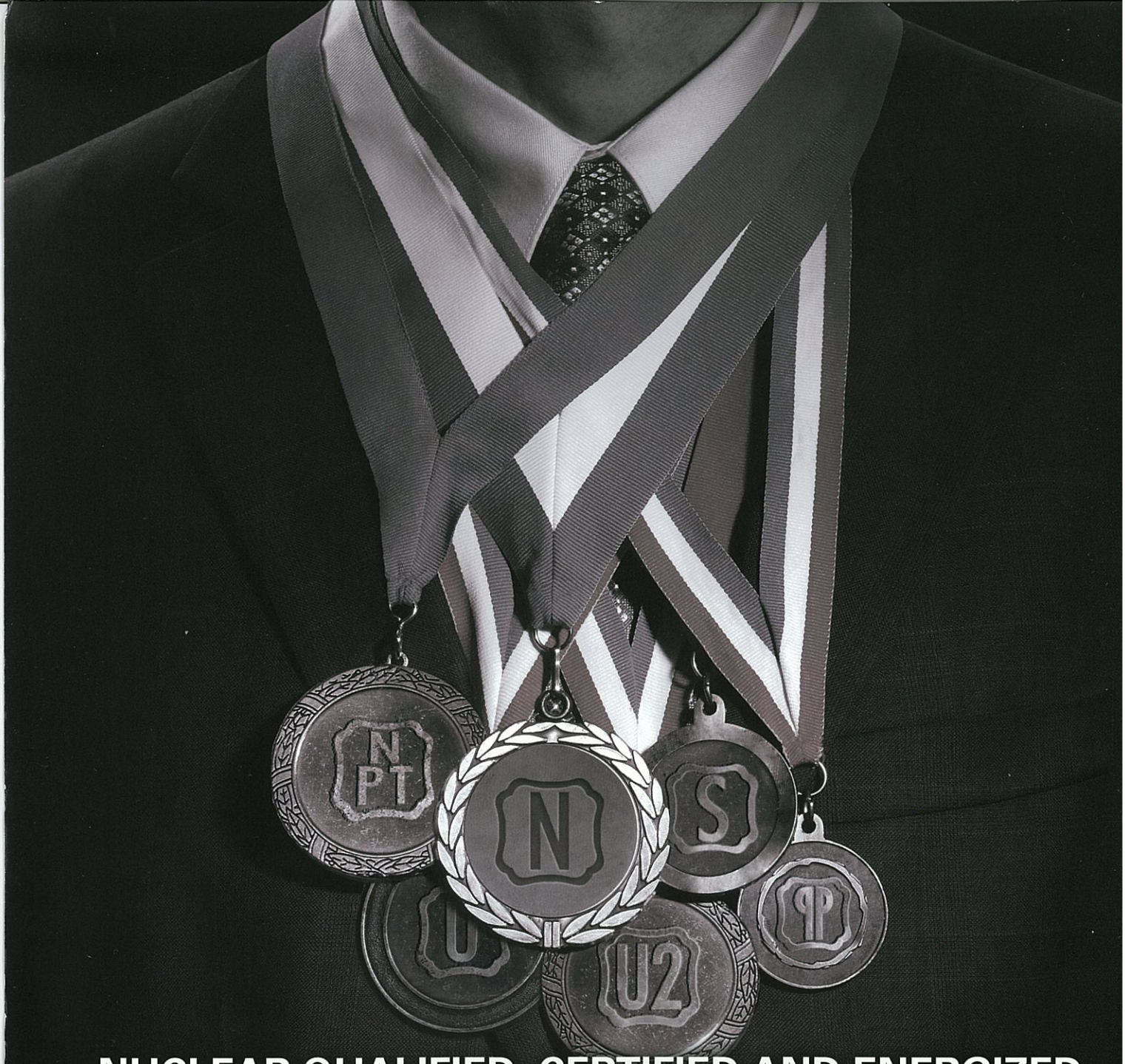
CANADIAN NUCLEAR SOCIETY

Bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

JUNE 2013 JUIN VOL. 34, NO.2

- CNS Annual Conference
- Honours and Awards
- CNSC hosts IAEA Regulatory Conference
- Accidents, Black Swans and Risk
- Early Canadian Research on Thorium



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Clowns and Jokers: Rationalizing the Irrational

The Ontario Power Authority was set up by the Liberal party in 2005 to provide integrated power system plans for Ontario. None has ever been implemented. It is very probable that the system planning engineers came up with rational and affordable long term energy plans. Instead, however, they were "directed" by the Liberals to implement the government's Long Term Energy Plan under the guise of the Green Energy Act. What we got was terribly expensive contracts with private corporations to produce electricity from giant wind farms and gas generators.

The privately owned wind and gas corporations are reaping huge profits while our public crown corporation takes a loss in revenue as well as a loss in asset value by shuttering their most manoeuvrable plants. To add insult to injury caused by the skyrocketing electricity bills, the Liberals added an 8% tax on electricity. While the Auditor General estimated rates would rise 46% by 2015, the Liberals had the gall to call a 10% rebate a "clean energy benefit". And where are those 50,000 new jobs that the Liberals promised with the Green Energy Act?

The cost of bad political decisions is normally paid for by taxpayers, but the cost of the electricity screw-ups is being paid by electricity users, and it's hurting everyone. The recent rate hike approved by the Ontario Energy Board includes the cost of cancelling the Oakville gas plant. That's one email that the Liberals cannot delete.

It may be rational to install wind turbines in certain regions where there is a steady supply of wind, such as northern Ontario or on the Atlantic and Pacific coasts. Instead, the Liberals have installed them in the farmlands of southern Ontario, where winds are very intermittent. Furthermore, the output from these wind farms is low during high demand. This has caused nuclear units at Bruce B to shut down (due to so-called Surplus Base Generation), and when a reactor is shut down it takes two or three days to start up again. Meanwhile, expensive gas picks up the load when demand increases while cheap and reliable nuclear units remain idle.

Could the Liberals possibly screw things up even more? The technical problem is dispatching generators to reduce power when demand is low, and increase power when demand is high. To accommodate the generators who cannot be readily dispatched (nuclear), wind and gas will now be dispatched to avoid longer term unavailability of nuclear. Dispatching wind was not allowed in the contracts, so they will now be paid "nameplate" generation (the maximum rated output of a generator) even if the wind does not blow. That is, they will be paid more than for the power they actually produce!

There are jokers to the left of me and clowns to my right ... Can we ever elect a rational government?

In This Issue

Our 2013 Annual Conference attracted some 400 delegates as well as a surprise visit form the Honourable Minister of Natural Resources Canada, Joe Oliver. In addition, the CNSC hosted the IAEA Regulatory Effectiveness Conference. These events as well as the EIC 3rd Technical Conference on Climate Change are reported in this issue of the Bulletin.

We have a new Executive Council following the CNS Annual Meeting in June. In the CNS News section the new executive is introduced along with the annual reports from our Branches. Because a number of role changes have not yet been determined, the usual "Council" page will not appear in this issue.

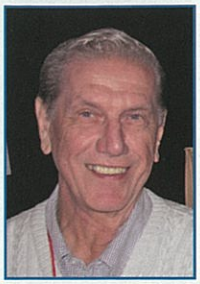
We have an interesting historical account of Canada's R&D in the 1940s on nuclear energy from Thorium by CNS member Mike Attas. Today, world interest in Thorium has increased due to its abundance and some advantages it has over Uranium (see General News).

Two papers from the Annual Conference are included that provide insights into risk. "Accidents, Black Swans and Risk", by John Luxat looks at a new approach to addressing incidents having very high consequences, and "Post-Fukushima Focus on Fire Protection" by Shanker and Rawlingson looks at the challenges in addressing fire issues.

As usual, Jeremy Whitlock has provided an interesting Endpoint. Risk and safety is a common theme in the Bulletin and Jeremy takes a look at the softer side of safety.

Summer is now upon us, kids are out of school, and the beach is looking pretty good. This is a time to enjoy the outdoors while keeping a focus on safety. Splash, laugh and paddle, but don't forget your sunscreen and PFDs.

From The Publisher



Society Activities

The past couple of months have been active ones for the Society, especially for the Council and the organizers of the Annual Conference.

Continuance

First there was the continuing activity towards the transition from incorporation under the Canadian Corporations Act (CPA) to "continuance" under the new Canadian Not for Profit Corporations Act (CNPA).

The first formal step has been taken through a motion passed at the Annual General Meeting (held Sunday, June 9, 2013 immediately before the opening of the 2013 Annual Conference) to modify membership to just one class as required under the new CNPA. That needs to be filed under the existing CPA. Once that is formalized (expected quickly) then a further motion is required to request what is called "Continuance" under the CNPA.

This is a formal, legal process and will have little or no real impact on the operation of the Society but will make it easier to modify our internal By Laws in the future.

CNSC Intervention

Second, was the precedent setting decision to "intervene" at the second day public hearing of the Canadian Nuclear Safety Commission (CNSC) on the application by Ontario Power Generation (OPG) to renew the operating licence for the Pickering Nuclear Generating Station. The CNSC and OPG suggested the Society should do so and legal advice sought by John Roberts, then President, affirmed such an intervention would not be considered "lobbying".

The opening remarks by John Roberts are printed in the CNS News section. They, and the excellent brief prepared by Secretary (and Yearbook Publisher) Colin Hunt, will be posted on the CNS website.

Annual General Meeting

As mentioned above, the 16th Annual General Meeting of the Society since incorporation was held June 9, with the usual minimal attendance, requiring proxies to meet the quorum requirement. This is not unusual for corporations but for organizations that are reputedly representative of a large number of individuals it is, to me, very unsatisfactory.

Given the capability of modern electronic communication many similar groups have gone to electronic voting. It is not a panacea but does allow for a broader expression of opinion and, generally, precludes the situation of a pre-chosen list being accepted without a vote (as happened again at this year's AGM.)

Annual Conference

Turning to a positive observation, this year's CN Annual Conference was among the best held by th Society. And it was all done by volunteers. Adriaa Buijs and his large team deserve great praise for puttin together an interesting and very well run event.

Although the Plenary program, chaired by Walte Thompson, had more speakers than usual, amazingl almost all of them stayed within their restrictive time allo ments while presenting interesting views. Dorin Nichit and his committee organized a full set of high quality tech nical papers (which will be available on a CD) while Eri Williams and Ann Greve managed to obtain substantia sponsorship and exhibit participation despite the curren state of the Canadian nuclear program. And, of course behind the scene, Ben (and Denise) Rouben kept th many obvious but essential elements, such as projector for all of the technical sessions, running smoothly.

Canadian Nuclear Program

In some ways this has been an active period for th nuclear program, or, at least for announcements. Th Minister of Natural Resources Canada, Joe Oliver, chos the CNS Annual Conference to announce two majo initiatives of the federal government – one on a long overdue major revision to the Nuclear Liability Act – th other on Canada's intention to sign an internationa agreement on trans-national nuclear events.

