydrostatic pressure test, and "hot conditioning". CANDU® units that have followed a similar path, include Bruce Unit 8 and the refurbished Bruce Units 1 & 2 and Point Lepreau.

Bruce Units 3 & 4 were "hot conditioned" as part of their return to service in 2003. Fuel had been loaded using fuelling machines, following spacer location and relocation. For both processes heavy water was within each heat transport system.

The EDTA process for "hot conditioning" was not used for Bruce Units 3 & 4 because the fuel channels would not have withstood remaining at 150 C; this was due to the total hydrogen (equivalent) contained in the fuel channels. Rather the conventional "hot conditioning" approach using lithium hydroxide and reducing conditions was used [7].

4. What Hot Conditioning Actually Does

As mentioned earlier, the "hot conditioning" process lays down a protective magnetite coat on carbon steel surfaces. The magnetite that is formed on carbon steel results from two processes, the one being corrosion of the base iron which forms an adherent, protective oxide coat. The second involves precipitation of magnetite from solution onto every surface within the heat transport main circuit, including carbon steel, resulting in a less adherent secondary coat. It is this less adherent coat which is believed to be the reason why the Bruce reactors having boilers tubed with Inconel-600 do not suffer from Co-58 radiation fields [8]. The deposited magnetite offers a degree of protection from corrosion of the I-600 tubing. Co-58 is formed from neutron activation of Ni-58, released from corrosion of I-600 (steam generator tube), and has resulted in significant difficulties for US pressurized water reactor operators.

Magnetite that is precipitated from solution coats all surfaces within the heat transport system – fuel, fuel channels, endfittings, endfitting liners, feeders, headers, steam generator bowls, steam generator tubing, main pump bowls and interconnecting piping.

In summary, "hot conditioning" allows carbon steel surfaces to be offered a degree of protection from corrosion and results in reduced radiation fields from reduced corrosion of steam generator tubes.

5. Approaches to Hot Coditioning

Both the "conventional" and "EDTA" "hot conditioning" processes result in the same carbon steel protection and steam generator tube protection [1]. The difference lies in the benefits offered by EDTA as opposed to the conventional approach:

The EDTA process takes a shorter time to execute (about five days total versus ten for the conventional approach) with clear economic implications;

The EDTA approach also offers the advantage of a low concentration chemical clean (at 150°C). There is but one opportunity to remove unwanted contaminants from the heat transport system prior to power operation and that is via the EDTA approach to "hot conditioning". An example would be that of Bruce A. During the first three years of operation Zn-65 was the major contributor to radiation fields on all four units' heat transport systems. At Bruce B zinc was effectively removed during the EDTA "hot conditioning" process and Zn-65 radiation fields were not an issue.

6. Heat Transport System Chemistry and Magnetite

Normal operational chemistry for the heat transport system utilizes high (apparent) pH (pH_a) from lithium and reducing conditions from an overpressure of deuterium. For an operating unit using within-specification chemistry the maximum solubility of magnetite is in the reactor core and is a function of temperature, pH and radiation chemistry [8, 9].

However, during the "hot conditioning" process the temperatures around the main heat transport system are, in effect, the same. This is because the significant heat input is from the main pumps whereas during power operation the significant heat input is from the fuel. The difference is that during "hot conditioning" there is neither temperature differential nor significant radiation chemistry across the fuel channel; however, a significant temperature differential (about 50°C) and significant radiation chemistry effects exist during high power operation.

Interestingly, the first CANDECON[TM] (CANDU® decontamination) of a Pickering unit was considered unsuccessful as determined by a decontamination factor (DF) of one. The ion exchange capacity requirements had been underestimated as a result of using the oxide loading on corrosion coupons removed from the heat transport system autoclaves.

The investigation, which followed, included removal of segments of inlet and outlet feeders. What was discovered was that the magnetite loading was considerably higher in some locations than indicated by evaluation of the corrosion coupons, consequently insufficient ion exchange resin had been deployed to remove the mobilized iron. Acceptable DFs were obtained in subsequent CANDECONs.

Unfortunately the reason for the unexpected higher magnetite loading was not apparently further investigated, otherwise feeder thinning might have been identified about ten years sooner!

7. Deposits on Fuel

7.1 Initial Start-up/Start-up following refurbishment

It was recognized during "hot conditioning" that magnetite was deposited onto all heat transport system surfaces, including fuel. It was also recognized that the magnetite would dissolve from in-core surfaces once normal, high power, operating conditions (associated temperature and radiation chemistry) were achieved; however magnetite would deposit in the cold leg of the steam generators. This was demonstrated in Bruce Unit 6 when the author was the first person to inspect and enter the boiler primary hot and cold heads. It was impossible to scrape oxide off the hot leg surfaces, but small amounts of less adherent oxide were able to be removed from the cold leg surfaces [10].

For Bruce Unit 7, which was the first unit to be "hot conditioned" with fuel in-core, two fuel bundles were removed following "hot conditioning" and the magnetite loading determined. This was at the request

of Ontario Hydro's Design and Development division circa 1985/6; the work was conducted in the Bruce B chemical laboratory and the magnetite dissolved using Clarke's solution. This solution is very corrosive and as a consequence these two fuel bundles were not allowed back into core. They resided in the Bruce B chemical laboratory radioactive source safe for several years. The magnetite loading results were contained in a report which, so far, has proven elusive to find.

Operating experience has demonstrated that when reactors are started up and run at low power the magnetite deposited during hot conditioning takes a greater duration to redissolve. This is because the fuel channel differential temperature and radiation chemistry effects are naturally lower than when the reactor is operating at high power.

Hence should fuel be removed from core prior to refueling to maintain of equilibrium reactivity, magnetite deposits would be expected to be observed if the reactor had not been operated at high power.

7.2 Unit Outages

All too often during unit outages control of heat transport chemistry is difficult, if not impossible, to maintain. Some CANDU® reactor designs do not allow for shutdown purification of heat transport systems whereas other CANDU® reactor designs, luckily, have this facility built-in.

7.2.1 Prescriptive Error

Even with a built-in shutdown purification capability chemistry control can be difficult to maintain. This was first demonstrated to the author in 1997, at Bruce B, when an Ontario Hydro directive prescribed that all boiler and preheater manways would be opened simultaneously! This resulted in the maximum possible air exposure of the heat transport heavy water. The resin for one bank of purification ion exchange columns takes about four days to prepare for service. The purification bank was exhausted (from bicarbonate/carbonate as a result of air ingress) within 24 hours! So they gave up trying to control heat transport chemistry and suffered huge releases of magnetite from feeders.

"Wet scrape" of fuel channels, which had previously been most successful, had to be cancelled. This was due to the released magnetite depositing in the liner and reducing the clearance between the scrape delivery tool and the endfitting liner. The consequence was that the delivery tool became stuck and galling occurred.

During the previous successful "wet scrape" campaign heat transport chemistry had been well controlled with insignificant release of magnetite.

7.2.2 Outage Sequencing Errors

As a result of the directive to open all boiler and preheater manways simultaneously, at Bruce B, special bungs were procured to prevent air ingress during subsequent outages. Often during outages the staff planning and executing the work fail to grasp how fast chemistry control of the heat transport system can be compromised. Any delay in deploying bungs after boilers/preheaters manways have been opened, or having too many manways open simultaneously, results in loss of heat transport system chemistry control with consequential release of magnetite and partially oxidized forms of magnetite. The correct air exclusion measures are of great importance, and not only to fuel but also to outage maintenance activities.

7.3 Heat Transport System Crud and Unit Start-up

Crud is underisable as it will deposit on fuel and neutron activation will follow. When the crud is released from the fuel undesirable radiation fields can result. For crud that is released from feeders during an outage it is probable that such crud, due to the lower coolant velocity, when using shutdown cooling or maintenance cooling pumps, would tend to accumulate in/on the lower areas of a fuel bundle.

Hot surfaces appear to "attract" deposits. It is therefore to be expected that following an outage during which there has been significant release of magnetite/iron oxide the hot fuel would "attract" deposits. During operation with normal chemistry and the reactor at high power the iron oxide would be reduced back to magnetite and the magnetite would, over time, dissolve off the fuel.

8. Fuel Failures from Deposits

The author has personally overseen the construction, commissioning and initial operation of five new CANDU® units and four restarted CANDU® units for a total of nine units. In each case the heat transport systems were "hot conditioned" and fuel was in-core for all but one of those "hot conditioning" evolutions. All, but one, of these units has unfortunately suffered fuel defects. In no case were any of the fuel failures the result of deposits on the fuel, rather as a result of foreign material/debris.

9. Conclusions

1. Every CANDU® reactor has had its heat transport system "hot conditioned" during initial commissioning.
2. Several CANDU® reactors, starting with Bruce Unit 7, have been "hot conditioned" with fuel in-core.
3. The design of some CANDU® reactors does facilitate control of heat transport chemistry during outages.
4. Loss of chemistry control of heat transport system

during outages results in release of magnetite from feeders.

5. On return to high power operation all iron oxide will be reduced back to magnetite and all in-core magnetite will eventually be dissolved and transported out-of-core.
6. Most CANDU® reactors have experienced fuel defects following "hot conditioning" but no defects resulted from deposits on fuel.

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Description and Operational Experience of the Stern Labs Flux Detector Removal Tool System

by B. SIMONS[1], G. HADALLER[1], K. MERRIFIELD[2], B. BALLANTYNE[3]

[Ed. Note: The following paper was presented at the 10th International Conference on CANDU® Maintenance in Toronto, Ontario, Canada, May 25-27, 2014.]

Abstract

The Flux Detector Removal Tool (Chopper Tool) is a system for removing and compacting Single Individually Replaceable (SIR) In-Core Flux Detectors (ICFD) from a CANDU®1 reactor. The Chopper Tool was produced in response to customer demand for a portable, modular system suitable for use with either Vertical or Horizontal Flux Detector (VFD or HFD) housings that could allow multiple ICFDs to be replaced in a single shift without modifications to the primary containment boundary. The system was developed in several phases, funded by a CANDU Owner's Group (COG) joint project, and has been successfully used at multiple CANDU® stations, most recently to remove 9 vertical ICFDs at the Darlington NGS.

This paper reviews the original design constraints, outlines the final system design, and details the tests required for factory acceptance of each tool system. Some problems with earlier versions of the Chopper Tool, and the research and development required to resolve them are highlighted. Finally the results of the most recent ICFD removal campaign are presented. The successful implementation of the Chopper Tool demonstrates Stern Laboratories' ability to research and develop new reactor maintenance tooling, and reflects well on the COG framework for pooling expertise and resources amongst CANDU® utilities.

1. Background

ICFDs, also known as Self Powered Detectors (SPDs), are instruments used to measure the neutron flux inside the core of a CANDU® reactor. They consist of an interior wire surrounded by concentric layers of ceramic insulation and Inconel sheath, swaged together in a manner similar to thermocouples, as shown in Figure 1. ICFDs are 12 to 14m long, and roughly 1mm in diameter for most of their length, except for a roughly 1m long, 3mm diameter "bulb" or "emitter" section at their end. The detectors are mounted in small diameter, single ended tubes that penetrate the Calandria vessel from the top (Vertical Flux Detectors or VFDs) and from the side (Horizontal Flux Detectors or HFDs). Groups of 12 or 13 of these tubes are bundled together in a "well housing".

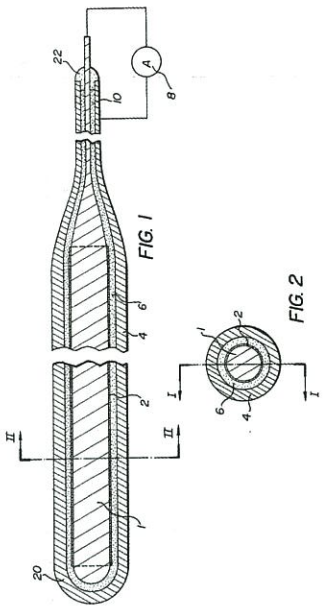

Figure 1. ICFD Schematic from U.S. Patent 4284893

These wells house the electrical connections between the ICFDs and the reactor operating and shutdown systems. They are purged with helium and sealed to protect against moisture ingress [1, 2].

ICFDs have a limited operating life, and must be replaced periodically. Removing them safely poses a major challenge as neutron activation of trace cobalt in the Inconel causes ICFDs to become highly radioactive in service [3]. Traditionally CANDU® operators have pulled ICFDs into a specially built, full length shielded flask. The size and weight of this flask introduced operational risks of its own. When used for VFD removals, the flask had to be hoisted above safety-critical reactivity mechanisms. When used for HFD removals, operators had to prepare penetrations in the vault containment boundary for long guide tubes, since the length of the flask exceeded the distance available between the HFD well housings and the inner reactor vault wall.

In response to these challenges, the authors2, 3 began work on a new concept for ICFD removal, shown in Figure 2. In this concept, a short portable tool would be affixed to the well housings. The tool would contain two simple mechanisms – one for pulling an ICFD wire from its well tube, and another to slice the wire into short "particles". These particles would be transported from the tool to a smaller shielded flask stationed away from any reactivity devices via a pneumatic vacuum system. The device would be

1 Stern Laboratories, Hamilton, ON
2 KLM Nuclear Solutions, Port Elgin, ON (formerly of Bruce Power)
3 Intoo (Innovating Tooling) Solutions, Kincardine, ON (formerly of Bruce Power)

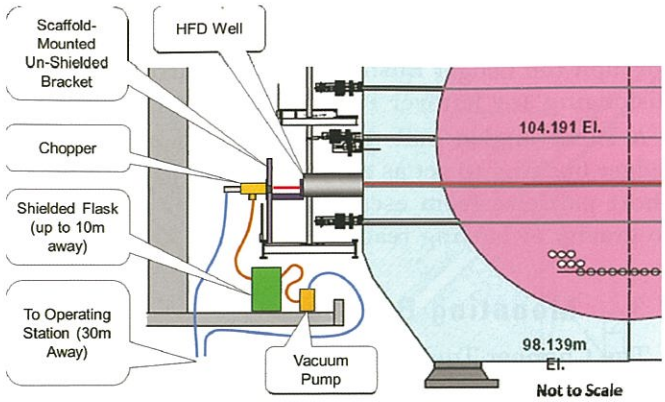

Figure 2. Chopper Tool Layout (HFD Removal at Darlington / Bruce)

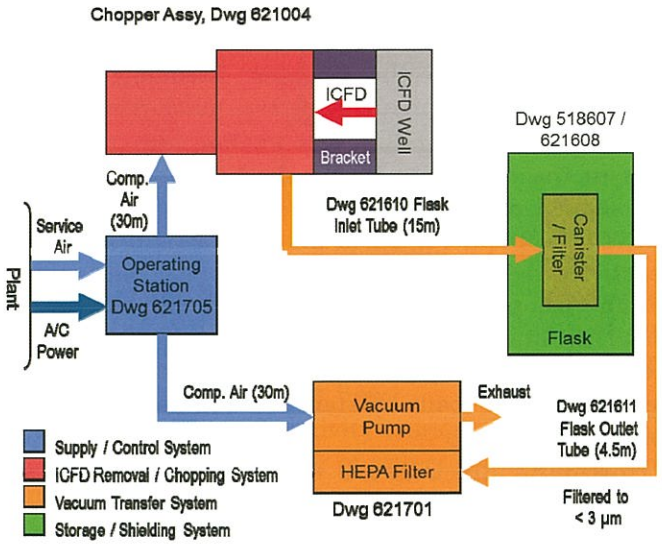

Figure 3. Chopper Tool System Diagram

monitored and controlled remotely. Removal of each detector would take only a few minutes.

After fabricating a proof-of-concept, the authors2, 3 brought the idea to the attention of the CANDU Owner's Group (COG). A Joint Project [4] was initiated and Stern Laboratories was contracted to develop the concept into a commercial IFCD removal system meeting COG members' specifications [5, 6, 7]. The first ICFD "Chopper Tool" systems were manufactured in 2007, and used to successfully remove detectors in the Wolsong and Bruce NPPs. Experience gained from these campaigns [8, 9] led to the initiation of a second COG Joint Project [10] to develop a "Mark II" ICFD Chopper tool. This paper will describe the design and operational experience of Stern Labs' Mark II ICFD removal tool.

2. Technical Description

The ICFD Chopper Tool System consists of four connected sub-systems, as illustrated in Figure 3: the Removal / Chopping system, the Vacuum Transfer System, the Particle Storage system, and the Supply / Control system. This modular design permits the Chopper Tool to be installed in the cramped work areas inside containment, to accommodate both HFDs and VFDs with a single tool package, and to allow quick component change-outs for decontamination, or repair.

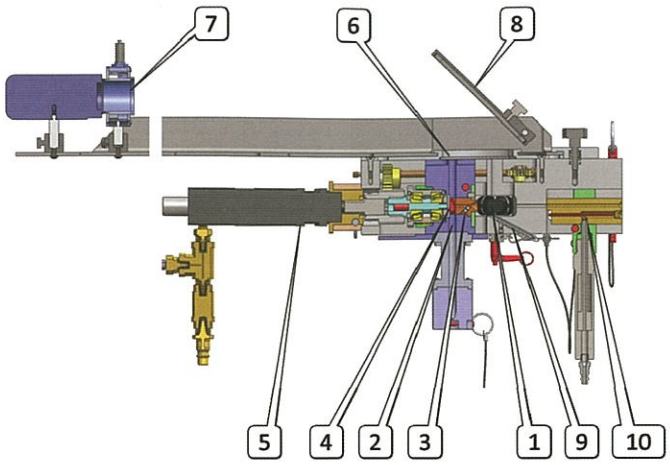

Figure 4. Chopper Assembly Components

2.1 Removal / Chopping System

The Chopper Assembly, shown in Figure 4, is a portable tool that mounts to the Well Housing via site-specific and location-specific Mounting Brackets. Its purpose is to draw detectors from their well tubes, chop them into 3mm long particles and deliver the particles to the Vacuum Transfer System.

The detector wire is pulled from the well by a pair of rubber drive wheels (item 1 in Figure 4) mounted at fixed spacing. The drive wheels feed the detector into a cutting chamber (item 2) through a hardened ledger bushing (item 3) where it is cut into particles (see Figure 5) by a rotating blade (item 4 in Figure 4 and Figure 6). The two mechanisms are connected via a gear train and a single air motor (item 5) drives both. The top of the cutting chamber is covered by an acrylic viewing port (item 6), separated by a thin gap that forms the chamber's air inlet. The bottom of the cutting chamber tapers to match the ID of the vacuum transport tubes. A high- definition camera and light (item 7), mounted on a short boom above the viewing port provides operators with a clear view of the drive wheels and interior of the cutting chamber via a mirror (item 8).

The Mark II Chopper Assembly itself is divided into quickly replaceable modules. The air motor can be removed after removal of a single ball detent pin. The ledger bushing, cutting blade and cutting chamber are mounted together in a "Center Block Module" which can be removed and replaced in a manner similar to the Motor Module. The camera, light, mirror and boom disconnect from the viewing port as a single module, and can be repositioned without losing its alignment or focus.

Figure 5. Cutter Blade

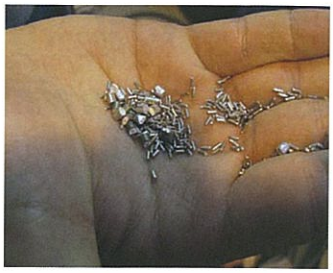

Figure 6. Chopped Detector Particles

2.2 The "Last Inch" Solution

Ensuring that the end of the ICFD enters the cutting chamber after it has cleared the drive wheels was a focus of much development work. Ordinarily the small pressure differential between the cutting chamber and atmosphere is enough to force this "last inch" of wire, shown in Figure 7, through the Ledger Bushing. However it was observed during tests with the Mark I Chopper Tool that the deformation caused by the cutting process could lodge a short particle inside the Ledger Bushing with more friction than the pressure differential could overcome. Consequently a pair of redundant "Clearing Devices" was added to the Mark II to dislodge any detector wire remaining outside the cutting chamber.

The "Downstream Clearing Device" (item 9 in Figure 4) consists of a short length of flexible cable that can be inserted into the Ledger Bushing through the gap between the Ledger Bushing and the downstream edge of the drive wheels. Once operators have confirmed via teledosimetry and video that a length of detector remains wholly inside the Ledger Bushing, they can actuate the Downstream Clearing Device from a safe distance by means of a long "Push-Pull Cable".

The device is adjusted prior to installation to ensure that the flexible wire reaches the entire length of the Ledger Bushing without penetrating the Cutting Chamber.

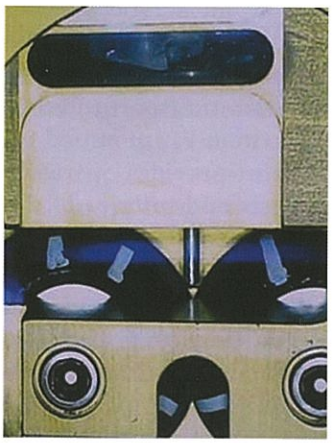

Figure 7. "Last Inch" of detector wire after clearing drive wheels

The "Upstream Clearing Device" (item 10 in Figure 4) consists of a pneumatically actuated magazine containing a short length of 3mm diameter aluminum rod, long enough to span the distance between the drive wheels and the cutting chamber. When actuated at the control console, the Upstream Clearing Device injects the aluminum rod into the upstream side of the rotating drive wheels. The wheels then push the rod through the Ledger Bushing into the cutting chamber, dislodging any leftover ICFD wire along the way.

A small angled ball detent has been added to the ledger bushing to act as a one-way lock, preventing any short particles from escaping the ledger bushing due to gravity or cutting reaction forces.

2.3 Mounting Brackets

The Chopper Tool Mounting Brackets provide structural support for the Chopper Assembly, and alignment with the Well Housing to ensure the detector wire is not significantly bent during removal. Differences between CANDU® reactor designs, and between HFD and VFD work areas have led to the design of six unique Mounting Bracket types. All Mounting Bracket designs connect to the Chopper Assembly using a standardized attachment using two quick-release pins.

Vertical Mounting Brackets anchor into the openings in the Reactivity Mechanism (RM) deck, which are shaped differently for Bruce, Darlington and the CANDU®-6 plants. Vertical brackets extend above the reactivity mechanisms to provide space and access for the Chopper Assembly, and are equipped with a small amount of removable shielding to help reduce fields during operation. The brackets are cross-braced against seismic loads by station personnel using scaffold or rigging.

Horizontal Brackets are unshielded to reduce the weight operators must carry by hand to reach the cramped platforms next to the HFD Well Housings. The spacing between HFD Well Housings and the platforms varies significantly between HFD locations and between CANDU® stations. Furthermore, the HFD Well housings offer no load-bearing interface for the mounting brackets. Consequently Horizontal Mounting Brackets are designed to be self-supporting on scaffold poles, which must be installed carefully using the jigs provided to ensure good alignment with the Well Housings.

2.4 Vacuum Transfer and Particle Storage System

Chopped ICFD Particles are transported from the Center Block to the Shielded Flask by way of a "Flask Inlet Tube" assembly (item 3 in Figure 8). Particles are carried by air flow through a continuous length of 16mm ID polyethelyne tube no more than 10m long. The tube terminates inside a filtered, stainless steel Canister at the center of the Shielded Flask (item 2), such that there is only one seam between the Cutting Chamber and the Canister. The outlet of the filtered Canister is connected (item 4) to an air-powered vacuum pump with integrated HEPA filter.

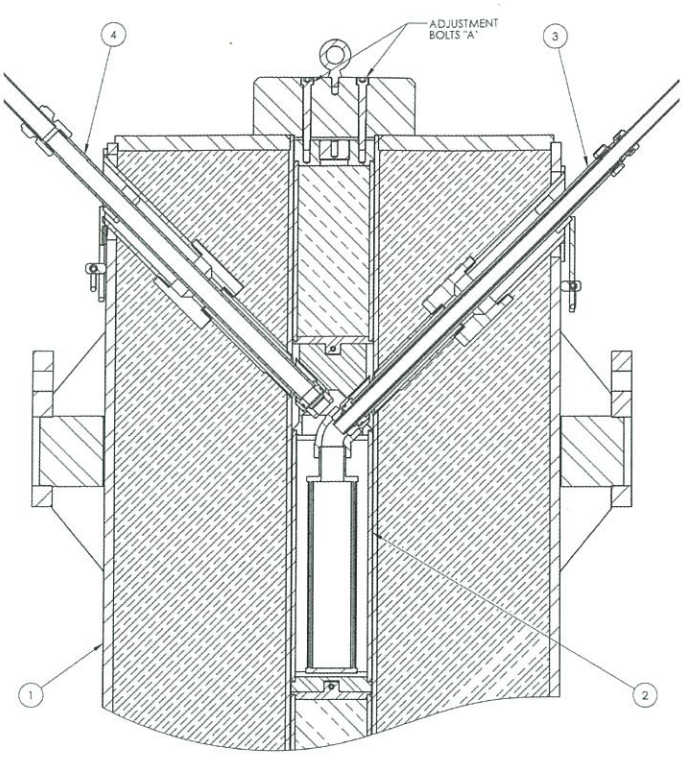

Figure 8. Canister and Flask in Operating Mode

The Canister has sufficient volumetric capacity to store 12 full-length detectors, or the contents of one complete Well Housing, and still maintain enough filter area to guarantee air flow.