The Canadian Nuclear Safety Commission held its secon day meeting on the extension of the Operating Licence fo the Pickering NGS. For the first time, the CNS Counc decided to intervene as the Society (as reported in the CN News section. The submission appeared to be well receive by the members of the Commission.

At the end of June, too late to be reported in thi issue, Ontario Power Generation reported that they ha received the detailed submissions from Candu Energ and Westinghouse for the provision of two new nuclea units to be located at the Darlington site. As has bee noted elsewhere, the final decision on such a projec rests with the Ontario government.

The front end of the fuel cycle is moving ahea with the announcement that the Canadian Nuclea Safety Commission has issued a licence to Camec Corporation for the construction and operation of th Cigar Lake mine. It is gratifying to see that the man difficult geological problems faced by Cameco for thi rich deposit have finally been overcome.

Summer greetings to all.

Fred Boy

All the views expressed above are strictly personc and should not be attributed to the CNS Council or an member of it.

Contents

~ Cover Photo ~

View of the McMaster Nuclear Reactor, showing the characteristic blue Cherenkov radiation around the reactor core.

Photo courtesy of McMaster University

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The Canadian Nuclear Society
655 Bay Street, 17th Floor
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Telephone (416) 977-7620
Fax (416) 977-8131
e-mail: cns-snc@on.aibn.com

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.

Editor / Rédacteur
Ric Fluke
Tel. (416) 592-4110
e-mail: richard.fluke@amec.com

Publisher
Fred Boyd
Tel./Fax (613) 592-2256
e-mail: fboyd@sympatico.ca

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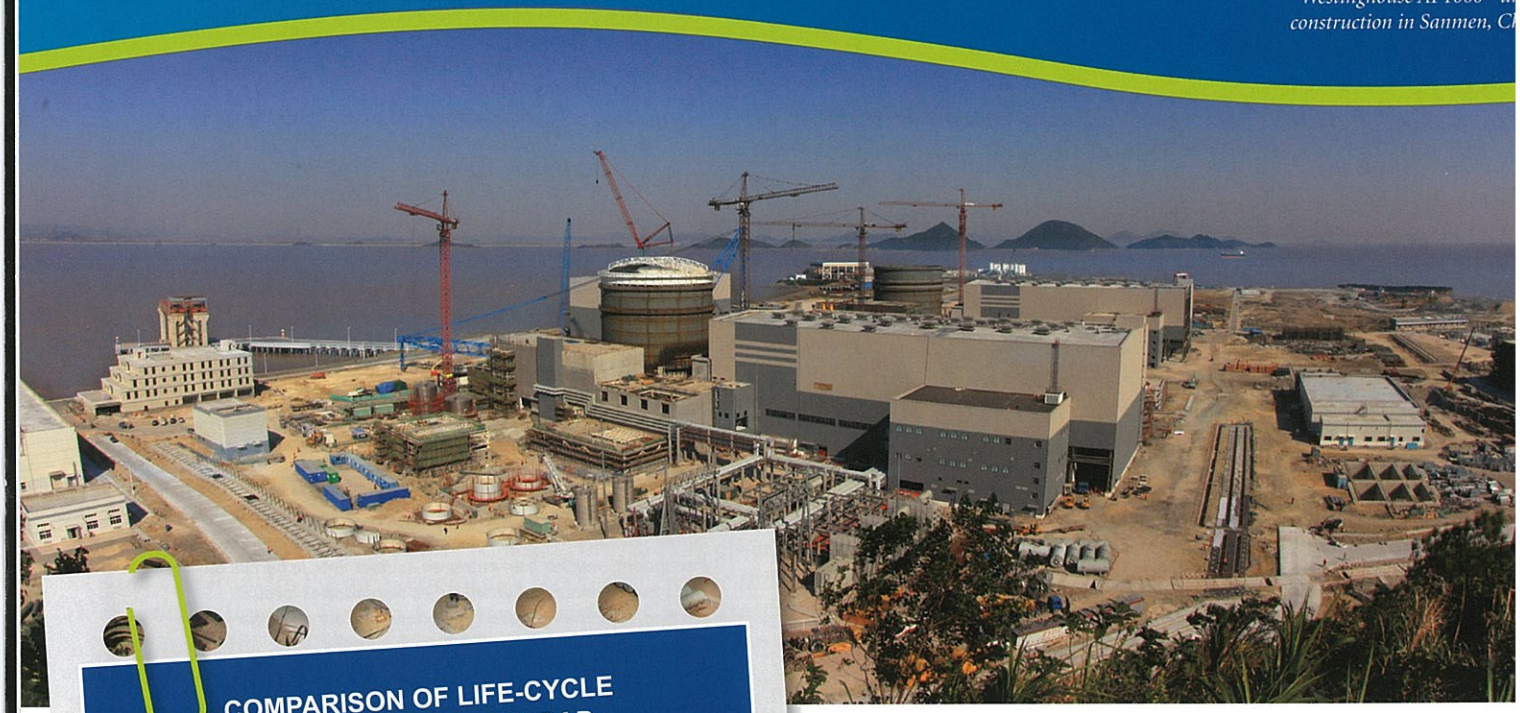

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CNS 2013 Annual Conference draws strong participation

Minister of NRCan chooses venue to make important announcement

by FRED BOYD

The program of the 2013 Annual Conference of the Canadian Nuclear Society actively engaged the 400 participants in the many facets of this well-run event. Held at the Marriott Eaton Centre hotel in downtown Toronto, June 9-12, 2013, the conference combined excellent plenary speakers, a full set of technical papers, challenging student poster competition, interesting exhibits, extensive refreshments and meals and a special night out at Casa Loma, Toronto's famed "castle".

At the opening reception on the Sunday evening the recently appointed Minister of Research and Innovation in the Ontario government, **Reza Moridi**, extended a welcome to the delegates. An engineer who has worked in the nuclear field, Moridi noted the potential for nuclear power around the world and praised the skills and capacity of the nuclear community in Ontario.

The conference program for the Monday morning was modified to respond to a request from the Minister of Natural Resources Canada to make an important announcement. *(See below.)* While waiting for the Minister to arrive, the scheduled program began with the first plenary session, on the theme *Nuclear Power - a Business Driver for the next Generation*.

As "honorary" conference chair, **Duncan Hawthorne**, President, Bruce Power, offered a few "off the cuff" comments from his role as President of WANO (World Association of Nuclear Operators). There are three "camps" in WANO, he said; those building plants (Asia); those planning (Asia and elsewhere) and those focussing on life-extension (North America). In Ontario there is now surplus generation capacity, he noted, so no new plants are likely in the foreseeable future. The job now is to operate well and make sure nothing goes wrong, he stated in closing.

The first plenary speaker was **Don Hoffman**, V.P., President-elect, American Nuclear Society and President, EXCEL Service Corporation. He noted that the USA generates more than 4,000 billion kilowatt-hours of electricity each year but only 19 percent is from nuclear. Coal provides about 60 percent. The abundance of low-cost natural gas from the "fracking" process is changing the situation. Nuclear is the most regulated energy source, he stated, and there is no waste repository, no national energy policy and many misleading statements about nuclear in the public media. In closing he commented that it is unlikely that new nuclear plants will be built in the USA in the near future.

Robert Walker, President, Atomic Energy of Canada Limited, spoke about the new focus for AECL's Chalk River Laboratories (CRL), which had been formally announced at the annual conference of the Canadian Nuclear Association in February. *(See the report in the March 2013 issue of the* CNS Bulletin.*)* While the emphasis for CRL will continue to be on science and technology, he said, that must be connected with the business community. The federal government has accepted its responsibility for historic and legacy radioactive waste which will be a major program. The science and technology program will be on a cost recovery basis. We need new investment and new investment models, he commented in closing.

At that point, the Minister of Natural Resources Canada, **Joe Oliver**, arrived and Walker turned to introduce him.

Oliver began with a quick review of recent events in the nuclear arena beginning with the restructuring of AECL's Chalk River Laboratories and the emphasis on cost-sharing. Then he turned to his announcement. New nuclear liability legislation will soon be introduced that will increase the liability of nuclear plant operators from the current $75 million (that was established 40 years ago) to $1 billion for consequences of events causing harm outside the plant boundaries. He noted that there had been extensive consultation with all of the stakeholders. Nuclear plant operators will continue to be totally responsible.

Canada will also sign the convention of the International Atomic Energy Agency for trans-border consequences which is not yet in force, awaiting the required number of signatories.

In closing Minister Oliver commented that there have been no claims under the existing Nuclear Liability Act.

At that point the plenary session continued, with the final speaker of the first part, **Jonathan Dart**, British Consul General, Toronto, who spoke about the plans for new nuclear units in the United Kingdom. The government is currently reviewing designs from

Westinghouse (AP 1000) and EDF / AREVA (EPR) and is expecting an application from Hitachi. The Generic Design Review process takes about three years, he said. There is a possible role for CANDU, he commented, but the UK would expect support from the Canadian and/or Ontario governments.

After a short break, the second part of the first plenary session began.

Sermet Kuran, Director, AFCR and Fuel Cycles, Candu Energy Inc., noted his company's program with China on the use of CANDU for recycling depleted uranium together with thorium. Minimal design changes are needed for CANDU units to use different fuels, he noted. He mentioned a 24 month Advanced Fuel CANDU Reactor (AFCR) project together with China National Nuclear Company with a target completion of 2014.

Next was **Chen Mingjun**, Technical Director, CNNO Plant #3, TQNPC, China. He began by noting the Chinese reaction to the Fukushima event of March 2011. The country's National Nuclear Security Administration conducted a thorough review and decided to continue the nuclear program. The CANDU units at Qinshan, he noted, had shortened the length of their periodic shutdowns. Four partners, three in China plus Candu Energy, are involved in a study of new fuel cycles. The Qinshan units are likely to begin using NUE (natural uranium equivalent) fuel in 2014. In closing he commented that there are several steps towards building new CANDU units in China but it would need Canadian cooperation.

A change of focus was offered by the next speaker, **Gary Newman**, Chief Engineer and Senior Vice President, Bruce Power. He offered a quick review of the industry response to the requirement by the Canadian Nuclear Safety Commission (CNSC), following the Fukushima event, to review the Design Basis and Beyond Design Basis criteria for existing Canadian plants. The industry response included: emergency water for the steam generators; emergency electrical supply to key loads; additional piping for the fuel storage bays; improved emergency plans combined with more drills and new emergency management centres.

Fred Dermarkar, Vice President, Engineering Strategy, Ontario Power Generation, continued the theme of industry response to CNSC requirements, with a focus on organizational changes. A framework for accident prevention, control and management has been developed. It has been recognized that a new approach is needed; from rule-based procedures to knowledge-based accident management. However, important as that action is, he emphasized that it is essential to concentrate on daily performance of the stations.