Station-specific radioactivity storage limits may further constrain the number of detectors stored in each Canister.

Once filled, the Canister is sealed permanently via threaded plugs with tin-alloy seal rings. These seals are designed to prevent moisture ingress during intermediate storage < 30 years. However the Canister is not designed as a waste disposal container. Operators must ensure that the Canisters are enclosed in a certified enclosure before permanent disposal.

A Flask with 200mm of lead shielding on all sides encloses the Canister. Plans to manage the filled canisters differ between CANDU® operators, so the Flask is designed to accommodate as many options as possible. The Canister may be stored in its Flask permanently, locked in place with stainless steel latch bars and security seals. Alternatively, the Flask can be unloaded into another shielded enclosure through vertical or horizontal transfer. The Flask may be unloaded underwater so that the Canister can be stored for the intermediate term in the Irradiated Fuel Bay (IFB). The Flask is not designed as a radioactive material transport package, and must be packed inside a certified container before being transported off-site.

2.5 Supply / Control System and Operating Sequence

During removal and cutting operations, the Chopper Tool system is monitored and controlled from a safe distance about 30m away. A Control Console provides a central supply connection for plant compressed air. From the console, compressed air lines run to the Chopper Assembly Motor Module, and to the Vacuum Pump through and umbilical.

Compressed air was chosen to power the system for several reasons: The air-powered vacuum pump has no moving parts, increasing its reliability. The air-powered Chopper Motor has excellent low and stall speed torque characteristics, and is light-weight. The Manifold in the Control Console ensures that the Motor cannot run without also supplying power to the Vacuum Pump.

Chopper Tool operators have five sensor systems for monitoring detector removal. A high- definition monitor provides video feed from the Camera Module monitoring the Chopper wheels and Cutting Chamber. A differential pressure sensor transmits the vacuum level inside the Cutting Chamber to a display on the Control Console. Gauges are provided to monitor the Plant Air supply pressure at the Manifold. A microphone is installed on the Flask Inlet Tube to detect particle flow. Finally the Chopper Tool operating manual calls for operators to deploy station teledosimetry resources to monitor radiation levels close to the Chopper Assembly, Transport Tubes and Flask.

Operation of the Chopper Tool System proceeds as follows:

1. The target ICFD well is located and verified, and the electrical connections are severed.
2. The location-specific mounting bracket is installed and aligned with the target well.
3. A pre-installation check of the Chopper Assembly is completed,
4. The Chopper is connected to the Bracket, Vacuum Transfer System, Particle Storage System and Operating Console and a post-installation test of the Chopper Tool is conducted.
5. One operator is stationed at the Chopper Assembly and another at the Control Console. The operator at the Chopper Assembly feeds the end of the ICFD into the Chopper Tool and monitors the chopping of the first few feet of detector (which is not radioactive).
6. The Chopper Assembly operator then closes the compressed air valve on the Motor Module to pause the chopping, and radios the Control Console operator to shut off the air supply at the Control Console.
7. The Chopper Assembly operator then opens the valve on the Motor Module and retreats to a safe distance.
8. Once the operators have received confirmation that the area around the Chopper Assembly is clear, the

compressed air supply is opened at the Control Console and the tool is allowed to run until the detector is completely removed and chopped.

9. Should teledosimetry reveal that a length of detector wire remains downstream of the drive wheels after cutting, one or both of the Clearing Devices may be activated to clear the Chopper Assembly of ICFD particles.
10. The Vacuum Pump is allowed to run for a few minutes more to ensure that all particles are transported to the Flask and then the compressed air supply valve is closed and the tool is stopped.

Removal of one full-length detector takes approximately seven to eleven minutes after the ICFD is first fed into the Chopper Assembly.

3. Failure Modes And Risk Mitigation

During detector removal, fields at the Chopper Assembly can be high enough to make it difficult to approach it safely. Thus it is critically important that the Chopper Tool system run without incident for the duration of the cut. Stern Laboratories is not involved in operational and contingency planning at each station, however significant efforts are made at the factory to minimize the risk of breakdown.

Operating procedures [11] specify that each detector to be removed is checked to ensure that it slides completely freely in its well tube. If there is any resistance to pulling, or visible corrosion on the detector or well tube, the removal operation should not be attempted.

The complete Chopper Tool System is tested extensively at Stern Laboratories before being shipped to the customer. The system is used to cut two complete ICFDs, and enough Inconel- sheathed thermocouple wire to represent eleven more, for a total of 13 full detectors. The pull force of the wheels, minimum-operating vacuum level in the cutting chamber, and minimum- operating supply air pressure at the console are measured and verified to ensure they exceed the specified requirements [12]. Finally the canisters are helium leak tested to ensure they form a water-tight seal when plugged, and the Flask is radiometrically checked to ensure there are no voids in the lead shielding.

The Chopper Tool is designed to be modular, and quickly serviceable. In the event of a malfunction of the Chopper Assembly air motor for instance, the Motor Module can be pulled and replaced with a functioning replacement extremely quickly to minimize operator dose.

Modules are connected using quick-release ball detent pins which may be removed using long- handled tools or robotics if available.

4. Operational Experience At Darlington

The first ICFD removal campaign using the Mk II tool was completed during the Darlington unit 2 outage in September 2012. 9 vertical detectors were removed in total from1 well housing. The ICFD removal tool system performed as designed, and the campaign was completed in 3 days, with about 4 hours total cutting time.

The only hiccup occurred when a piece of felt cloth, added by OPG as a contamination-control measure, caused the non-irradiated portion of a detector to jam in the vertical bracket and the drive wheels to slip. This cloth was removed, and no further interruptions were witnessed.

Following detector removal and sealing of the canister, contact dose-ratings on the surface of the shielded flask were approximately 15 to 20 mRem/hr. Contamination levels on the Drive Wheels, Center Block, and Flask Inlet Tube were not provided to Stern Laboratories, but were understood to be manageable. OPG plans to store the sealed Canister inside the Flask at Darlington for the intermediate term.

5. Conclusions

The Stern Laboratories ICFD Chopper Tool system provides CANDU® operators with an efficient method for flux detector removal.

The 'Mark II' system design has been improved through operational experience with the Mark I system. The design is highly modular to simplify installation in cramped work areas, and to ease component replacement. Reliability is verified through extensive factory testing.

The system was recently used to remove and store 9 VFDs at Darlington.

The Mark II ICFD Chopper tool has now been deployed to several CANDU® stations. The success of this project reflects well on the COG framework for pooling expertise and resources amongst CANDU® utilities.

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GENERAL news

(Compiled by Fred Boyd from open sources)

Hearing for Bruce DGR Reconvenes

On June 3, 2014 the Joint Review Panel for the Deep Geologic Repository Project for Low and Intermediate Level Radioactive Waste (DGR) at the Bruce Power site announced it had scheduled additional public hearing days on the proposed project. These will begin on **Septem**ber 9, 2014 at 9:00 a.m. and continue for approximately two weeks. They will be held at the Royal Canadian Legion, 219 Lambton Street, Kincardine, Ontario.

The public hearing will give participants, Ontario Power Generation and the Canadian Nuclear Safety Commission the opportunity to provide their views in relation to the subjects of the information requests issued by the Panel since November 2013. Any person may attend the public hearing as an observer.

Amended Hearing Procedures that describe how to participate have been issued by the Panel. Participants may make a written-only hearing submission or an oral presentation to the Panel at the hearing. Anyone wishing to make an oral presentation must indicate their intention by providing a completed Hearing Participation Form to the Panel by June 23, 2014. Oral presentations must be supported by a written submission.

Subjects that will be addressed over the course of the hearing days are the following:

- Methodology used to determine the significance of adverse environmental effects
- Updates to the geoscientific verification plan
- Expansion plans for the DGR project
- Relative risk analysis of alternative means of carrying out the project
- Implications of revisions to the reference waste inventory
- Applicability of recent incidents at the Waste Isolation Pilot Plant (WIPP) to the safety case for the DGR project

For further information contact: Debra Myles, Panel Co-Manager c/o Canadian Environmental Assessment Agency. Email: DGR.Review@ceaa-acee.gc.ca, or Kelly McGee, Panel Co-Manager c/o Canadian Nuclear Safety Commission. Email: OPG-DGR@cnsc-ccsn.gc.ca

The DGR is a proposal by Ontario Power Generation to prepare a site, and construct and operate a facility for the long-term management of low and intermediate level radioactive waste at the Bruce Nuclear site, within the Municipality of Kincardine, Ontario.. Used nuclear fuel will not be stored or managed in the DGR.

Pickering Hold Point removed

On June 3, 2014 the Canadian Nuclear Safety Commission (CNSC) announced its decision to approve Ontario Power Generation Inc.'s (OPG) request to remove the regulatory hold point for the Pickering Nuclear Generating Station (NGS).

The removal of the regulatory hold point authorizes OPG to proceed with operation of the Pickering NGS beyond 210,000 Equivalent Full Power Hours (EFPH), up to 247,000 EFPH.

The decision follows a public hearing held on May 7, 2014, in Ottawa (ON). During the hearing, the Commission received and considered submissions from OPG and 55 intervenors, as well as CNSC staff.

The *Summary Record of Proceedings and Decision* of the hearing is available upon request with the Commission Secretariat. The webcast of the hearing is also archived for a period of 90 days on the CNSC website, *nuclearsafety.gc.ca*

OPG's current operating license for the Pickering NGS expires on August 31, 2018. The Commission has directed OPG and CNSC staff to update the Commission on a detailed risk improvement plan for the Pickering NGS at the Commission public meeting in August 2014.

Pickering NGS

Operating Licences for Bruce Power Extended

In early May 2014, the Canadian Nuclear Safety Commission (CNSC) announced thast it had extended for seven months the Power Reactor Operating Licences for the Bruce Nuclear Generating Stations A and B located in the municipality of Kincardine, Ontario.

As a result, public hearings for the renewal of Bruce Power's operating licences are now tentatively scheduled for February 4 or 5, 2015 in Ottawa (Part 1) and April 14-16, 2015 in Kincardine (Part 2).

Bruce Power had requested the extension to ensure that all relevant documentation was available in time to facilitate more meaningful public participation in the upcoming public hearing process that had originally been scheduled for September 2014.

The *Record of Proceedings, Including Reasons* for Decision from the hearing on the extension that was held on April 24, 2014, has been published on the CNSC website.

TRIUMF Orders New Cyclotron for Tc 99m Production

TRIUMF announced in early June 2014 that it had placed an order for a TR24 cyclotron to further its work on alternative sources of supply of medical isotopes.

TRIUMF head Paul Shaffer shows Minister Michelle Rempel around Triumf's facilities (Image: Government of Canada)

This followed an announcement by Federal Minister for Western Economic Diversification, Michelle Rempel, of a 5.5 million funding package to support the procurement of the new cyclotron and establish a new body, the Institute for Accelerator-based Medical Isotopes (IAMI), to develop new isotope products, processes and services.

TRIUMF is located at the University of British Columbia in Vancouver but is owned and operated by a consortium of Canadian universities, with support from the Canadian government.

Tc-99m is the world's most widely used medical isotope, used in about 80% o in early June 2014f nuclear medicine diagnostic procedures. The isotope has a short half-life and is therefore generated at the point of treatment from the slightly longer-lived molybdenum-99 (Mo-99) which is produced in research reactors. Canada produces around 40% of the world's supply of Mo-99 in the NRU reactor at Chalk River, but the unit is scheduled to cease isotope production in 2016 after nearly 60 years of service.

Canada and other countries have been stepping up efforts to secure alternative supplies of medical isotopes. One such method involves producing Tc-99m directly in a cyclotron by bombarding a molybdenum-100 (Mo-100) target with a proton beam.

Following the announcement of the funding, Advanced Cyclotron Systems Inc (ACSI), based in Richmond B.C., signed an agreement to supply a TR24 cyclotron to TRIUMF. The TR24 will be the fourth cyclotron to be installed by ACSI on TRIUMF's campus in a relationship dating back over 30 years.