The final presenter in this opening plenary session was **Neil Mitchell**, Vice President, Refurbishment Engineering, Ontario Power Generation, who outlined the plans for the refurbishment of the four units Darlington. There are three phases to the proje he said, initiation; definition; execution. The or nization for the project involves four componen refurbishment engineering; nuclear safety; engine ing services; engineering projects. A full scale react mock-up will be built. This is a very complex proje he stated, and a challenge in "getting the scope right

At the luncheon the first day the *W. B. Lewis Lectu* was presented. This lecture series, sponsored a arranged by AECL, was established a number of yea ago in memory of Dr. W. B. Lewis, who was the scie tific head of AECL from 1946 to 1973 and very infl ential in the development of nuclear power in Canad

This year's lecturer was **Dr. Nig Lockyer**, Laboratory Directo TRIUMF. He titled his presentati *From Higgs (Boson) to Mass.*

The observation of the Higgs Bos at the CERN Large Hadron Collid (LHC) earlier this year he said was t "discovery of the century". It show that interacting with a Higgs field how elementary particles have mass. He comment that there were six authors of the initial paper but t name of Higgs became prominent. At the end of h fascinating but challenging talk he closed with a vid extract from the TV series *Big Bang Theory.*

That afternoon, Tuesday morning and Wednesd afternoon were devoted to technical presentations.

The format for the technical program involved ea period having three or four parallel sessions. The se sion titles were:

- Reactor and Radiation Physics
- Environment and Spent fuel Management
- Operations and Maintenance
- Fusion Science and Technology
- Advanced Reactors and Fuels
- Plant Life Extension, Refurbishment and Aging
- Safety and Licensing
- Chemistry and Materials
- Thermalhydraulics

A CD of the technical papers will be available fro the CNS office.

That evening, conference attendees were bussed Casa Loma for the conference banquet or, as it w billed, "Fun Night". Most of the delegates had not v ited this castle-like mansion, built by Sir Henry Palle in the years immediately preceding the First Wor War, and thoroughly enjoyed the ambiance of this fa cinating building and the excellent dinner.

Presentation of the *Canadian Nuclear Achieveme Awards*, sponsored jointly by the Canadian Nucle Association and the Canadian Nuclear Society w

conducted following the Tuesday luncheon. *See the separate report in this issue of the* CNS Bulletin.

The second Plenary session, held on the Tuesday afternoon, was divided into two themes. On the theme, *Licensing – the Next Generation*, the first presentation was by **Ian Grant**, formerly of the CNSC but for the past few years serving as Director, Nuclear Safety Department, Federal Authority for Nuclear Regulation (FANR), United Arab Emirates.

He noted that the UAE had decided to augment its oil resources with nuclear. For its first plant it chose the Korean Advanced Power Reactor, APR 1400. The country set up the FANR following guidelines of the International Atomic Energy Agency. FANR may issue regulations and licences. Four licensing steps are involved for building the plant: Site Selection; Site Preparation; Limited Construction; Construction. UAE has adopted a comprehensive regulatory framework based on IAEA guidelines and has made a long-term safety commitment.

A different view of nuclear regulation in emerging countries was given by **Neil Numark**, President, Numark Associate Inc. He focussed on the role of technical support organizations in assisting countries initiating a nuclear program. With reference to the IAEA Guide GSG-4, he emphasized that the nuclear regulatory authority must possess a basic technical capability.

Coming back to Canada, **Marcel de Vos**, Senior Project Officer, CNSC, spoke about some of the special challenges of regulating small and medium reactors (SMRs), especially for remote locations. Among the challenges is the fact that a number of the SMR designs are not water cooled and are proposed to operate with little or no on-site staff. However, he stated that the Canadian nuclear regulatory approach is flexible and the small SLOWPOKE reactors have been licensed to operate without an operator present.

Peter Hastings, from Generation mPower LLC (a subsidiary of Babcock & Wilcox), reported they are well into detailed design of a 180 MWe plant, which, he said, they had decided was the optimum size. The company plans to submit it to the USNRC next year. The reactor would be placed underground. .

The final presentation in this session was by **Jay Harris**, an independent consultant, who titled his talk *Nuclear North of 60*. He spoke of the particular challenges and opportunities for SMRs in Canada's north. A sub-title for his presentation, he said, could be *Total Energy Supply for Remote Human Habitations.* He emphasized the need for energy sources in the north and proposed that nuclear was a rationale choice.

After a break the plenary session resumed on the theme *Maintaining Operational Excellence for the Next Generation.*

Leading off was **Gaetan Thomas**, President and CEO, New Brunswick Power, who began by noting that last December, the Point Lepeau station completed its 4½ year refurbishment. "Now, we must operate and manage for excellence", he stated. As well as operating safely and producing predictable power, Point Lepreau must re-establish trust with the public, he added. He stated that he expected Point Lepreau to run safely and predictably for the next 25 years.

Steve Ramjist, Director of Operations and Maintenance, Darlington Nuclear Generating Station, Ontario Power Generation chose the title *Building Capability: Beyond Knowledge Transfer.* He referred to a guide from INPO (Institute of Nuclear Power Operations) on a Vision and Plan for Excellence, which has two key directives: Invest in the Plant and Invest in Human Capital. Referring to the generational change that is occurring he commented that the challenge is more than technical transfer. Managerial skills must also be developed.

Rounding out the session, **Gary Newman**, of Bruce Power, gave a presentation on their Asset Management on behalf of Phil Wilson, Bruce VP, Corporate Strategy and Business Development, Program who was unable to attend.

The first requirement, he said, is to understand the assets. Then he outlined the need for refurbishment which involves outages for major component replacement, such as installing and replacing bulkheads; replacing calandria and pressure tubes; replacing feeders and possibly, such as the case for Units 1 and 2, replacing steam generators;

On the Wednesday morning a special presentation was added prior to the final plenary session,.

Professor **Haruki Madarame**, former Chair, Japanese Nuclear Safety Commission, was scheduled to speak about the Fukushima Daiichi accident at McMaster University the following day and agreed to present a shorter version to the conference.

In a remarkably frank talk he acknowledged that the nuclear regulatory system in Japan had been obsolete and ineffective. The lack of preparedness led to confusion when the Fukushima event occurred. He noted that he had been appointed Chairman of NSC just ten months prior to the accident. An IAEA report of 2007 had noted "organization problems" but little had been done in response.

He provided a "snapshot" of a meeting in the Prime Minister's office shortly after the accident. There was no clear chain of command, he stated. When the Prime Minister asked him if there was likely to be an explosion such as at Chernobyl he replied "no" because he had been informed the units were shutdown. Then the hydrogen explosion in Unit 1 occurred and he was accused of giving bad advice. In closing he said that accident planning and exercising involving all relevant organizations was essential.

Then the meeting returned to the scheduled session, entitled, *Competency Assurance for the Next Generation*

with the first speaker **Basma Shalaby**, President of UNENE (University Network for Excellence in Nuclear Education) and former Chief Engineer at AECL Sheridan Park.

The focus of UNENE is on technology, specifically to maintain knowledge of the design and licensing basis of the current fleet, and support safe long-term operation. She noted that UNENE is sponsoring the development of a CANDU textbook.

Chip Horton, Manager, Training Division, Bruce Power spoke on his company's plans to ensure competency over the next decade. He noted that two thirds of their workforce had joined in the last ten years. He mentioned two special groups that need focussed training. Supplemental staff engaged for outages need training to ensure they are task qualified. Entry level unionized staff need training to develop relationships with their colleagues and be certificated The breadth and depth of the training is evolving in the face of fewer retirements and less recruiting.

A unique perspective from the USA was provided by **Jim Little**, Chairman, Carolinas Nuclear Cluster. That organization was formed in 2008 to bring nuclear-related businesses together to cooperate rather than compete. It now has 54 members, which, he said, has the largest concentration of nuclear talent in the country.

Wrapping up the plenary program was **Tom Henderson**, Director, Information Exchange, Candu Owners Group. The objective of COG's Knowledge Management Program is to capture and retain the distinctive CANDU experience. This includes the extensive CANTEACH program.

Following the luncheon on the Wednesday, the prizes for the student poster conference were presented, as follows:

Undergraduate: **Gilbert Jordan**, UOIT, poster tit
LASER Scanning of Flaws Inside the Pressure Tubes a CANDU reactor

Masters: **Michael Roeterink**, RMC, poster tit
Simulation of Personal Protective Equipment Exposu to Radioactive Particulates

Doctorate: **Suraj Persaud**, U of T, post title: *Evidence of Internal Intergranular Oxidati as a mechanism of Primary Water Stress Corrosi Cracking in Alloy 600*

The conference was organized and presented by large committee of CNS volunteers, chaired by Adria Buijs.

It was supported financially by the following org nizations: AECL, CNA, OPG, Hitachi, B & W, Can Energy, Kinectrics, Bruce Power, Power Worke Union, Westinghouse, CNSC, SNC-Lavalin, AME Tetra Tech, Energy Solutions, Stern Laboratories, C Hitachi. Most of the sponsors also had exhibits.

Other exhibitors were: ANRIC, ANI, Cameco Fu Canberra, Deep Trekker, Consolidated Controls, CTSN EcoMetrix, Fedoruk Centre, Kanata Electronics, Metalo Inspection,Mirion Technologies, NRCAN Canm NAYGN, OCI, RollsRoyce, UNENE, Women in Nuclea

On the Sunday, prior to the opening of the conf ence the North America Young Generation Nucle organization held an all-day Professional Developme Seminar with about 50 attending.

In 2014 there will be no CNS Annual Conferen The usual topics will be merged into the **19th Paci Basin Nuclear Conference**, sponsored by the CN to be held in Vancouver, B.C. 24- 28 August 2014 *(S ad in this issue of the CNS Bulletin)*

Scenes from the Conference

Canadian Nuclear Achievement Awards

Each year the Canadian Nuclear Society joins with the Canadian Nuclear Association to recognize individuals and groups who have made significant contributions to the Canadian nuclear program.

The ceremony for the presentation of the 2013 recipients of these awards took place following the lunch of the second day of the 2013 CNS Annual Conference held in the Marriott Eaton Centre Hotel, Toronto, June 11, 2013

Following are a description of, and criteria for the awards given and the citation for the recipients.

Ian McRae Award

The *Ian McRae Award of Merit* was established in 1976 by the Canadian Nuclear Association in honour of the late Ian F. McRae, the first President of the Canadian Nuclear Association and Chairman of the Board of Directors of the Canadian General Electric Company Ltd.

Its purpose is to honour an individual for substantive contributions, other than scientific, to the advancement of nuclear energy in Canada.

This year the award went to Tom Mitchell, President and CEO of Ontario Power Generation.

Tom Mitchell

Citation

Tom Mitchell has been at Ontario Power Generation since 2002, after an extensive career in the United States. Since Tom became CEO in 2009, the nuclear generating part of the company has achieved several successes, all under a strict safety-first work requirement.

OPG has experienced 12 million work-hours at Darlington, and 8 million at Pickering, without a lost-time injury. At the same time, OPG has achieved exceptional improvements in operating standards. Darlington has received the Award of Excellence from industry peers, the first to receive such an award outside the US, and 3 Darlington units were rated in the top quartile of all U.S. and CANDU units.

OPG project management improved to the point that (for example) vacuum-building outages and the Pickering lay-ups were completed successfully, to schedule and budget. OPG's successes are being put to use in New Brunswick, where OPG personnel have been assisting New Brunswick Power to successfully restart Point Lepreau.

Beyond these substantial accomplishments, Tom

Mitchell has assumed increasing responsibilities internationally. Most notably, he chaired the WANO post-Fukushima Commission, and saw the report unanimously adopted by the industry. With this came an increasing number of speaking engagements. Also, Tom was appointed to the Board of Directors of EPRI in 2012.

Tom Mitchell has truly made a tremendous contribution to raising the Canadian nuclear industry's profile at home and abroad.

Outstanding Contribution Award

The purpose of this award is to recognize Canadian-based individuals, organizations or parts of organizations that have made significant contributions in any field related to the beneficial uses of nuclear energy. These contributions may be either technical or non-technical. There are two categories of the award, one for individuals and another for organizations or parts of organizations.

Dr. Brent Lewis

Citation

Dr. Brent Lewis is the Dean of the Faculty of Energy Systems and Nuclear Science at the University of Ontario Institute of Technology, which he recently joined after an illustrious career as Professor and NSERC / COG / UNENE Industrial Research Chair in Nuclear Fuel at the Royal Military College of Canada.

He has made outstanding contributions to the Canadian Nuclear community, both in his wide-

ranging research and in his training and mentoring of a large number of young professionals to help move Canadian nuclear technology forward in the future. His work in nuclear-fuel modelling and in fission-product behaviour, first at AECL and subsequently at RMC, is recognized internationally for its excellence, rigour and significance.

Prof. Lewis has built up a wide-ranging publication history. He has also made leading contributions in the areas of aircrew and space-crew radiation exposure, and in novel methods of radiation dosimetry. During his years at RMC he built an impressive record in graduating highly qualified personnel for the nuclear community.

George C. Laurence Award for Nuclear Safety

The *George C. Laurence Award for Nuclear Safety* was established in 2012 - named in honour of Dr. George C. Laurence, who was the first full-time President of the Atomic Energy Control Board (now the Canadian Nuclear Safety Commission) from 1961 to 1970. He was a strong advocate of safety throughout his career.

This award is presented to an individual or team to recognize major contributions to the philosophy, science, and application of safety principles for nuclear reactors.

Marc-Antoine Petrilli

Citation

Throughout his long career in safety analysis at Hydro-Québec and as an independent consultant, Marc-Antoine Petrilli has shown leadership in his field, and a commitment to the guiding principles of nuclear safety. Being associated with Gentilly-2 since its startup, Mr. Petrilli has witnessed not only the evolution of safety analysis at a mature nuclear facility, but the evolution of the field of nuclear safety itself. In dealing with these changing requirements he has championed new methodologies and approaches for the industry, while maintaining a healthy respect for the balancing of economic and safe operation.

The respect for Mr. Petrilli's expertise within the industry is evidenced by his participation in numerous working groups and technical committees reviewing safety methodologies, standards, and practices, and developing safety plans. His opinions and knowledge on the administration and execution of sound nuclear safety principles are in high demand amongst his peers.

By contributing significantly to the evolution of licensing rules in Canada, to the resolution of several generic safety issues with CANDU operation, and to the development of safety plans for CANDU refurbishment, Mr. Petrilli has left a lasting legacy in the fi of nuclear safety.

Education and Communication Award

The *Education/Communication Award* was est lished by the Canadian Nuclear Society in 1997.

This award recognizes the recipients for signific efforts in improving the understanding of nuclear s ence and technology among educators, students a the public. Three awards were made, two to individua one to a group.

Dr. Jovica Riznic

Citation

Dr. Riznic of the CNSC has served the nuclear ind try with distinction through his research, writing, a designing courses, and through extensive commu cations on nuclear reactor safety, thermalhydrauli heat transfer and materials lifecycle. Dr. Riznic also a scientific-journal editor. He has served on t organizing committee of several NURETH conferen and, in particular, was the Technical Program Ch for NURETH-14, which was held in Canada in 2011

An avid promoter of risk-informed decision maki Dr. Riznic helped design a course for the CN USNRC, the NEA, and the IAEA, and is on the spe ers' bureau for the American Nuclear Society.

In Canada, Dr. Riznic is on external advisory boa for Ph.D. theses at Carleton University and McMas University. He also is a key contributor to progra that place speakers in middle schools, and a valua coach for summer students during their placement

Through all of these activities and more, Dr. Riz has made a considerable contribution to our und standing of the nuclear industry and the science t makes it safe and reliable.

Dr. Ed Waller

Citation

Dr. Waller is a Professor in the Faculty of Energy Systems and Nuclear Science at the University of Ontario Institute of Technology, and a founding father of two of its undergraduate and graduate programs at UOIT: one in Nuclear Engineering, and the other in Health Physics and Radiation Science. He was also instrumental in setting up the faculty's graduate program.

Dr. Waller started his academic career after being associated for a decade and a half with Science Applications International Corporation primarily as a specialist in threat assessment, health physics, and applications of radiation. Since 2008, he has held the position of UNENE/NSERC Associate Industrial Chair in Health Physics and Environmental Safety.

Throughout his career, Dr. Waller has used his unique expertise in Radiological and Health Physics to effectively communicate and demonstrate how nuclear science and technology can be used to solve technical issues encountered in a wide spectrum of industries. Dr. Waller's goal is to develop a pool of highly trained professionals that will make advancements in the field of Health Physics and its application to the Canadian nuclear industry.

The 2012 AECL Open House Organizing Team

Left to right: Philip Kompass, Cindy Corrigan, Cathy Bennett, Shane Matte, Kristina Tittley, Crystal Donak, Jennifer Sterling, Shelley Rolland-Poruks, Nicole LeBlanc. Pat Quinn is missing from photo.

Citation

On Saturday, August 11, 2012, AECL Chalk River Laboratories welcomed more than 2,000 visitors to its first public Open House in twelve years. AECL's 60th anniversary provided the incentive to tackle the considerable challenges of opening the doors of Canada's largest and most complex scientific complex to the public, within the security and regulatory realities of the new millennium.

As planning proceeded, it became clear that the incentive was personal as well – that employees were eager to share their part of the Chalk River story with family, friends, and the broad public. The scope of the event grew quickly as more departments offered to participate, and employees came forward in droves to help. The Open House surpassed not only original expectations, but the scale of past Open Houses as well, and based on public feedback was an enormous outreach success.

This award recognizes the AECL team that managed the logistics of the day, coordinated the army of volunteers, and worked with departments and facilities across AECL to showcase their unique tools and technologies, as well as those of ten nuclear industry partner organizations. See the names of people on this team under the photo.

Fellow of the Canadian Nuclear Society

CNS members who are appointed *Fellows of the Canadian Nuclear Society* belong to a membership category established by the Society in 1993 to denote extensive contributions to the Society and meritorious service to the nuclear field in Canada.

Dr. Duane Pendergast

Citation

Duane Pendergast joined the CNS in 1982. He served as Co-Chair of the Environment and Waste Management Division from 1999 to2003. He was one of the principal organizers, and Program Chair, of the first CNS Climate Change Conference (October 2001), and a major contributor to the organization of the

2006 and 2009 Climate Change Conferences.

Duane served on the CNS Council from 2008 to 2010. After relocating to his home province of Alberta, Duane organized the CNS Alberta Branch. Under his guidance as Chair, the Branch became one of the most active Branches, contributing extensively and effectively in outreach to both the scientific community and the public sector in Alberta.

Dr. Pendergast holds a PhD. in Mechanical Engineering. He spent four years as Assistant Professor of Engineering before joining AECL in 1974, where he was involved in professional and managerial aspects of CANDU nuclear reactor safety analysis, environmental assessment and reactor licensing. From 1990, he concentrated on issues relating to energy and greenhouse gas emissions. After retirement, he became heavily involved in assisting with the development of the Canadian government's technical response to the Kyoto Protocol.

R. E. Jervis Award

The *R.E. Jervis Award* recognizes excellence in research and development as well as in overall academic achievement by full-time graduate students in nuclear science and technology.

The award was established in 1992 by former students of Professor Robert E. Jervis of the University of Toronto and the CNS to honour his achievements. The award was in the past administered by the University of Toronto, and is now sponsored and administered by the Canadian Nuclear Society. Two awards were presented.

Sahil Gupta

Citation

Sahil Gupta graduated in 2012 with distinction from the Faculty of Energy Systems and Nuclear Science at the University of Ontario Institute of Technology (UOIT) with a Bachelor of Engineering (Honours) Degree in Nuclear Engineering. Sahil is currently a full-time MASc student at UOIT. His research focuses on heat-transfer correlations for supercritical water, the coolant of Canada's Generation-IV nuclear reactor design, and for supercritical carbon dioxide, which is used in supercritical-pressure Brayton gas-turbine cycles in other Generation-IV reactor designs.

His supercritical-water correlation was found to be among the most accurate in predicting heat transfer coefficients at supercritical pressure for water within supercritical sub-regions: the liquid-like, the gas-li and the critical and pseudo-critical regions.

His work related to supercritical CO_2 studies v awarded with the highest student award at the 2(ICONE-20 Conference in Anaheim, USA. Sahil alre has 19 publications on his research – one paper i refereed journal and 18 papers in refereed confere proceedings.

Pamela Yakabuskie

Citation

Ms. Pamela Yakabuskie is a fifth y graduate student in the Chemis Department of Western Univers She has been studying radiation ch istry induced physical chemistry un Professor J. Clara Wren.

Pam is one of the best students at Western, hav been one of the top candidates of her graduating cl and has maintained a high level of academic achie ment as reinforced by her receiving various scho ships including a prestigious NSERC post-gradu doctoral scholarship.

Ms. Yakabuskie's work and reputation led her being invited to address the 27th Miller con ence on Radiation Chemistry (Sweden) and eighth International Radiolysis, Electrochemistry Materials Performance Workshop (Québec). At Gordon Research Conference on Radiochemistry served as co-chair of the Graduate Research Semi Pam also led a collaborative project at the Univer of Notre Dame Radiation Laboratory.

Pam's specific focus has been in the area of so water, and liquid-water, interfacial reaction kine and transport under radiation conditions. This is area of immense value to power reactor operators.

Award winners pose for a group photo. The two women at the centre are Cindy Corrigan and Nicole LeBlanc who accepted the award for the AECL Open House Gro

CNSC hosts IAEA conference on Regulatory Effectiveness

by FRED BOYD

From April 8 to 12, 2013, the Canadian Nuclear Safety Commission hosted a major conference on Regulatory Effectiveness under the auspices of the International Atomic Energy Agency. It was held at the Chateau Laurier Hotel in Ottawa and attracted 275 participants from 55 countries and international organizations.

The full title of the event was *International Conference on Effective Nuclear Regulatory Systems* with a sub-title *Transforming experience into regulatory improvements.* It was convened to discuss nuclear regulatory challenges and lessons learned in light of the Fukushima Daiichi nuclear accident. This was the third International Conference of its kind organized by the IAEA since the initial one held in Moscow in 2006 and one held in Cape Town, South Africa, in 2009. It was the first such meeting since the Fukushima event of 2011.