According to ACSI, the TR24's beam capabilities make it ideal for the production of isotopes for use in both the SPECT (Single Photon Emission Computed Tomography) technology widely in use in hospitals and also the isotopes used in emerging PET (Positron Emission Tomography).

Board Changes at OPG

In April 2014 the Ontario government announced changes of the members of the Boards of Directors of Ontario Power Generation and Hydro One.

New appointments to the OPG Board are: Elisabeth (Lisa) DeMarco; Brendan Hawley; Ira Kagan; Nicole Boivin.

Elisabeth (Lisa) DeMarco is a partner at Norton Rose Fulbright Canada, LLP and Head of the Toronto Energy, Sustainability and Climate Change International Business Group. She also has experience as a lawyer in the public sector and is a member of the board of directors of the Ontario Energy Association and the Toronto Atmospheric Fund Investment Committee.

Brendan Hawley runs a consulting firm that specializes in advocacy communications. He has worked on issues related to energy, innovation and health care policy for a variety of public and private clients.

Ira Kagan is a senior and founding partner of Kagan Shastri LLP. His practice has focused on municipal law, including representing clients in some of the leading land use cases in the Greater Toronto Area.

Nicole Boivin is a business executive with more than 30 years' experience in financial services, telecommunications and public and not-for-profit indus-

tries. She is currently the chief branding officer for Manulife Financial.

Re-appointments to OPG's board include: Bernard Lord, Chair; Tom Mitchell; George Lewis; Margaret Jean Mulligan; Roberta Jamieson, William Coley; Gerry Phillips, John Herron.

Biographies of these individuals are available on OPG's web site.

Fukushima Builds Ice Wall

Construction has started of a wall of frozen soil at the Fukushima Daiichi nuclear power plant to prevent groundwater entering the reactor buildings. The ice wall is expected to take nine months to complete.

Drilling of the first of 1550 holes has started at Fukushima Daiichi (Image: Tepco)

Tokyo Electric Power Company (Tepco) began work to build the underground ice wall in early June 2014 after receiving approval from Japan's Nuclear Regulation Authority to proceed.

Ice wall technology is already widely used in civil engineering projects, such as the construction of tunnels near waterways. Small-scale tests using the technology have already been completed at the Fukushima Daiichi site. However, the full-scale use of the technology at Fukushima will see the largest ground freezing operation in the world.

Tepco plans to drill holes some 30-35 metres into the ground and insert pipes through which refrigerant will be then be pumped. This cooling will freeze the soil surrounding the pumps creating an impenetrable barrier around the reactor buildings. In total, some 1550 pipes will be placed in the ground to create a 1.5km-long ice wall around units 1 to 4.

Reducing the amount of contaminated water that it must deal with is a priority for Tepco. Groundwater naturally seeps from land to sea, but at the Fukushima Daiichi site the basements of reactors buildings are in the way. It is thought that more than 400 tonnes of groundwater enters the basements each day through cable and pipe penetrations as well as small cracks, mixing with the heavily contaminated water previously used to cool the damaged reactor cores.

Tepco recently started diverting groundwater around the reactor buildings at Fukushima Daiichi by pumping it out of the ground before it reaches the plant and then releasing it into the sea. As well as this bypass, an impermeable underground wall has also been built between the reactors and the sea. Together with the ice wall, Tepco believes these measures should virtually eliminate the movement of groundwater.

CNSC Releases Draft Study:
Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures

On June 4, 2014, the Canadian Nuclear Safety Commission (CNSC) released, for public review, its draft study entitled *Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures.*

The study is in response to the Commission's request to assess the consequences and possible preventative mitigation of a hypothetical severe nuclear accident to address concerns raised during public hearings on the environmental assessment (EA) for the Darlington Nuclear Generating Station refurbishment project.

The study focuses on the assessment of health impacts of a hypothetical, unlikely scenario of a severe nuclear accident. Various scenarios were assessed without full consideration of the multiple safety systems at Canadian nuclear power plants. Had all of the Fukushima Task Force enhancements been fully considered in the study, the likelihood of a severe accident would have been practically eliminated.

The study concludes that in the unlikely event of a radioactive release, there would be no detectable increased risk of cancer for most of the population, with the exception of a theoretical increase in childhood thyroid cancer risk. The result is not unexpected given the sensitivity of a child's thyroid gland to radia-

tion. The findings suggest that further consideration is needed in how children are considered as part of nuclear emergency planning.

The study is available for public comment until August 29, 2014. Copies may be requested and comments can be submitted through *info@cnsc-ccsn.gc.ca*.

The *Study of Consequences of a Hypothetical Severe Nuclear Accident and Effectiveness of Mitigation Measures* is being presented to the Commission as an information item at the June 19, 2014 public meeting.

Half of Chernobyl Cover Completed

The first half of the Chernobyl arch has been assembled and has been moved to make way for construction of the other half.

The first half of the structure will be moved to a holding area (Image: ChNPP)

The New Safe Confinement (NSC) is being assembled in two halves, each comprising several arched sections. The first half has been completed and moved 112.5m into a holding area in front of unit 4.

Assembly of the second half of the NSC has already begun. Once this is complete, the first section will be moved back towards the second half and the two will be joined together. This is scheduled to take place by the end of 2014. The arch will then be fitted with cladding, cranes and remote handling equipment during 2015.

The entire structure - some 108m high, 257m wide and 150m long and weighing around 31,000 tonnes - will then be moved 330m into position over the reactor building of unit 4 and part of its turbine hall. This will be done using hydraulic jacks in a three-day sliding operation scheduled to be done before the end of 2015. End walls will then be built to strengthen the NSC and make it airtight.

The NSC, which is being funded by the international community through donations to the European Bank for Reconstruction and Development is designed to last at least 100 years, by which time most of the decommissioning work on unit 4 should be completed.

No Impacts at Bruce Power Following Thunderstorm

On June 17, 2914 Bruce Power issued a media release stating there were no impacts on safe operations at Bruce Power following a thunderstorm earlier that day.

A widely circulated photo taken during a thunderstorm on June 17 generated media attention but the storm had no impacts on operations.

Bruce Power employs an extensive lightning suppression system to protect the stations and other buildings on site in the event of a lightning strike. The system operated as designed today as it has in similar situations over decades of operation.

Station staff are trained to deal with a number of abnormal situations including lightning procedures are in place to guide them in the event of a potential lightning strike. All outside work is suspended when severe weather is forecast.

Staff followed the procedure, performed a number of equipment checks to confirm everything was normal earlier today and confirmed there was no impact on the station.

CNSC Challenges Court Decision re Darlington Site Approval

On June 20, 2014 the Canadian Nuclear Safety Commission announced that it is appealing to the Federal Court of Appeal the Federal Courts judgement of May 14, 2014 regarding the 2012 decision to issue a *Nuclear Power Reactor Site Preparation Licence* for the Darlington New Nuclear Power Plant Project proposed by Ontario Power Generation.

The CNSC announcement stated that, in its view, there are aspects of the decision that contain errors of law with respect to the court's interpretation of the Canadian Environmental Assessment Act and the

manner in which it reviewed the assessment done by the Joint Review Panel in this case.

Back on August 17, 2012, the CNSC announced the decision of a Joint Review Panel (of CNSC and Canadian Environmental Assessment Agency) to issue a *Nuclear Power Reactor Site Preparation Licence* to OPG for its proposed new nuclear power plant project at the Darlington site for a period of 10 years.

The Joint Review Panel had been established earlier, in 2009, to consider the environmental assessment and licence application for the proposed Darlington project. (That OPG proposal did not specify the specific type of nuclear power plant.) The JRP submitted its report to the Government in August 2011 with the conclusion that that the project was unlikely to cause significant adverse environmental effects. In May 2012 the government agreed and authorized the project to proceed to licensing to prepare a site.

Because of a decision of the Ontario government against new nuclear plans OPG did not proceed to apply for a site preparation licence.

Darlington NGS

CNSC Report on NPPs for 2013

The Canadian Nuclear Safety Commission is inviting comments on the report from its staff, titled, *Staff Integrated Safety Assessment of Canadian Nuclear Power Plants for 2013*. The deadline for comments is July 17, 2014.

CNSC staff will present the report's findings to the Commission at a public meeting to be held on August 20, 2014.

Overall performance highlights for 2013:

- there were no serious process failures at the NPPs
- no member of the public received a radiation dose that exceeded the regulatory limit
- no worker at any NPP received a radiation dose that exceeded the regulatory limits
- the frequency and severity of non-radiological injuries to workers were minimal
- no radiological releases to the environment from the stations exceeded the regulatory limits
- licensees complied with their licence conditions concerning Canada's international obligations

The report includes an annual update on the implementation of the safety enhancements made by the licensees in response to the Fukushima Daiichi accident as well as an update on the Darlington new nuclear project.

The 190 page report is available at the following website: http://www.nuclearsafety.gc.ca/eng/reactors/power-plants/safety-performance-reports/index.cfm

Atucha 2 Achieves First Criticality

The 745 MWe pressurized heavy water reactor (PHWR) Atucha 2 in Argentina achieved first criticality on June 3, 2014.

The unit had received a licence from the Autoridad Regulatoria Nuclear on May 29, 2014 allowing nuclear operations to begin. On the same day the reactor vessel was filled with borated heavy water. The neutron-absorbing boron was gradually extracted from the heavy water allowing the controlled nuclear chain reaction to occur.

Grid connection is expected soon, after which tests will be conducted at different power levels to verify the performance of the systems to reach commercial operation.

The program to build Atucha 2, originally a Siemens-designed PHWR, was suspended in 1994 after 13 years of construction work. The project was revived after a 2006 government decision to complete the plant as part of a $3.5 billion strategic plan for the country's nuclear power sector. The reactor design is unique to Argentina.

Atucha 2 is Argentina's third nuclear power plant, joining the 335 MWe Atucha 1 PHWR, which has been in operation since 1974, and the 660 MWe Embalse PHWR, operating since 1983.

Exercise Unified Response

More than 50 organization, utility, regulator, and provincial and municipal agencies joined forces in a major multi-jurisdictional nuclear emergency response exercise May 26 – 28, 2014, given the name *Exercise Unified Response*. This was the first such exercise since 1998.

Since the Fukushima accident of 2011, the Canadian Nuclear Safety Commission, licensees and all levels of government have been working to reduce the likelihood of such an accident and to improve how all the organizations can work together in the event of an emergency.

The exercise used a variety of real-time scenarios to test how the organizations work as a team and to reinforce collective emergency preparedness at all levels.

The results will be presented at an open meeting of the CNSC.

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35th Annual CNS Conference
39th CNS/CNA Student Conference
Saint John, NB • May 31 - June 3, 2015
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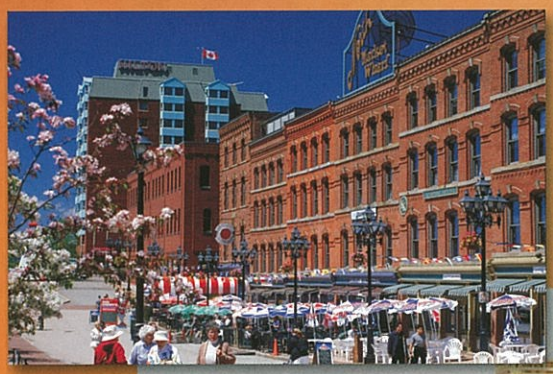
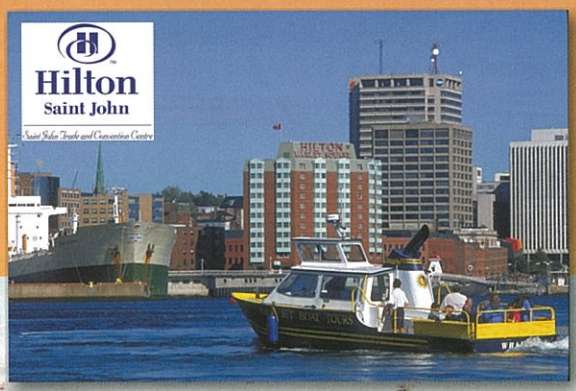




- Sponsorship and Exhibition opportunities
- Many plenary and technical sessions
- Student technical poster session
- Honours and Awards Banquet
- 2015 W.B. Lewis Lecture/Luncheon
- North American Young Generation in Nuclear Professional Workshop
- Reception, breaks, exhibits, and other networking opportunities
- Guest program: breakfast, tours, shopping, etc.