The conference opened with a Plenary session and Keynote Panel Discussion late afternoon April 8, followed by a reception. The Panel session focussed on Awareness of Safety at a National Level. Chaired by Michael Binder, president of the CNSC, it included representatives from regulatory agencies in China and Germany, the IAEA, World Association of Nuclear Operators (WANO) and World Nuclear Association (WNA).

The next three days were filled with presentations by representatives of national nuclear regulatory organizations and related bodies such as the International Commission on Radiological Protection, followed by panel discussions in which questions were invited from the floor.

There were five topical sessions, two on each of the first two full days and one on the Thursday. On the Friday, a number of delegates took advantage of tours of AECL Chalk River Laboratories or the Nordion complex in suburban Ottawa. Each of the topical sessions consisted of six presentations followed by a panel discussion in which questions were invited from the floor.

The titles of the topical sessions were:

- Regulatory Lessons Learned and Actions Taken
- Waste management and Spent Fuel Safety
- Emergency Management
- Emerging Programs
- Human and Organizational Factors – Safety and Security Culture

After the Tuesday luncheon, Dr. Claire Cousins, current chair of the International Commission on Radiological Protection, spoke on the topic of ICRP recommendations for protection of people during and after a nuclear emergency. She acknowledged that there is a need to consider the associated risks of non-radiation hazards, such as from evacuation.

Following the Wednesday luncheon, the Canadian representative to the IAEA and currently chair of its Board of Governors, Dr. John Barrett, outlined the role of the Board on the broad question of Nuclear Governance.

On the Wednesday evening there was a conference dinner held at the Museum of Civilization in Gatineau, across the Ottawa River from Ottawa. Following dinner the guests were treated with a musical presentation "A musical taste of Canadian heritage" by a group known as Odyssey Showcase.

Holding the conference in Canada was largely the initiative of Ramzi Jammal, Executive Vice President, CNSC. He served as Conference Co-President jointly with Tero Varjoranta, Chairman of STUK, the Finnish Radiation and Nuclear Safety Authority, and also as Chair of the Conference Program Committee.

In his concluding comments Varjoranta commented that nuclear regulators had invested many resources into understanding what happened at Fukushima and why. Much has been done, he said, but much more remains to be done,

Jammal observed that the conference discussions reinforced the importance of openness and transparency in nuclear regulation and the critical role communication plays in maintaining public confidence.

The IAEA secretariat summarized the main conclusions from this conference as:

- Peer reviews must clearly include national action plans and follow-up missions to complete the process;

- While regulators perform detailed assessments of regulatory requirements, systems and processes following significant operational events, they do not have a systematic way of collecting, analyzing and sharing regulatory experience, nor do they routinely assess less significant events and issues which would contribute toward continuously improving the regulatory process;
- Spent fuel pool safety should be reviewed regarding obvious weaknesses in defense in depth and possible new mechanisms to eliminate as far as possible the possibility of serious accidents occurring;
- Emphasizing the importance of communication, coordination and consistency in national and international responses to emergencies, regulators should ensure that national communication plans are developed, tested, implemented and improved well before any accident occurs;
- Introducing a nuclear power program entails a wide range of long term safety and security infrastructure issues, including the establishment of an effective nuclear regulatory system, as well as responsibili that go beyond national borders. Regulators shc use the IAEA peer review process as early as sible, report the results openly and take the nee follow-up actions;
- Projected growth in nuclear power combined v retiring experts will require a workforce with skills necessary to face these challenges. A n consistent, international effort is still needed the IAEA was called upon to take further actions these issues; and
- Regulators must promote a blame-free, but acco able safety and security culture, recognizing humans are fallible and promoting the concep shared accountability - that good system design staff's good behavioral choices together prod good results.

The next International Regulatory will be held 2016 and will be hosted by the European Nuc Safety Regulators Group. The location has not yet b decided.

EIC 3rd Climate Change Technical Conference

Nuclear prominent at Climate Change Conference

By FRED BOYD

Although not on the agenda, nuclear energy was strongly supported by several of the speakers at the *3rd EIC Climate Change Technical Conference* held in Montreal, May 27 - 29, 2013.

Dan Meneley

Nuclear was not explicitly on the program even though the two primary organizers were former presidents of the Canadian Nuclear Society. **Dan Meneley** chaired the Plenary Program and **Eric Williams**, chaired the large Technical Program committee. Nevertheless, the positive role of nuclear was mentioned by several speakers and was noted or referenced in many of the discussion periods.

Eric Williams

The conference, sponsored by the Engineering Institute of Canada, drew about 200 attendees. It was held in two buildings of Concordia University .Plenary sessions were held in the Henry F Hall Building while the technical sessions were n the near-by EV building.

The conference began on the Monday with a keynote address by **Donald Johnson**, former Secretary General of the Organization for Economic Cooperation and Development (which was read on his behalf due to his illness). In his paper he stated that nuclear power must be a necessary component of electricity generation if the emission of carbon dioxide (CO_2), the "greenhouse gas" of most concern, is to be curtailed.

That presentation was followed by the first Plenary session, focussed on *Policy Matters*. The first speaker was **S. de Boer**, Canada's Deputy Climate Ambassador, who spoke of the negotiations under the *United Nations Framework Convention on Climate Change* and the work of the *Climate and Clean Air Coalition to Reduce Short-Lived Climate Pollutants*. A key solution to tackling climate change lies in the development of clean energy technologies, which, he said, includes nuclear.

Next was **Katherine Albion**, of the Canadian Academy of Engineering, who noted Canada has a history of "big (technical) projects. New big projects could continue this tradition, she said, with emphasis on sustainable development and on upgrading our energy resources into value-added products.

Tom Blees, President of the Science Council of Canada, referenced the Council's recent report *Prescription for the Planet* which is available on its website. Turning to the need for water he noted desalination, which requires energy. Then he turned to the current developments for small reactors and mentioned, in particular, liquid-cooled fast reactors which could burn all of the spent fuel from existing water reactors.

Following a break the second plenary pursued the topic of *Food and Population.*

Leading off was **J. Kennelly** of the University of Alberta. Increased food production is essential, he stated, to meet the needs of a growing world population. Although "agro-food" is a major part of the Canadian economy he said there are questions of the sustainability of the existing model.

Chandra Madramootoo, of McGill University, focussed on *Innovation in Water Management.* In the USA, the yield of corn per acre has doubled since 1960, he commented, with much of the increase a result of improved water use. However, the rate of improvement has fallen significantly in recent years. Better water management is needed, he said, along with the development of genomic tools to improve crop yields.

Next was **Rashid Sumalla**, of the University of British Columbia, who spoke on *Potential Economic and Food Security* with a sub-title, *Implications of Warming Oceans.* Climate Change (global warming) will have several negative impacts, he stated, noting smaller catches of fish and decrease of fishing revenues.

Rounding out the first morning plenaries was **Bertrand Derome**, of the Institut de Dévelopment de Produits (IDP). He offered an engineer's view of the climate change issue. There is a need to try to bridge the gap between the UN approach to climate change and that of engineers and scientists, he said. After noting the changes of world temperature over the last 1,000 years he commented that the engineering perspective is typically a century. We have time to adapt, he asserted, but the engineering voice is lost against the volume of the "environmentalists".

Lunch was provided the first day in a university cafeteria. It was followed by a presentation by **Darrel Danyluk**, from Engineers Canada, the national organization of the 12 provincial and territorial associations that regulate the practice of engineering in

Canada and license the country's more than 250,000 professional engineers.

That afternoon saw the first of the several parallel technical sessions. Typically four topical sessions ran at the same time. The technical papers were grouped into the topics listed below: Many of the topics had more than one session. There were 100 technical papers in the program.

- Modelling
- Net Zero energy Buildings
- Engineering for Adaptation
- Education, Program & Strategy
- Engineering for Mitigation
- Advanced Research
- Miscellaneous
- Risk Management
- Canadian Artic
- Alternate Solutions
- Cost Benefits Affordability
- Extreme Events
- Engineering Codes & Standards

Both the Tuesday and Wednesday mornings began with short Plenary sessions of four presentations.

The Tuesday Plenary focussed on *Energy*, with the first presentation being given by **Frank Saunders**, Vice President, Nuclear Oversight and Regulatory Affairs, Bruce Power.

The Bruce Power site, with its eight operating units, is the largest nuclear power facility in the world, he noted. Although the refurbishment of units 1 and 2 ended up being lengthy and expensive, it was worth it, he stated, since they will now produce economic, emission-free electricity for many years to come.

He was followed by **David Layzell**, Director, Energy Systems Analysis, at the University of Calgary. We need a serious debate about energy system choices, he stated. Saying "no" to one technology often means saying "yes" to something else. Assessment of each technology should include cost and benefits over the entire lifetime of the application, he asserted..

Richard Moffett, of Candu Energy, began by noting the role of Montreal in the Canadian nuclear with the Montreal Laboratory from 1942 to 1945 and, much earlier, at the beginning of the 20th century, Ernest Rutherford's Nobel Prize winning research at McGill University, He then turned to outlining the attributes of the CANDU design.

The final speaker of that third plenary session was **Colin Clark**, Chief Technical Officer, Brookfield Resource Energy Corporation. He noted it was formerly Brascan and earlier Brazilian Light & Power. Brookfield has 196 hydro-electric plants in Brazil, Canada and the USA, as well as 11wind farms. Noting the GHG free characteristic of hydro-generation, he referred to a recent report of the International En Agency which highlighted that the world is failin put global energy on a more sustainable path.

A conference banquet was held on the Tuesday ning with the Ambassador of Norway, **Mona Brotl** the guest speaker. After the banquet EIC held Honours and Awards presentation.

The final short plenary session on the Wednes morning focussed on *Water*.

The opening speaker was **Margaret Catley-Carls** former Chair of the Global Water Partnership (GV GWP was founded in 1996 by the World Bank, United Nations Development Programme (UNDP), the Swedish International Development Coopera Agency (SIDA) to foster integrated water reso management (IWRM).

She began by stating there, even without clin change, there is a world crisis with water and f Climate change exacerbates the challenge. Focus on water, she listed the "drivers" of water use: url ization; agriculture; energy production. We h already reached limits, she stated, noting dry r basins, overdraft of ground water, decreasing fish yields. When asked, during the discussion per about the potential of desalination, she denigrated idea, stating that we just must use water better.

Bringing a different perspective was **Kim Sturg** of Alberta WaterSmart, a Calgary based, fee for vice, company committed to improving water man ment in Alberta. Water is an emotional topic, he s especially in the prairies. A basic problem, he sta is poor management. In the arable part of the p ince. Agriculture is by far the greatest user of water to 85 percent in the South Saskatchewan River Reg

David Sauchyn, of the University of Regina, vided a further view of the water challenges of prairies. A basic challenge, he noted, was the g variability of the river systems and compoun that, a trend of decreasing flows. He made a comn that provoked many questions, that the prairie w came from the Pacific Ocean and was affected b temperature.

The final plenary presentation was by **Bi Mergelas**, of Ontario WaterTAP. The name is an a nym for the Water Technology Acceleration Project mandate is to foster world-class water technology b nesses and make Ontario a centre of water excelle He said there are over 900 companies in the secto

The conference closed with an open discussion sion moderated by Dan Meneley which was atter by about 50 delegates. Comments on the confer were exchanged leading to a number of suggestion how to move forward.

It was stated that all of the presentations woul available on the EIC website.

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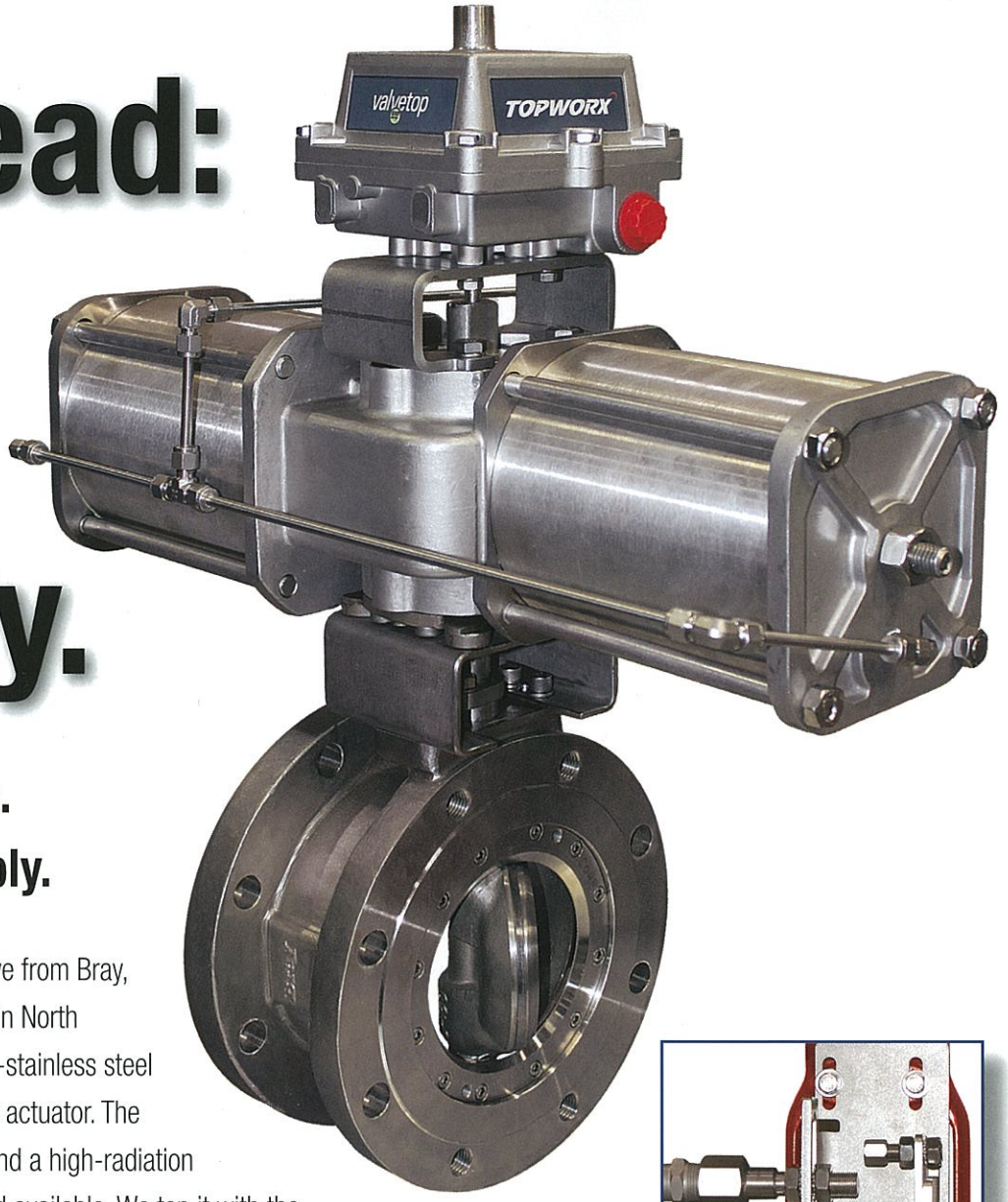

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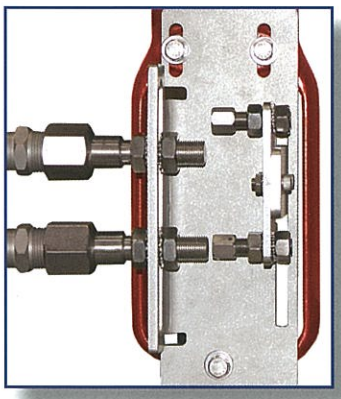

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Dash for Gas: Will Ontario repeat the UK's mistake?

By DON JONES

Ontario's electricity market today is reminiscent of that in the United Kingdom in the 1990s. Cheap natural gas discovered in the North Sea together with the coincident development of combined cycle gas turbines (CCGT) effectively put a stop to any future nuclear build. The "Dash for Gas" had started. The last nuclear plant to be built in the UK was Sizewell B in 1995 but planned follow-on units were cancelled because of the availability of low cost gas-fired generation.

Today the situation in the UK is much different. North Sea reserves of 'natgas' are down and gas prices are very much up. Imported gas will account for 75 percent of all gas consumed in UK by 2015. All operating nuclear units, except for Sizewell B, will be retired by 2023 and coal-fired stations that do not meet the European Union pollution directive will be retired by 2015. All this is likely to lead to electricity shortages in the next few years unless something is done. The UK government's plan is a low-carbon energy mix of nuclear, gas and renewables. However the plan is bogged down by the need to set a price for electricity that satisfies both government and the low-carbon vendors. This means the government may be forced into increasing the proportion of gas-fired generation as a quick fix since it can be online quickly but electricity prices will be high and it makes the country dependent on a risky off shore fuel supply while still producing carbon dioxide and other emissions. The government must now wish that its predecessors had only used natgas to replace those smog producing coal fires that kept British homes warm and not wasted it on electricity generation which should have been the task of nuclear.

Something like the UK of the 1990s Ontario has lots of cheap gas but it's mostly gas from shale deposits fractured by large quantities of very high pressure water, sand and toxic chemicals and not conventional natgas. This controversial 'frackgas' has been said to have the same lifetime cycle greenhouse gas emissions as coal. Despite the present low gas prices the electricity from the gas-fired plants in Ontario's hybrid market is significantly more expensive than that from Ontario's nuclear plants. Frackgas prices will surely rise because well depletion rates are high and drilling rigs are moving on to more lucrative oil exploration, reducing supply and putting CCGT electricity generating costs even higher. The market price of frackgas in some areas is lower than its production costs, a situation that can't last. Increases in the non-electricity generating uses of frackgas, including future Liquefied Natural Gas exports and expansion into road and rail transportation, will lead to increased gas demand, put a strain on pipeline capacity, and, like the UK, make Ontario dependent on a fuel for electricity generation that has long term risks in price and availability.

Something like the UK of today Ontario is facing over 10 years of nuclear shutdowns for refurbishment, and shutdown of all its perfectly good coal-fired stations by 2014. This could put Ontario in an energy crunch even before 2020 when Pickering is shutdown for decommissioning. However unlike the UK Ontario has time to get new nuclear units up and running at Darlington B without the need to expand precarious frackgas-fired generation. Also Ontario has twelve large coal-fired units, four of them fitted with flue-gas clean-up systems that can be used for meeting intermediate/peak loads at low operating cost if the government would reconsider its closure mandate. CCGT plants are parachuted into the province from foreign suppliers and provide a minimum of construction and operating jobs. Alternatively, an EC6 nuclear plant would have a Canadian supply chain and provide thousands of well paid trade and professional jobs.

Once the initial capital investment is made a nuclear plant will be able to provide reliable power at a stable competitive cost for 60 years and likely very much longer. With nuclear and hydro and temporary use of coal until more very flexible EC6 units are on line Ontario would be immune to the inevitable increases in frackgas prices and carbon costs, be immune to fuel shortages, be independent of imports, and be one of the lowest emitters of greenhouse gases in the world. Or does Ontario want to follow the UK example and make the same mistake made there 20 years ago?

Author's note: *Before joining AECL at Sheridan Park in 1967 the author spent five years as an engineer in the Technical Dept. of Orenda Engines Ltd., Malton, Ontario, a company that designed and manufactured gas turbine engines and certainly does appreciate the sophisticated engineering of CCGT units.*

Editor's note: For the full version of this article please see item 27 at http://thedonjonesarticles.wordpress.com/articles/

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Accidents, "Black Swans" and Risk

by JOHN C. LUXAT[1]

[Ed. Note: The following paper was presented at the 2013 CNS Annual Conference, held at the Marriott Eaton Centre hotel, Toronto, June 9-12.]

Abstract

Major accidents and natural disasters with severe consequences have occurred in all sectors of industrial activity with relatively high frequency. The severe consequences of concern involve either significant loss of life or major economic loss, or both loss of life and economic loss. Such events have the last two years been referred to as "black swan" events following publication of Taleb's bestselling book. These events demonstrate limits to PRA application that arise from the underlying high uncertainty associated with the estimation of frequency of occurrence of such events. An approach is proposed in this paper that, consistent with the concept of defense in depth employed by the nuclear industry, augments probabilistic risk assessment with a methodology based upon "threat – risk assessment". This approach shifts these very low frequency high consequence "black swan" events out of the probabilistic risk assessment domain into a deterministic emergency response assessment domain.

1. Introduction

Major accidents with severe consequences have occurred in all sectors of industrial activity with relatively high frequency. The severe consequences of concern involve either significant loss of life or major economic loss, or both loss of life and economic loss. Despite the intense scrutiny that occurs following such events, history would indicate that the occurrence of such accidents may be expected to continue with relatively high frequency. Many of these accidents are initiated by failures in engineered systems or by human actions and are referred to as accidents with man – made origins. The energy sector, in particular, is recognized to be one of the major sources of man-made accidents and disasters [1, 2]. Major accidents have occurred in all areas of the energy sector, including resource extraction, transportation, production and distribution.

Other accidents are triggered by natural disasters that often are compounded by subsequent human actions and errors. Worldwide, natural disaster events are occurring with an apparent increasing magnitude and increasing frequency. This has been attributed by some, particularly in the media and popular press, as evidence that we are currently experiencing an era of significant climate change. Examples which come to mind are, Hurricane Katrina and Hurricane Sandy in USA. However, not all natural disasters are linked to apparent climate change. Some are random in nature and essentially unpredictable, although their location of occurrence is not. Examples of such events are the 2004 Indian Ocean earthquake and tsunami and the 2011 massive Tohoku earthquake and tsunami off the coast of Japan. Both of these events occurred in the seismically active "Ring of Fire" region in the Pacific.