Conference Organization: Canadian Nuclear Society
Host: NB Power

www.cnsconference2015.org

35th Annual Conference of the Canadian Nuclear Society and 39th Annual CNS/CNA Student Conference

Nuclear Innovation through Collaboration
La collaboration facilitant l'innovation nucléaire

2015 May 31-June 3
Hilton Saint John / Saint John Trade & Convention Centre, Saint John, NB, Canada

Call for Technical Papers

The Canadian Nuclear Society's 35th Annual Conference will be held in Saint John, New Brunswick, Canada, 2015 May 31-June 3, in conjunction with the 39th Annual CNS/CNA Student Conference, at the Hilton Saint John / Saint John Trade & Convention Centre.

The central objective of this conference is to provide a forum for exchanging views, ideas and information relating to the application and advancement of nuclear science and technology, and for discussing energy-related issues in general.

- Invited speakers in Plenary sessions will address broad industrial and commercial developments in the nuclear field.
- Speakers in ***technical sessions*** will present papers on industrial, research and other work in support of nuclear science and technology.
- Plenary, technical and student sessions will highlight future developments in the field and discuss the challenges faced by the nuclear community.
- University students in Student sessions will talk about their research and academic work (a separate Call for Students' Extended Abstracts will be issued for the Student Conference).

Conference Website:
www.cnsconference2015.org

Deadlines

- **Receipt of Abstracts: 2014 November 1.**
- **Receipt of full papers: 2015 February 1.**
- **Notification of accepted paper: 2015 March 1.**

Paper abstracts (<100 words) should be submitted to the Conference Website. Please note that the abstract submission represents the author's commitment to submit a full paper on or before 2015 February 1 and, if the paper is accepted by the Conference Paper Review Committee, to present it at the Conference.

General Guidelines for Full Papers

Papers should present facts that are new and significant, or represent a state-of-the-art review. They should include enough information for a clear presentation of the topic. Usually this can be achieved in 8-12 pages, including figures and tables. The use of 12-point Times New Roman font is preferred. Proper reference should be made to all closely related published information. The name(s), affiliation(s), and contact information of the author(s) should appear below the title of the paper.

NOTE
For a paper to appear in the Conference Proceedings, at least one of the authors must register for the Conference by the "early" registration date (2015 April 15).

Paper Submission Procedure

The required format of submission is electronic (Word or pdf). Submissions should be made via: www.softconf.com/d/CNS2015Technical

Questions regarding papers and the technical program should be sent to:

Ruxandra Dranga
CNS-2015 Technical Committee Chair
e-mail: cns2015@cns-snc.ca
Tel: 613-584-3311, Ext. 46856

General questions regarding the Conference may be addressed to:

Ben Rouben
e-mail: cns2015org@cns-snc.ca
Tel: 416-977-7620

Dr. Agnes Bishop

(from the Canadian Nuclear Safety Commission)

The CNSC looks back at the contributions of Dr. Agnes J. Bishop, a driving force in both the medical and nuclear community Dr. Bishop was the first woman to be physician-in-chief at the Children's Hospital of Winnipeg in 1985. She was also the head of Pediatrics at St. Boniface General Hospital, and the chair of the Department of Pediatrics at the University of Manitoba where she specialized in pediatric hematology and oncology. Her vast skill and knowledge in the fields of pediatric hematology and oncology would lead the Royal College of Physicians and Surgeons of Canada in seeking her to be the first woman to be selected for presidency; however, she declined the position to take on the responsibilities of president of the Atomic Energy Control Board (AECB) in 1994 and then the Canadian Nuclear Safety Commission (CNSC) until 2001.

Under her guidance, Dr. Bishop led the AECB's transition to the CNSC under the Nuclear Safety and Control act. Recognized even by the then Prime Minister, Jean Chrétien, for her renowned reputation as a capable leader he said "By appointing a highly respected physician to the position, the government is emphasizing its commitment to health and safety... We look to Dr. Bishop for leadership in ensuring that the use of nuclear energy does not pose an undue risk to health, safety, security and the environment."

Dr. Bishop also led the AECB/CNSC in achieving a number of other significant accomplishments. In September of 1994, not long after her appointment as president, Dr. Bishop signed the Nuclear Safety Convention on behalf of the Government of Canada. She was also responsible for ensuring that the Canadian nuclear sector was prepared for the turn of the millennium.

Dr. Bishop died in Winnipeg, May 16, 2014.

Roger Steed

Roger Graham Steed, a long-time member of the staff of the Point Lepreau NGS and of the Canadian Nuclear Society, died in Saint John, N.B. March 16, 2014 at the age of 72.

He was born near Newcastle upon Tyne, England on April 7, 1941. His family immigrated to Canada in 1949, when Roger was 8 years old. He was selected for a Regular Officer Training Plan scholarship to attend the University of Toronto, where he earned a Bachelor of Applied Science degree in Mechanical Engineering.

Upon graduation he continued his career with the Royal Canadian Navy until 1966 when he became a design engineer in Dupont of Canada Maitland Works, near Brockville, ON. During that time, he married his wife Ruth.

In 1969 he joined Atomic Energy of Canada Ltd in Mississauga, ON, and became the Fuel Handling Commissioning Engineer for the Pickering Generating Station project. In 1975, he joined NB Power, as a member of Point Lepreau Generating Station commissioning staff. He served at Lepreau, in various roles until he retired in 2003.

Roger had many interests outside work. Notably, he was a member of the Association of Professional Engineers and Geoscientists of New Brunswick and the Canadian Nuclear Society. He especially enjoyed playing the bells at Trinity Anglican Church, where he was warden, vestryman, sidesperson, and tenor in its choir. He was also the second oboist in Symphony New Brunswick for 18 years.

He loved to read and authored 5 books of his own which were subsequently published. He is survived by his loving wife of 46 years, Ruth, and his three children: Catherine (Steed) Bishop (David), Geoffrey Steed (Linda) and Andrea (Steed) Fry (Allen), six grandchildren: Ashley and Tyler Bishop, Julia and Olivia Steed and Logan and Sierra Fry.

The funeral was held March 22, 2014 at Trinity Anglican Church, Saint John, with Internment later in the Columbarium of Trinity.

Obituaries

Dr. Robert E. Jervis, Ph.D., F. C.N.S., F.R.S. C. 1927-2014

Professor Robert Jervis died on his 87th birthday on May 21, 2014, after an amazing life. He was devoted to his Christian faith and his family. He was a distinguished scientist, a man of principle, but also great humility. Above all he was a man of integrity, greatly admired and respected by his students and scientific colleagues around the world and deeply loved by his family.

Born in Toronto, he came from humble roots. A child of the depression, he achieved an undergraduate degree in Math, Physics and Chemistry in 1949 and an M.A. and PhD in Physical Chemistry in 1952, all at the University of Toronto. He worked at the Chalk River nuclear research facility from 1952-58 pioneering novel methods of trace element analysis in the environment by applied nuclear chemistry. He joined the U of T Faculty of Applied Science and Engineering where he continued his research in applied analytical and environmental chemistry. He was professor at U of T for five decades, including as Professor Emeritus in his final years. His work took him around the world lecturing and consulting with scientists and scientific bodies and as a visiting professor at the University of Tokyo, University of Cambridge and University of Kuala Lumpur. He published over 250 scientific papers.

Robert Jervis received numerous awards and honours: the Lewis Medal, Canada's highest nuclear scientific award; the international Hevesy Medal, for radioanalytical chemistry; the American Nuclear Society's Emmon Medal; and he was the first foreign recipient of the Russian Academy of Science's Ressovsky Medal. He was a fellow of the Royal Society of Canada, the Canadian Nuclear Society, the Canadian Society for Chemistry and an honourary fellow of the Atomic Energy Society of Japan and the Indian Academy of Sciences. He lived his faith in all aspects of his life and always traveled with a bible, seeking to bring God's love to all. His deepest professional satisfaction came from instilling first year students with a love of science.

His greatest love was his family – his devoted wife Jean, from whom he was inseparable for 70 years, daughter Ann, son Peter, grandchildren Dylan, Bronwen and Max – who shared more than a lifetime's worth of happy memories together. He is also survived by his beloved sister Kathleen. He will be deeply missed by them, all of whom are overwhelmed with gratitude for his kind and gentle presence in their lives. Funeral service took place in the Ogden Chapel on Monday, May 26, 2014 at 1 p.m. Interment at Pine Hills Cemetery.

http://v1.theglobeandmail.com/servlet/story/Deaths.20140523.93343485/BDAStory/BDA/deaths

Reminder to members

The Members Section of the CNS website contains considerable information about the Society reserved for members.

This includes:

- all of the presentations given at the Annual General Meetings of 2014. 2013, 2012, 2011
- the report from the Independent Public Accountant of the 2013 accounts
- information on all members of Council
- a directory of members
- information on upcoming CNS events and those of partner societies

CNS Annual General Meeting

by FRED BOYD

The 17th Annual General Meeting of the Canadian Nuclear Society as an incorporated organization was held Sunday, 23 May 2014 in the Toronto Convention Centre, immediately prior to the opening of the *CANDU Maintenance Conference.*

The meeting was formally constituted by CNS President, Adriaan Buijs, at the appointed hour of 3:30 p.m., with 63 members present or represented by proxy. (Additional attendees joined during the meeting.)

Following his welcome to those attending, President Buijs noted that all the reports for the meeting had been posted on the members' section of the CNS website. Each chairperson had been asked to produce a one-page Power-Point "slide" summarizing their report.

The first order of business was acceptance of an amendment to the minutes of the last Annual General Meeting held June 9, 2013 and of the Special General Meeting held November 3, 2013. These were related to the changes of the By Laws to make them appropriate for application for "Continuance" (as a non-profit organization) under the federal government's new Canadian Not-for-Profit Corporations Act (CNCA). (Continuance was granted in April 2014 meaning the Society remains a fully authorized non-profit organization.)

The President diverted from his PP submission and made the following comments on his activities.

During the past year, I have performed the following activities:

- *I have attended the CNA conference in Ottawa and represented the CNS at a number of activities: in particular: CNA board meetings; Nuclear Leadership Forum; meeting with NRCan Deputy Minister, Serge Dupont, on the prospects for a research reactor at CRL.*
- *I met with Dr. Binder from the CNSC to discuss possible conflict of interest situations with his personnel getting involved with CNS activities. The outcome was that he encourages his people to be active in the CNS, and that they should use their judgment when conflict of interest situations arise. For example, CNSC employees should not participate on behalf of the CNS in interventions held by the CNSC.*
- *I gave the speech at the President's Dinner at the Chalk River Branch.*
- *I have been involved with the organisation of the PBNC and the upcoming CANDU Reactor Safety Course.*
- *I have signed the vision statement of the Nuclear Leadership Forum on behalf of the CNS.*
- *I have attended the N6 meetings.*
- *Chaired the Special General Meeting on November 3rd, called to have the revised bylaws for the CNCA approved by the membership. This was successful.*
- *Attended the launch in Canada of the British company Cavendish, formerly Babcock, at an event at the British High Commission in Ottawa on November 20th. Cavendish is entering the Canadian market with the explicit objective of managing AECL Chalk River under the GoCo model.*
- *Attended the CNA board meeting in Toronto on Dec. 6, 2013 which was the first meeting with new CNA President John Barrett.*

In his PP slides Buijs also noted the achievement of Continuance and offered special thanks to the CNS staff, Denise Rouben and Bob O'Sullivan.

The President then called on Past President John Roberts, chair of the nominating committee, to present the proposed slate of members for the CNS council and the Executive. Executive members must also be members of Council. Since the number of nominees for Council was less than the maximum specified by the By Laws, all were acclaimed.

Under the new By Laws the executive also need to be voted. For most of the positions there was only one candidate and they were acclaimed. However, two members were nominated for the position of Second Vice-President – Parva Alava and Peter Ozemoyah. Ballots were distributed for the vote with the result that Peter Ozemoyah was elected as Second vice-President.

(See the list of Council and Executive members in this section of the Bulletin.)

Treasurer Mohamed Younis then presented his

report, noting first that under the CNCA a formal full audit is not required so the Society had a review by an independent Public Accountant.

Due to a marked decrease in revenue from conferences and courses the Society ended up with a deficit in 2013 even larger than that anticipated, as shown in the following chart.