The above observations raise a question: are we merely experiencing a period of "bad luck" or are there inherent technical deficiencies in our risk assessment and accident management response planning methods? This question is addressed in this paper. It is suggested that there are indeed limits in the applicability of probabilistic risk assessment [PRA] to very low frequency, high consequence events. The limits arise from the underlying high, non-quantifiable uncertainty associated with the estimation of frequency of occurrence of such events. Such events have the last few years been increasingly referred to as "black swan" events, following publication of Taleb's bestselling book [3]. A secondary question is: to what extent are lessons learned from severe accidents in all sectors of industrial activity being used to improve safety in a specific sector, such as nuclear energy?

If indeed, as suggested in this paper, there are fundamental limits to the applicability of probabilistic risk assessment, which is an important tool in supporting nuclear safety and nuclear industry, then what can we do to address the deficiencies? An approach is proposed in this paper that is consistent with the concept of defense-in-depth employed by the nuclear industry and which augments probabilistic risk assessment with a methodology based upon "threat–risk assessment". This approach shifts these very low frequency, high consequence "black swan" events out of the probabilistic risk assessment domain and places them into a deterministic emergency response assessment domain. The proposed approach is discussed further in this paper.

1 Professor & NSERC/UNENE Industrial Research Chair In Nuclear Safety Analysis, Department of Engineering Physics, McMaster University

2. Review of Natural and Man-Made Accidents and Disasters

Over the past 30 – plus years, a series of man – made accidents and natural disasters have been experienced worldwide. The extent and magnitude of such ev have been strongly influenced by either human act or inaction. A representative set of events is describe summary form in Table 1. As is evident from this t the accidents and disasters have occurred in a rang

Table 1
Some Relevant High Consequence Accidents and Disasters

ACCIDENT	TYPE	DESCRIPTION
Dona Paz, Philippines 1987	Man-made: Oil transportation	The MV Doña Paz, a Philippine-registered passenger ferry, sank after colliding with the oil tanker MT Vector on December 20, 1987. The Vecto cargo ignited and spread to the Doña Paz. The survivors jumped off the ship and swam in shark-infested flaming waters around the ship. The Do Paz sank within two hours of the collision, and the Vector sank within fo hours. It took 8 hours for Philippine maritime authorities to learn of the accident, and another 8 hours before search and rescue operations wer undertaken. The collision resulted in the deadliest peacetime maritime disaster in history with >4300 deaths.
BP Texas Oil Refinery Fire 2005	Man-made: Oil production	On March 23, 2005, an explosion occurred at BP's Texas City Refinery, th third-largest refinery in the United States. The explosion occurred in a isomerization unit which was overfilled with liquid that overheated, leac to liquid discharge and formation of a ground level vapor cloud. The cloud was ignited by the running engine of a contractor's pickup truck. workers were killed and more than 170 were injured. At the time, this w considered one of the worst industrial accident in US history.
Deepwater Horizon 2010	Man-made: Oil production	On 20 April 2010, while drilling at the Macondo Prospect in the Gulf of Mexico, an explosion on the rig caused by a blowout killed 11 crewmen and ignited a fireball visible from 56 km away. The fire could not be extinguished and, on 22 April 2010, Deepwater Horizon sank, leaving the well gushing at the seabed and causing the largest offshore oil spill in history.
Challenger disaster 1986	Man-made: Aerospace	The Space Shuttle Challenger disaster occurred on January 28, 1986, when the vehicle broke apart 73 seconds into its flight. The spacecraft disintegrated over the Atlantic Ocean, off the coast of central Florida. Disintegration of the entire vehicle began after an O-ring seal in its righ solid rocket booster failed at liftoff. The seven crew members died.
Columbia disaster 2003	Man-made: Aerospace	The Space Shuttle Columbia disaster occurred on February 1, 2003, whe it disintegrated over Texas and Louisiana during re-entry into the Earth' atmosphere. The loss of Columbia was a result of damage sustained dur launch when a piece of foam insulation broke off from the Space Shuttl external tank and struck the leading edge of the left wing, damaging the Shuttle's thermal protection system which shields the vehicle from the intense heat generated from atmospheric compression during re-entry. seven crew members were killed.
9/11 2011	Malevolent act	A series of four coordinated terrorist attacks were launched by the Islamist terrorist group al-Qaeda upon the United States in New York City and the Washington, D.C. areas on September 11, 2001. Two planes American Airlines Flight 11 and United Airlines Flight 175, were crashed into the North and South towers, respectively, of the World Trade Cente complex in New York City. Both towers collapsed within two hours and falling debris, combined with fires that the debris initiated in several surrounding buildings, led to the partial or complete collapse of all the other buildings in the World Trade Center complex. A third plane, American Airlines Flight 77, was crashed into the leading to a partial collapse in its western side.an a fourth plane, United Airlines Flight 93, targeted at the United States Capitol in Washington, D.C., crashed into field in Pennsylvania after its passengers tried to overcome the hijacke Almost 3,000 people died in the attacks, including all 227 civilians and hijackers aboard the four planes.

ACCIDENT	TYPE	DESCRIPTION
Hurricane Katrina 2005	Natural disaster	Hurricane Katrina made landfall on Monday, August 29, 2005 in southeast Louisiana, causing severe destruction along the Gulf coast from central Florida to Texas. Flooding in in New Orleans, Louisiana, occurred when the levee system catastrophically failed. The hurricane surge protection failures in New Orleans are considered the worst civil engineering disaster in U.S. history. It was the costliest natural disaster, as well as one of the five deadliest hurricanes, in the history of the United States. At least 1,833 people died in the hurricane and subsequent floods, and total property damage was estimated at $81 billion.
Hurricane Sandy 2012	Natural disaster	Hurricane Sandy is the largest Atlantic hurricane on record, with a diameter of 1,800 km, affecting 24 states, including the entire eastern seaboard from Florida to Maine and west across the Appalachian Mountains to Michigan and Wisconsin. Severe damage from the storm surge occurred in New Jersey and New York, where it flooding streets, tunnels and subway lines and cutting power in and around the cites. Damage in the US is estimated at over $100 billion and approximately 285 people were killed along the path of the storm in seven countries.
Indian Ocean tsunami 2004	Natural disaster	The 2004 Indian Ocean earthquake was an undersea subduction megathrust earthquake that occurred on Sunday, 26 December 2004, with an epicentre off the west coast of Sumatra, Indonesia and a magnitude of 9.1–9.3. The subduction caused a series of massive tsunamis along the coasts of most landmasses bordering the Indian Ocean. Over 230,000 people in fourteen countries were killed, and coastal communities were inundated with waves up to 30 meters.
Three Mile Island - U2 1979	Man-made: Nuclear Power	The Three Mile Island Unit 2accident was a partial core meltdown. The accident which occurred on March 28, 1979, was the worst accident in U.S. commercial nuclear power plant history. The accident was initiated by failures in the non-nuclear secondary system, followed by a stuck-open pilot-operated relief valve (PORV) in the primary system, which allowed large amounts of nuclear reactor coolant to escape. The failures were compounded by the initial failure of plant operators to recognize the situation as a loss-of-coolant accident due to inadequate training and human factors, such as poor ergonomic design of the control room. Small amounts of radioactive gases and radioactive iodine were released into the environment, resulting in insignificant radiation exposure to plant operators and the public.
Chernobyl U4 1986	Man-made: Nuclear Power	On 26 April 1986, reactor Chernobyl Unit 4 experienced a catastrophic power increase, leading to explosions in the core which dispersed large quantities of radioactive fuel and core materials into the atmosphere and ignited the combustible graphite moderator. The burning graphite moderator increased the emission of radioactive particles, carried in a plume, as the reactor had no containment structure. The accident was initiated during an experiment conducted at the start of a scheduled outage to test a potential safety emergency core cooling feature. It is considered to be the worst nuclear power plant accident in history. Over 600,000 people were involved in the clean-up and the estimated cost was 18 billion rubles.
Fukushima	Natural disaster + Man-made: Nuclear Power	The Fukushima accident was initiated by a massive 9.0 magnitude earthquake of the north-east coast of Japan which resulted in a series of massive tsunami waves. The tsunami flooding resulted in loss of all normal and backup electrical power to 3 operating units and 1 shutdown unit. Two other units which were in outages at the time managed to restore backup power because their higher elevation limited the extent of flooding. Meltdown of three reactor cores to an as yet to be determined extent is predicted to have occurred. Severe damage to the outer reactor buildings of 3 units occurred due to hydrogen explosions. There were no fatalities due to radiation exposure but a large number of people were evacuated from a region to the northwest of the station.

industrial activities including: energy transportation (Dona Paz ferry disaster); energy (Deepwater Horizon [4], BP Texas Refinery fire [5], TMI-2 [6], Chernobyl [7], Fukushima [8]); and aerospace (Challenger [9], Columbia [10]). Other disasters have origins in natural events (2004 Indian Ocean tsunami [11], Hurricane Katrina [12], Hurricane Sandy [13]) and malevolent acts (9/11 [14]) whose consequences were compounded by combinations of human error and deficiencies in design and emergency response planning.

3 Compounding Factors in Accidents

While the initiating events do not necessarily share unique common factors, the consequences of the events are generally compounded by a number of factors that lead to an increase in the severity of the event and/or inadequate emergency response to the event. These compounding factors are briefly discussed below.

3.1 Design deficiencies

This factor is common to a wide range of accidents and disasters involving engineered systems. Any system, be it an element of industrial infrastructure or a system engineered to protect members of the public against hazards, is subject to possible deficiencies in design which can result the failure of the system when subject to challenge and stress. Deficiencies include: failure to specify key design requirements; failure to recognize interactions within and between systems when subjected to conditions that challenge their functioning; common - mode failures of components; and common - cause external events that expose system vulnerabilities following the initiating events. These latter common - mode or common - cause factors are the most difficult to account for in probabilistic risk assessment simply because their probability of occurrence usually cannot be predicted *a-priori* and are accounted for in a general, simplistic manner. Most often, it is only after the failure events have occurred that it is possible to understand the nature of the failure and assign an event frequency value, albeit that this value will retain high uncertainty given the small number of such events that have been experienced.

3.2 Procedural non-compliance/ inadequate training

These factors reflect the contribution of the human operator to compounding the consequences of an event. Systems that are designed to have operator actions to assure their correct functioning are subject to these compounding factors. Assurance of safe operation requires that operating procedures be developed to regulate the manner in which operators interact with the systems. Failure to either understand (inadequate training) or follow procedures (procedural non-- compliance) result in operators taking either inappropriate act (*commission of an action*) or failing to take ac (*omission of an action*) during the progression o event, thereby resulting in more severe consequen

3.3 Inadequate Emergency Preparedness

If an organization, then this failure can diminis capability to respond to the event and, in turn, re ing worsening the impact the event. These fail include lack of a well-designed emergency resp function, lack of training in the application of response function, inadequate or non-- existent port equipment, and an inadequate ability to de equipment in a timely manner.