Comparison with Original 2013 Budget		
	Budget for 2013	Actuals for 2013
Net Revenue from Conferences and Courses	$ 206K	$ 93K
All Other Revenue	$ 173K	$174K
Total Revenue	$ 379K	$ 267K
Expenditures	$ 458K	$ 404K
Deficit	$ 79K	$ 137K

He noted that CNS's assets were $667K at the end of 2013 primarily in sound investments.

Then followed concise reports from the various Divisions, Committees and Branches.

It was noted that the new Western Branch, embracing members in Saskatchewan, Alberta, and British Columbia, has been holding meetings via Skype.

There being no further business, incoming president, Jacques Plourde, gave a short address on his vision for his term of office which is included separately in this issue.

Adriaan Buijs (R) presents incoming President Jacques Plourde with a traditional gavel at the close of the 2014 CNS Annual General Meeting.

Adriaan Buijs then presented the new President with a traditional gavel (see photo). In turn Jacques Plourde presented Adriaan with a plaque commemorating his second term as President. (Adriaan Buijs was also president for the 2010 – 2011 term.

(All of the PP slides are available on the CNS Members section of the CNS website.)

News from Branches

Following is a report on activities of CNS Branches extracted from the report by Branch Affairs Chair, Syed Zaidi, for the May 2, 2014 meeting of the CNS Council. His report for the Annual General Meeting held May 25, 2014 can be accessed through the Members section of the CNS website.

CHALK RIVER – Scott Read

Speakers:

- The CNA, CNS, and AECL set up a joint screening of the film "Pandora's Promise" on **March 31** at the Keys Campus of AECL in Deep River. Dr. Peter Poruks of the CNA provided an introduction for the film and hosted the Q&A session afterwards. The screening was attended by over 100 CNS members and non-members. The discussion afterwards was riveting with many questions from both members of the CNS and members of the public.
- Dr. Joan Miller gave a talk entitled "Global Threat Reduction Initiative" on **April 10**. Reportedly it was well-received by the local CNS members.

Education and Outreach:

- The Renfrew County Science Fair occurred on Saturday, April 5th. The CNS booth was championed by Scott Read, Ken McDonald, Dan Campbell, and Ammar Bhatti. Two awards were given out in the category of Excellence in Nuclear Research – an award which comes with a $150 cash prize.
- The winners were:
  - Rachel Lockley of General Panet High School for her study "Your Brain on Sugar". Her study timed separate groups of lab mice to find their way through a maze towards a piece of food. The groups were given different amounts of sugar to see the effect of the substance on their ability to perform through the maze. See **Figure 1**.
  - Kelvin Leung of Fellowes High School for his study "Investigation of Wind Turbine Blades with Tubercles". His study looked at the optimization of the design of tubercles on the trailing edge of wind turbines for lower flow losses leading to higher electrical output. Kelvin's experiment used both theories to

predict the tubercles would lead to greater output and experimental based trial-and-error to determine the optimal dimensions of the tubercles. See **Figure 2**

Other Initiatives:

An alternative to Science North's "Science En Route" was discovered and proposed as a slightly cheaper option to the Summerfest organizers. The organizing committee was to hold a meeting to discuss the options the CNS has put forward to them and determine whether or not they would like to go forward with a science demonstration. No feedback has been given so far, but the pledge of $650 from the CNS still stands.

Figure 1 - Rachel Lockley and Scott Read in front of Rachel's poster for her study "Your Brain on Sugar". Rachel was awarded one of two CNS awards.

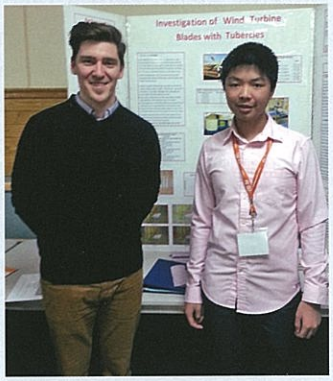


Figure 2 - Scott Read and Kelvin Leung in front of Kelvin's poster for his study "Investigation of Wind Turbine Blades with Tubercles". Kelvin was awarded one of two CNS awards.

GOLDEN HORSESHOE – David Girard

On **May 27**, the Golden Horseshoe Branch donated four prizes to the Bay Area Science Fair. Two members served as judges for the Branch prizes. There were over 300 Intermediate and High School student projects. The Canadian Nuclear Society Golden Horseshoe Special Merit awards were presented to four outstanding projects related to nuclear science, engineering, and energy research or climate science.

On **April 3**, we had to opportunity to welcome Alex Wolf from the Canadian Nuclear Association to host a viewing of Pandora's Promise at the McMaster Campus.

OTTAWA Branch – Ken Kirkhope

Current Branch Executive

While there was no change in the current Branch Executive some members have indicated that they wish to step down in the near future. The Branch executive held a special strategy meeting on April 17. Among the items discussed was the Branch Executive, improving attendance for branch events, planning the branch Speaker Program for 2014/15, and branch participation in other activities (university, science fair, other).

Meetings

April 1, 2014, the CNS Ottawa Branch held its Annual Dinner Event, with branch member and CNS Fellow Fred Boyd speaking on ***'Peaceful Nuclear Explosions (PNEs): A Historical Perspective'***. Ron Thomas introduced the speaker, recalling Fred's extensive and in many ways pioneering career in the Canadian nuclear industry, and also his long service to the Canadian Nuclear Society.

In his talk, Fred surveyed the development of the PNE concept over the period 1955-75, beginning with programs in the USA and USSR, and then reviewed the practicality for applications such as civil engineering excavations, mining engineering and mineral, oil and gas recovery. The source of much of the information for the talk was from a report prepared for the federal government at the time.

A very lively question & answer session followed. At the conclusion, Branch Chair Ken Kirkhope thanked Fred for his talk and presented him a special plaque in appreciation of his outstanding contributions in the nuclear field, and to the Branch and the Society. Further information and a copy of the presentation can be obtained at the Ottawa branch's website **http://cns-snc.ca/CNS/ottawa/.**

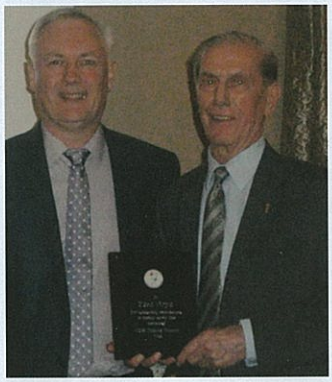


Figure 3 - Ken Kirkhope presents Fred Boyd a Plaque of Appreciation from CNS Ottawa Branch

Education:

Two members of the Ottawa Branch participated as judges in the Ottawa Regional Science Fair 2014. However, in the end, they decided not to award a prize as no projects were truly connected to nuclear science, technology or ionizing radiation this year.

Ottawa Branch members contributed as lecturers for the Nuclear Engineering Graduate Course, organized by Dr. Glenn McRae, held this semester at Carleton University.

SHERIDAN PARK Branch – Raj Jain

Peter Schwanke participated at the Peel Region Science Fair 2014 as a special judge. The following five students were awarded the special CNS award. The award is given to projects that investigate aspects of energy, such as production, usage, storage, conservation, etc.

1. Karishini Ramamoorthi and Smuruthi Ramesh (Port Credit Senior Secondary) "Go with the Flow: Benzoquinone Fulvic Acid NaCl Flow Battery";
2. Nolan Dey (Mississauga Secondary School) "Harnessing the Wind: Energy for Use in an Automobile";
3. Zahra Hasan (Port Credit Senior Secondary) "Fuelling the Future: Is Algae the Solution?";
4. Kevin Zhang and Justin Zhou (Homelands Senior Public) "Harvesting Surplus Energy";
5. Jafar Sanderji (Wali ul Asr School) "Making Biofuels Faster".

Hazen Fan from CNS Sheridan Park Branch participated as a special judge at **Bay Area Science & Engineering Fair 2014.** The following two projects related with nuclear were awarded the special CNS award.

1. **Nuclear Power: Fusion vs Fission, and**
2. **Mobile Phone Radiation.**

WESTERN Branch – Jason Donev

Aaron Hinman represented the **CNS** at **Earth Science for Society (ESFS)** which ran for three days, Sunday to Tuesday. Day one was open to the general public; days 2 and 3 were for Junior High school kids. He had good contact with the public, no specifically anti-nuclear people approaching my booth.

During the organized portion of the Exhibition aimed at the school kids, he ran an abbreviated program which answered the two questions selected by the people running the exhibition from the list of questions he had submitted for them. The response was very positive overall. The organizers of the Exhibition were pleased to have the CNS represented there and we were invited to come back for next year's event. Running the booth solo was challenging but not insurmountable.

In dealing with junior high school students Aaron found that almost none of them had heard of Fukushima itself, though they did know about the Tohuku Quake and Tsunami. This may mean we have passed the worst of the Fukushima PR fallout and are working again with a relatively clean slate.

This is very close to the kind of contact with the public we have been seeking here in Alberta. In the future additional manpower would be helpful. His voice was going near the end of the third day, having an extra set of lungs and vocal chords on hand would take some of the stress off. Also having handouts like more pellet cards and CNA booklets would be nice as well. He ran the CNS booth without handouts and what information he was able to present was almost entirely what he could tell the students directly face-to-face.

Are you aware of NORM?

by RUXANDRA DRANGA, Chair of CNS Education and Communication Committee

Any man-made consumer products which include naturally occurring radioactive nuclides are referred to as NORMs, or Naturally Occurring Radioactive Materials. These materials are used as teaching aids in high school classrooms to teach students about ionising radiation. Since 2008, the Canadian Nuclear Society has been placing Geiger Kits in Canadian high schools from coast to coast. These kits include a model "RM-80" Geiger detector produced by Aware Electronics, interface software which can be installed on a personal computer, a container of sodium-free table salt (NoSalt®), and a sample of clumping cat litter. Other NORM materials that may be used are high-end camera lenses from the 20th century containing thorium salts, "Vaseline glass" or "uranium glass" objects containing uranium salts, or regular balloons used in the "Hot Balloon" demonstration (used to collect and concentrate radon daughters from the air).

This year, with the generous sponsorship from AECL, the CNS placed 14 kits into high schools across Canada:

- One kit went to the high school in Pinawa (close to AECL's Whiteshell Laboratories),
- Five kits went to high schools in the Ottawa region(close to the AECL Ottawa offices),
- Two kits went to high schools in Port Hope and one to a high school in Richmond, Ontario (close to AECL's Port Hope office), and
- Five kits went to high schools in the Renfrew County (close to AECL's Chalk River Laboratories).

If you want to read more about NORM, you can watch the Ionizing Radiation Workshop presented to teachers and the "Hot Balloon" experiment, by visiting the CNS Education and Communication website at www.cns-snc.ca/cns/education-communications/teachers-students/.

Connie Matthews is a Chemistry teacher at Renfrew Collegiate Institute (RCI) in the Renfrew County. She is one of the 14 Geiger Kits recipients. She and her husband, Mr. Matthews, who is a Physics teacher at RCI, are very excited about using the kits in their classrooms to teach students about radiation.

Incoming President's Address

Following are the notes used by Jacques Plourde for his short address at the close of the CNS Annual General Meeting held in Toronto May 25, 2014.

Dear CNS Colleagues

I know you all want to move to the CMC 2014 reception in the next room, so I will be brief.

I would like to start by thanking Adriaan for the fine job he did in his second term as CNS President. His will be large shoes to fill.

I also wish to thank all of the members of the outgoing Council for their efforts.

And, congratulations and thanks to all of the members of the newly-elected Council. Although many of you are returning for yet another challenging year I see new faces and this is most heart-warming. It is a pleasure to lead such a strong, diverse and engaged team.

Let me take a few moments to reflect on the direction the CNS must take in these hard times for the industry. Like our colleagues in the Operating Utilities who have led the way in their journey to excellence, we must focus on fundamentals: our core business.

1. **Advocacy:** A balanced, technically-sound, strong and visible position in support of our nuclear facilities in Canada can go a long way at helping to secure long-lasting partnerships that will benefit the CNS.
2. **Education:** Outreach at all levels, from schools to parliament will get the numbers behind the CNS goal of promoting nuclear science and technology.
3. **Education:** Local activities make the CNS and "nuclear" more visible in the community. This ultimately means more engagement from the local utilities and service providers.
4. **Events:** Conferences, seminars and meetings that are tailored to the needs of the nuclear science and technology community, with their full involvement.
5. **Recognition:** Positive feedback is the only way to sustain engagement in, and continuous improvement of, CNS programs.

Already we are making small changes, a step at a time:

We will hold fewer Council meetings and more Executive meetings. The result will be increased Council quality time, with Council meetings better prepared and less distracted by the day-to-day business matters of the CNS.

We will re-organize Council meetings to address the core business first. This will place our Divisions, Committees and Branches in the limelight where they should be.

As President, it is my intention to involve the 1st and 2nd Vice-Presidents more in my affairs and I am asking all members with portfolios to look around for a colleague to learn the ropes and share the load.

Of course, we will continue to manage our day-to-day business (administration, finances, succession planning, record keeping, etc.) a necessary evil if we want to have a healthy Society. We have our office staff (Denise Rouben and Bob O'Sullivan), Ben Rouben as our Executive Director and Ken Smith as our Financial Administrator to keep us on the straight and narrow path. Thanks to them for a job well done.

These are not only challenging but also exciting times for the CNS. I am looking forward to working with all of you this year for the betterment of our great Society.

Thank you for your attention. Thank you for your time.

CNS Officers 2014 – 2015

President	Jacques Plourde
1st Vice-President	Vinod Chugh
2nd Vice-President	Peter Ozemoyah
Secretary	Colin Hunt
Treasurer	Mohamed Youris
Past President	Adriaan Buijs

CNS Council 2014 - 2015

Parva Alavi	Peter Ozemoyah
John Barrett	Tracy Pearce
Fred Boyd	Jacques Plourde
Adrriaan Buijs	Jad Popovic
Vinod Chugh	Ben Rouben
Emily Corcoran	Nick Sion
Rudi Cronk	Ken Smith
Ruxandra Dranga	Aman Usmani
Dan Gamage	Jeremy Whitlock
Colin Hunt	Mohamed Younis
Kris Mohun	Syed Zaidi
Dorin Nichita	

AECL EACL

Call for Papers

3rd International Technical Meeting on Small Reactors "Applications of Research Reactors and Small Modular Reactors"

2014 November 5-7
Ottawa Marriott Hotel, Ottawa, Ontario CANADA

Objective

Atomic Energy of Canada Limited (AECL) and Canadian Nuclear Society (CNS) are hosting the 3rd International Technical Meeting on Small Reactors. There is growing international interest and activity in the development of small nuclear reactor technology including building prototypes and research reactors. This meeting will provide participants with an opportunity to share ideas and exchange information on new developments.

Following the success of the 2nd Technical Meeting in November 2012, which captured the achievements, capabilities, and future prospects of small reactors, this 3rd Technical Meeting is dedicated to the applications of research reactors and small modular reactors.

This Technical Meeting will cover topics of interest to designers, operators, researchers and analysts involved in the design, development and deployment of small reactors for research and power generation. A special track is planned to focus on small modular reactors (SMR) for generating electricity and process heat, particularly in small grids and remote locations.

A technical tour of the Chalk River Laboratories will be hosted by AECL for all interested attendees on November 7. It will include the ZED-2 and NRU reactors.

Topics of Interest

Presentations related to the following topics are of interest to this Technical Meeting:

- Research reactors and low power critical facilities
- Radionuclide production
- Materials research and neutron beam
- Operating experience
- Aging management
- Commercial SMRs for electricity generation
- Small reactors for remote locations and niche applications
- Safety and licensing
- Autonomous control and operation
- Reactor physics
- Thermalhydraulics and passive safety
- Advanced materials and chemistry
- Advanced fuels
- Education, training and outreach

Abstract Submission

Abstracts (<250 words) and full papers must be submitted via the submission link on the meeting website. Papers should include sufficient information for a clear presentation of the topic; usually this can be achieved in 8-12 pages, including figures and tables. All papers will be published in a CD to be distributed at the meeting. The required format of submission is electronic (MSWord or PDF). Information on paper submission and templates is available from the website:
www.cns-snc.ca/events/3tm/

Technical Meeting Organizers

Advisory Committee: Adriaan Buijs (McMaster University), Benjamin Rouben (12&1 Consulting), Bhaskar Sur (AECL), Brent Lewis (UOIT), Dan Brady (NRCAN), Eleodor Nichita (UOIT), John Root (Fedoruk Centre), John Goldak (Carleton University), John Katsaras (ORNL), Marcel de Vos (CNSC)

Honorary Chair..... Romney Duffey (DSM Associates)
General Chair..... Metin Yetisir, AECL
Technical Program Chair ..... Steve Livingstone, AECL

Key Dates

Abstract submission ..... May 30, 2014
Acceptance/author notification ..... June 15, 2014
Draft paper submission .....July 18, 2014
Comments on draft paper to authors .....Aug. 15, 2014
Final paper submission .....Sep. 12, 2014

Further Information

Additional information is available from www.cns-snc.ca/events/3tm/ or Metin Yetisir, General Chair, AECL, Tel: (613) 584-8811 ext. 46577; Email: yetisirm@aecl.ca.

CANDU FUEL TECHNOLOGY COURSE

2014 October 6-7

Canadian Nuclear Society Fuel Technology Division

Best Western Plus Durham Hotel

559 Bloor St. West, Oshawa

Aim of Course

The aim of this course is to provide an understanding of the CANDU fuel design, performance and operation, and how the fuel interacts with the interfacing systems. The course will be of great interest to both management and technical staff, to fuel designers, manufacturers, station operations, fuel channel and fuel handling system designers, safety analysts, performance and inspection staff.

Course Outline

This course will provide an overview of the CANDU fuel design, performance and operation, with a special emphasis on the systems that interface with it. Fuel, more than any other reactor component, interfaces with many different systems. The course will describe the design of the bundle, the detailed nuclear physics of its operation, the thermal- hydraulic performance, the fuel handling, fuel and physics of the reactor, the discharge and storage of the fuel.

HOTEL ACCOMMODATION

Best Western Plus Durham Hotel
559 Bloor St. West, Oshawa

Please make accommodation arrangements, if required, directly with the hotel at 905-723-5271 or 1-888-247-2201. A special group rate of $109.99 + tax per night is available on the nights of October 5 & 6 if booked before 2014 September 6. Refer to "Canadian Nuclear Society Course" at time of booking. There is also a Comfort Inn next door, at a special rate of $99.99 +tax per night, if booked before September 6 at 905-434-5000.

Registration

Please register on-line via the link on the CANDU Fuel Technology Course web page, which you can reach directly at http://www.cns-snc.ca/events/2014_fuel_technology_course or via the CNS web site (http://www.cns-snc.ca).

The registration fees are shown below, and include HST (HST # 870488889RT)

- **CNS Member: $720 [Must be a CNS member in good standing]**
- **Non-CNS Member: $820**
- **Full-time student (CNS member) or CNS Retiree member: $300.**

For registration information, please communicate with:

CNS Office

4th Floor, 700 University Ave. Toronto, ON, Canada, M5G 1X6
Tel: 416-977-7620; Fax: 416-977-8131
e-mail: cns-snc@on.aibn.com

Course contacts (not for registration):

Steve Palleck
Consultant, Advanced Engineering Group
GE-H Canada
Tel: (705) 748-8259
E-mail: stephen.palleck@ge.com

Erl Køhn
Consultant, Fuel Design
AMEC-NSS Tel: (416) 592-4603
E-mail: erlkohn@acanac.net

Canadian Nuclear Society
Société Nucléaire Canadienne

1st Technical Meeting on Fire Safety and Emergency Preparedness for the Nuclear Industry

Delta Meadowvale Hotel & Conference Centre
Mississauga, ON, June 17 – 19, 2015

The 1st International Meeting on Fire Safety and Emergency Preparedness will provide a forum for nuclear professionals to network and communicate changes presently impacting the industry. It is an opportune time as the new standard, CSA N393 Fire Protection for Facilities that Process, Handle or Store Nuclear Material is approved for use. This standard may affect facility licenses as early as 2014. It is expected that CSA N393 will be included in a broader range of facility licences and will replace NFPA 801 Standard for Fire Protection for Facilities Handling Radioactive Materials in existing licences.

Emergency Preparedness is at the forefront of the nuclear industry since the 9.0 magnitude earthquake and tsunami 2011 that resulted in the Fukushima nuclear incident. The CNSC has introduced REGDOC 2.10.1 Nuclear Preparedness and Response to clarify emergency preparedness requirements. This document is now in draft form and has been issued for comments.

The conference is intended to attract participants from various sectors of the nuclear industry relating to power reactors, research reactors, nuclear laboratories, mines, processing, storage and handling facilities, decommissioned nuclear facilities, nuclear medicine and transportation of nuclear materials.

FSEP 2015 – Call for Abstracts

The Technical Program Committee invites the submission of abstracts for proposed presentations pertaining to the topic areas within each of the four conference themes. Abstracts are to be no more than 300 words in length and the deadline for submission of abstracts is **December 15, 2014**. Details will be on the conference website soon, www.cns-snc.ca.

Get engaged: plan to participate as a Speaker, Session Chair or member of the Organizing Team.

Technical Focus

Business Performance and Governance	Human Performance	Technology	Processes and Programs
Regulatory Affairs	Succession Planning	Communication	Nuclear Safety
Codes & Standards	Instructional Systems Development/Training	Event Simulation	Integrating Services
License and Laws	Personnel Safety	EME	Fire Prevention
Organizational Design/Alignment	Human Resources	Fukushima	Engineering Change Control
Management Oversight	Leadership	Emerging Technologies	Business Continuity
Visions of the Future	Ethics	Analytical Tools	Risk Management
Strategies	Human Factors	Fire Protection Systems	OPEX
Business Metrics	Management of Performance Systems	Emergency Response Equipment	Analysis, Evaluation and Measurement

Conference Chair:
Tracy L. Pearce
Atomic Energy of Canada Ltd
Chalk River Laboratories
1-800-377-5995 x 44084 pearcetl@aecl.ca

Technical Chair:
Rudy Cronk
Professional Loss Control
3413 Wolfedale Road, Suite 6, Mississauga, ON
1-800-675-2755 rcronk@plcfire.com

Calendar

2014

June 23-26 **PHWR Safety 2014 / CANSAS-2014**
CNSC, AECL, IAEA, CANSAS
Ottawa, Canada, Lord Elgin Hotel
Contact CNS Office: www.cns-snc.ca
email: cns-snc@on.aibn.com

Aug. 24-28 **19th Pacific Basin Nuclear Conference (PBNC 19)**
Hyatt Regency Hotel,
Vancouver, BC
website: www.cns-snc.ca

Aug. 24-29 **8th International Conference on Isotopes (8ici)**
Hyatt Regency Hotel,
Chicago, USA
website: www.cns-snc.ca

Aug. 24-28 **38th Annual CNS / CAN Student Conference (embedded in PBNC 19)**
Hyatt Regency Hotel,
Vancouver, BC
website: www.cns-snc.ca

Sept. 28-Oct. 3 **Physor 2014**
Kyoto, Japan
For information: CNS office
cns-snc@on.aibn.com

Oct. 6-Oct. 7 **CANDU Fuel Technology Course**
Best West Plus Durham Hotel
For information: CNS office
cns-snc@on.aibn.com

Oct. 26-31 **Nuclear Plant Chemistry Conference 2014 (NPC-2014)**
Sapporo, Japan
website: www.npc2014.net

Nov. 5-7 **3rd International Technical Meeting on Small Reactors**
Ottawa, Ontario, Canada
Ottawa Marriott Hotel
website: www.cns-snc.ca

Nov. 9-13 **American Nuclear Society - Winter Meeting**
Anaheim, California
website: www.ans.org

2015

Feb. 21-Feb. 26 **9th International Conference on Nuclear Plant Instrumentation, Control & Human-Machine Interface Technologies (NPIC & HMIT 2015)**
Charlotte, NC
website: www.cns-snc.ca

Mar. 15-Mar. 18 **7th International Symposium on Supercritical Water-Cooled Reactors (ISSCWR-7)**
Helsinki, Finland
website: www.cns-snc.ca

May 25 - May 27 **4th Climate Change Technology Conference (CCTC-2015)**
Hotel Omni, Mont-Royal
website: www.cns-snc.ca

May 31 - June 3 **CNS 2015 Annual Conference**
Saint John Hilton and Conference Centre
website: www.cns-snc.ca

2015 CNS Annual Conference

Saint John, NB

May 31 – June 3, 2015

The Annual Conference of the Canadian Nuclear Society is returning to New Brunswick for the first time since 2007. See the announcement and first Call for Papers in this issue of the *Bulletin*.

More information about the technical program and opportunities for sponsorship can be found on the CNS website: **www.cns-snc.ca**

Say Whaa...?

by JEREMY WHITLOCK

In the nuclear business one expects to be quizzed about blowing things up or glowing in the dark fairly frequently – these are the things that brand the technology in the public mind.

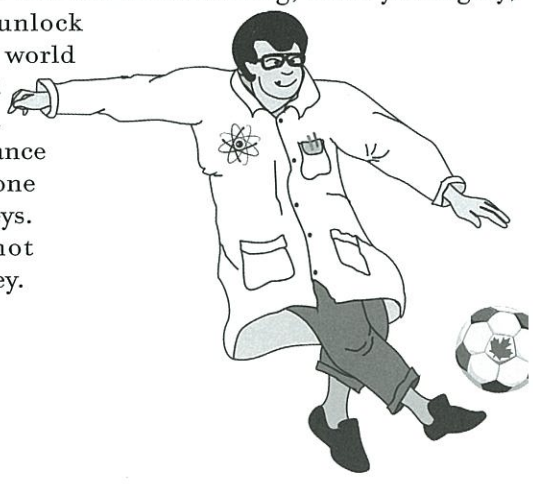
We need a new brand, a "wow" factor – the 30-second TED talk in the kitchen parties of the world that leaves listeners brimming with factoids they can't wait to share with an unsuspecting spouse or bowling buddy. The "Say Whaa..?" at the water cooler that leads to repetition and the spread of cool ideas!

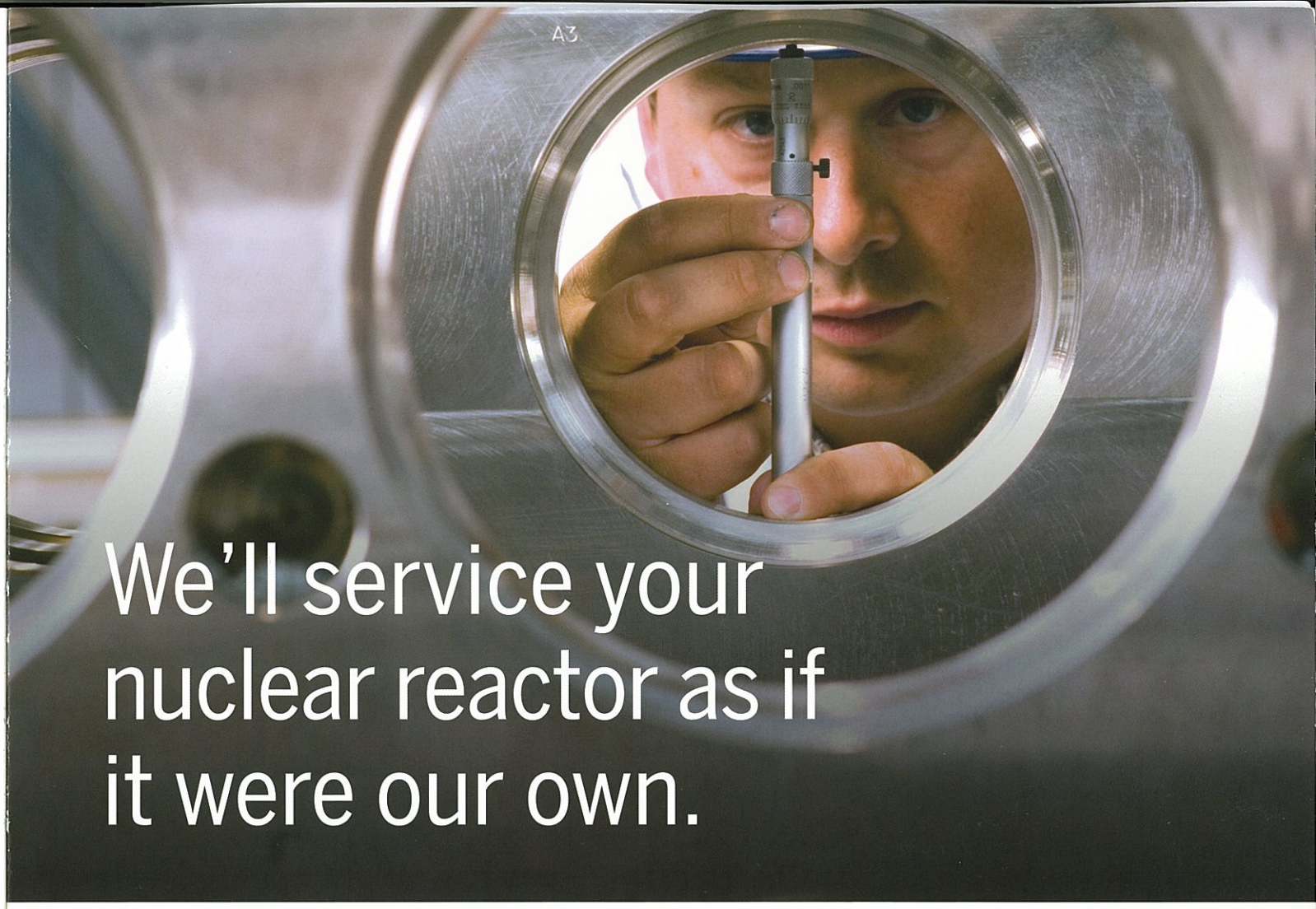
Fortunately there is ample fodder for this exercise: as an industry we have never lacked in niftiness – only the gumption to tell anyone about it.

To wit, listed here are a few "did you knows?" that are bound to enthuse and bemuse (and hopefully not confuse):

1. Atomic nuclei are wickedly small, but contain 99% of matter – meaning that we're really mostly empty space. It also means that everything we ever did as a species on this planet, until the middle of the last century, involved less than 1% of the energy around us. It took a global war to goad us into unlocking the remaining 99%, and even now we've only barely tapped that available potential.
2. How small? Those nuclei are so small that if we expanded, say, a uranium nucleus to the size of a soccer ball (which is convenient for demos since each of the 238 protons and neutrons would be the size of a ping-pong ball), then the nearest-neighbour nucleus would be about 6 km away. Say whaa..? And now imagine a ping-pong neutron drifting around in that vast empty space, unattracted in any way to the soccer ball in the centre. It's a wonder reactors work at all...
3. But man, do they work! So efficiently that a family's entire waste footprint, over everyone's entire lifetime, if all electrical needs were obtained from uranium alone, is the size of a fire log. And even then less than 1% of the potential energy of that "waste" has been utilized, making it more "slightly used fuel" than "waste".
4. And the family's fire-log-sized footprint doesn't go anywhere: solid and small, it is readily stored – currently on-site at each of the reactor plants, but even if stacked like cordwood in one place, all the "slightly used fuel" generated since 1962 would still only fill a single soccer field to the height of a player. This is approximately half the volume of garbage generated by the city of Toronto each day. Say whaa..?
5. What's more, dealing with the "slightly used fuel" in perpetuity (whether or not we as a species decide to extract the remaining 99% of energy from this material) is not the most complicated environmental stewardship humans will have to undertake. Nature herself is adept at isolating radioactive materials from the biosphere, which is the reason that concentrated uranium ore bodies still exist in the earth's crust in the first place, millions and often billions of years after they formed. And the most concentrated ore bodies in the world, in Saskatchewan's Athabascan Basin, are surrounded by enormous groundwater flow. We borrow the radioactive uranium from nature, use a fraction of its energy to make electricity and other products, then return it to nature in engineered repositories more robust than the environment in which it was found. That's the plan anyway; we're in no rush and have time to do it right.
6. Other products? What other products? Well how about pharmaceuticals for treating and diagnosing disease. After World War II Canada found itself with the planet's second-largest nuclear infrastructure, and the world's most powerful research reactor – which we used to pioneer both nuclear medicine and cancer beam therapy. Canadian visionaries like Dr. Harold Johns and Dr. Sylvia Fedoruk carried the torch lit by Marie Curie, whose own driving passion (to her own detriment) was finding ways to use radiation to cure disease.
7. In fact, nature has been using radiation to keep us alive since forever – not just at low environmental levels that stimulate our immune systems, but also distributed throughout the earth's interior, where the heat of uranium and thorium decay maintain the planet's magnetic field that makes all life on the surface possible.
8. These wheels were put into motion by extraordinary Canadian leaders, during a time of massive upheaval, when the science of nuclear fission was still being figured out, with a simple "Okay, let's go" – the same resolve that carried Canadians onto Juno Beach a couple of years later. The leadership of the day sensed that this nucleus thing, small yet mighty, would unlock a new world and that Canada had a chance to hold one of the keys. Let's not lose the key.

Say whaa..?





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Our history of developing and designing reactors to produce safe nuclear energy dates back over 50 years. With such breadth of experience comes a level of expertise that proves invaluable in servicing both heavy and light water reactors.

Candu Energy is a choice that makes sense, from a reliability, innovation and business standpoint.

In our capacity as an original equipment manufacturer and through our affiliation with AECL, we offer a full suite of engineering and field services solutions that meet the highest safety and regulatory standards.

Look to Candu Energy for both heavy and light water plant management programs, life extension projects, as well as a full range of operational and maintenance services.

We design and build nuclear reactors. It just makes sense that we're the best choice to service and maintain them.

www.candu.com

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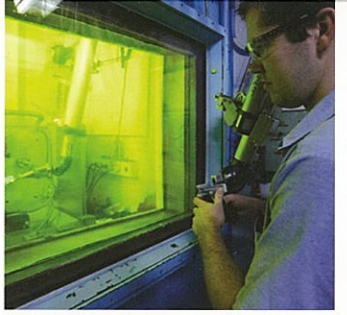
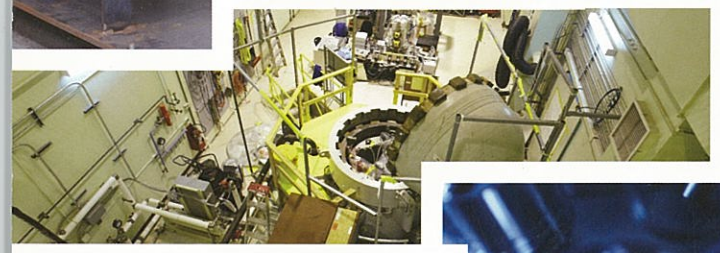
Powering prosperity.

AECL can help advance the innovatio
agendas of industry and academic partner
We welcome opportunities to collaborate

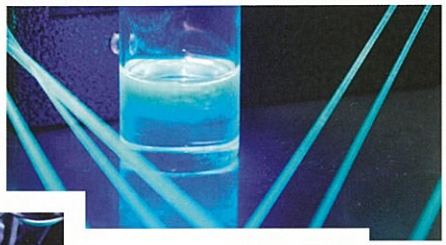
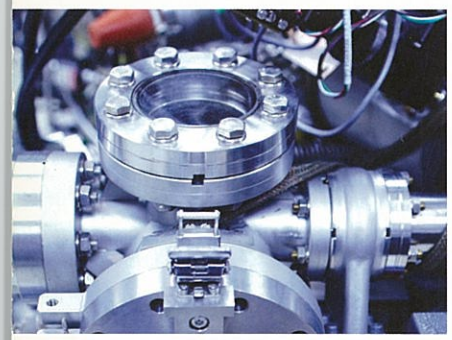
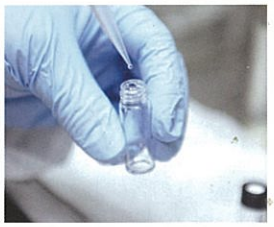


EACL peut aider à faire progresse
les projets en innovation de se
partenaires au sein des industrie
et des universités

AECL
EACL

Laboratoires de chimie analytiqu
Biofouling and Biocorrosion Facilitie
Installation de recherche en biolog
Co-60 Gamma Irradiation Facili
Core Disassembly Facili
Delayed Hydride Cracking Facili
Laboratoire de tritiu
Fission Products Behaviour Laborator
Laboratoire de diffraction des rayons
Confinement de substances réglementée
Fuel Development Branc
Installation de fissuration par hydruration retardé
Health Physics Neutron Generato
Installation de radiographie numériqu
High Pressure Water Test Loop Facilitie
L'irradiateur Gammacell 220 au cobalt 6
High Temperature Fuel Channel Laborator
Simulation dynamique GEANT
Large Scale Containment Facili
Laboratoires d'essais mécanique
Laser Dimensionin
Laboratoire de développement de modèle
Recycle Fuel Fabrication Laboratorie
Installations d'essai des crépine
Van de Graaff Accelerator Facili
Laboratoire de thermohydrauliqu
ZED-2 Research Reacto



... et plusieurs d'autres / and many mor

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