In the nuclear industry specific examples of t compounding factors include: lack of or inadeq ly developed severe accident mitigation guide (SAMG) and lack of preplanned and readily depl emergency support equipment that do not depen on - site services such as electricity and water supp Not only must SAMG exists, but they should be d oped from a well characterized knowledge base technical basis) and they should have a clearly a lated set of candidate high level actions that assi bringing the accident to a safe terminal state. Con to some current beliefs, the SAMG should not be re on a high degree of plant instrumentation, sinc functioning of the instrumentation cannot be ass with high confidence under the harsh conditions ciated with severe accidents. To build such depend on instrumentation into SAMG makes them suscep to failure should the instrumentation the lost.

3.4 Institutional Failure

This is a broad category of factors which relate t functional attributes and capability of operating or zations. It has become a popular term that is us denote situations where poor organizational design, definition of roles and responsibilities, poor commu tions and organization culture contribute to accid Institutional failures include, amongst other eleme

- poor safety culture,
- acceptance of deficiencies,
- a focus on mission imperatives (economic, p public relations) at the expense of a safety foc decision-making,
- poor communication between various groups w an organization or with external stakeholder,
- inadequate regulation, both external or interna

Nearly all major accidents and disasters exhibit degree of institutional failures. In some instances th ures are stark, such as Chernobyl, the Challenger di

and the Dona Paz ferry disaster, while in other instances the issues contributing to failure and ultimate outcomes are more complicated, for example the Columbia disaster, Deepwater Horizon, Fukushima and TMI-2.

Some of the key compounding factors associated with the high consequence accidents identified in Table 1 are listed in Table 2.

4 "Black Swans" and Risk

Following the publication in 2010 of Taleb's book, *The Black Swan: the Impact of the Highly Improbable*, the term Black Swan has become popular when discussing events with high consequences and perceived low probability of occurrence. A general definition for a Black Swan event is:

> *An event with high consequence which is judged to be incredible until it occurs, at which point the causes become apparent.*

One key aspect of a black swan event is that the frequency of its occurrence cannot be predicted with any level of certainty and, because their frequencies are perceived be very low based on historical evidence, it

Table 2
Characteristics of High Consequence Accidents and Disasters

ACCIDENT	TYPE	INITIATOR	COMPOUNDING FACTORS	CONSEQUENCES
Dona Paz, Philippines 1987	Man-made: Oil transportation	Procedural non-compliance of ferry crew	• Poor communication • Lack of Emergency Response • Institutional failure	**>4300 dead**
Deepwater Horizon 2010	Man-made: Oil production	Defective well seal design BOP failure	• Gas explosion • Poor safety culture • Institutional failure (BP)	**11 deaths Major environmental pollution of Gulf Coast. >> $10B loss**
Challenger disaster 1986	Man-made: Aerospace	Design defect: O-ring seal failure	• Low temperature • Institutional failure – mission imperative	**7 deaths, total loss of space shuttle**
Hurricane Katrina 2005	Natural disaster	Extreme weather event	• Inadequate flood control design. • Lack of Emergency Preparedness	**~1800 deaths ~ $200B loss**
Hurricane Sandy 2012	Natural disaster	Extreme weather event	• Inadequate flood control design.	**>200 deaths Major infrastructure damage > $100B+ loss**
Three Mile Island - U2	Man-made: Nuclear Power	Equipment failure: Loss of feed water	• Design deficiencies • OPEX failure • Poor operator training: • Inappropriate actions • Institutional failure: lack of safety culture	**Radiological: minimal Economic: major loss 0 deaths**
Chernobyl U4	Man-made: Nuclear Power	Operator action: test initiation	• Design vulnerability • Poor operator training • Institutional failure: lack of safety culture • Institutional failure – mission imperative	**Radiological: major release 28 deaths + 28 over next 20 years Environmental Economic: major loss**
Fukushima	Natural disaster + Man-made: Nuclear Power	Massive Earthquake + Massive tsunami waves	• Inadequate flood control design, backup diesels, electrical systems vulnerability • Lack of SAMG and Emergency Preparedness • Institutional failure: inadequate regulation, poor communications between utility and government	**Radiological: major release – multiple units (~ 10% of Chernobyl) 0 deaths Environmental contamination Economic: major loss**

Table 3
IAEA Levels of Defense In Depth [15]

LEVEL	OBJECTIVE	MEANS
1	Prevent abnormal operation and failures	Conservative design (e.g. redundancy, fail-safe features) High quality construction and operation Equipment maintenance In-service inspections Plant technical surveillance Trained operators
2	Control abnormal operation and detect failures	Control systems Protection systems Trained operators
3	Control of accidents within the design basis	Special safety systems Emergency procedures Trained operators
4	Prevent accident progression to more severe consequences or mitigate their consequences	Sever Accident Management Guidelines (SAMG) Trained operators & staff
5	Mitigate radiological consequences of a significant off-site release	Off-site emergency response Trained staff

is actually not possible to assign quantitative values to the frequency of occurrence. Another key aspect is that, because of the low perceived frequency of occurrence, the event is considered incredible, thereby "justifying" that the event be given no further consideration (for example, application of a lower bound cut-off frequency used to rule out events in PRA). This causes major difficulties in appropriately treating such events within qualitative risk assessment, such as PRA. This difficulty arises from very definition of risk employed in such assessments, that is:

Risk = Consequences x Frequency

The necessary conditions for performing a balanced quantitative risk assessment is that quantitative values for both of the two factors in the above equation can be reasonably assigned and, more importantly, the uncertainties in both factors in the above equation are not significantly biased towards one of the two factors. In the case of black swan events neither of these two conditions can be met for the frequency of occurrence.

The above does not imply that probabilistic risk assessment is an ineffective tool for assessing aspects of nuclear reactor safety. It is indeed an effective tool for assessing the robustness of nuclear plant designs and for identifying the risk dominance sequences associated with a well characterized design subject to internal failure events – in particular for evaluating component and system failure frequencies in a level I risk assessment and consequences in a level II risk assessment. The problem lies in the assignment of frequency values to:

- unknown common – cause failures
- the impact of human psychology that can result in unexpected behavior
- unidentified common – cause vulnerabilities, especially vulnerabilities to external events.

To deal with these limitations it is proposed probabilistic risk assessment be augmented threat-risk assessment methods which are not pr bilistically based. The application of threat- ris applied consistent with the use of defense-in-d concepts [15]. In particular, threat-risk assessr methods are applied at levels 4 and 5 of the I defense in depth construct shown in Table 3.

Threat – risk assessment is a deterministic assessr process that is often used by police, security and mil forces to support emergency preparedness plannin does not attempt to rank threats by their likelih Rather it postulates: "what if" a threat occurs t what are the range of consequences that may r and what are the options to mitigate the conseque and stabilize the event. This assessment is condu in a systematic and rigorous fashion to ensure tha vulnerabilities are overlooked and that the adequa mitigation measures can be evaluated. It is ideally s for addressing black swan events because the frequ of events does not enter to the assessment. Furthern application of this methodology does not lead to a dency to dismiss events as being incredible solely o basis of a perceived very low frequency. The outc of the assessment is focused upon emergency resp actions and emergency preparedness.

5. Conclusions

The characteristics of high consequence and frequency accidents and disasters have been id fied and related to the concept of a Black Swan e The inherent limitations of quantitative probabi risk assessment have been discussed and the prob associated with applying this assessment method to Black Swan events is shown to be associated

the large and difficult to quantify uncertainty associated with the frequency factor in the classical risk equation. An approach is proposed to address these limitations by augmenting probabilistic risk assessment with threat-risk assessment methods applied to the emergency response domain associated with levels 4 and 5 of the IAEA defense in depth construct.

6. Acknowledgments

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Post-Fukushima Focus on Fire Protection

S. SHANKER[1] and M. RAWLINGSON[2]

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Abstract

Fire is a known problem in industrial facilities, but also one that is not very well understood. In nuclear facilities, fires pose special concerns because of high temperatures post shut-down and highly radioactive fuels that are contained within them. They are also a major contributor to a reactor's core damage frequency. This paper aims to spark interest amongst young nuclear practitioners by providing an overview of fire protection, revisiting relevant OPEX in the wake of Fukushima, commenting on some challenges based on deep industry insights on dealing with fire issues, and providing some suggestions on meeting these challenges.

1. Introduction

The importance of fire protection at nuclear facilities was underscored by the 1975 Browns Ferry incident. A containment seal test was being performed in the cable spreading room using a candle to detect the slight inflows of air. The candle was inadvertently knocked over and set the polyurethane foam, used as penetration sealing material, on fire. The fire rapidly spread to the polyvinyl chloride (PVC) electrical cable insulation running through the penetrations. The result was a loss of control of reactor cooling, power

1 AMEC NSS, Toronto, Ontario, Canada
2 AMEC NCL, Toronto, Ontario, Canada

to some key safety systems, and indication of key plant parameters. Water level in the reactor fell, nearly uncovering some fuel bundles. Although the incident did not seriously damage the reactor core, it served as a wake-up call for the nuclear industry that raised the profile of fire protection and paved the way for more stringent regulations in the United States [1].

Today, fire continues to pose a significant threat to nuclear safety in comparison to other hazards because fire is a common mode event whose frequency exceeds that of earthquakes and weather related events. On average, there will be ten fires per year across over 110 nuclear facilities in North America [2].

In the post-Fukushima nuclear era, the latitude that was once granted by regulators is tightening, and society's tolerance of nuclear risks is diminishing. Operators are challenged to apply modern requirements to older facilities and regulators must ensure adequate safety margins exist during fire events. Finally, public confidence must be restored in the wake of serious events, such as the ones that are revisited in this paper. Therefore, it is important for the nuclear industry to respond more aggressively than it has in the past to fire risks. This paper aims to spark interest amongst young nuclear practitioners to confront fire protection challenges as they rise to leadership.

2. Background

Fires are relatively common in complex industrial facilities because their day-to-day operations entail handling hazardous materials. To illustrate, 80 fires broke out in 59 refineries in the United States between 2009 and 2011 [3]. Although common, many fires do not bear significant consequences [2]. Industrial fire hazards include, but are not limited to: flammable liquids, compressed gas cylinders, lubricant tanks, electrical equipment, welding/cutting processes, aerosol containers, or fueled industrial trucks [4]. While the consequences of many fires are not serious, any fire that does start must be viewed as a failure of basic fire prevention practices. Consequently, due to the unpredictable nature of fire, controlling one is more a matter of luck rather than good judgment.

Fires in nuclear power plants are treated much differently than other industrial fires due to radiological consequences and the enormous amounts of potential energy (> 3,000 MWth) in reactor cores, which require active cooling long after shutdown and also after defueling, when the fuel is stored in spent fuel bays. If fires impair cooling, controlling, and/or safety mechanisms, fuel rods may fail and expose radioactive materials [1]. Radioactive releases from fuel, particularly Iodine 131, may cause deaths or harm thousands [2]. Even after the accident is mitigated, the reactor will likely be damaged beyond economic repair – so too will public confidence in the nuclear industry. Therefore, fire protection grams in nuclear facilities must address threats f fire that could inhibit a reactor's ability to shut d safely (fire safe shutdown analysis).

Protecting nuclear cores from fires requires a anced approach and a careful selection and app tion of five key methods of controlling fires in nu plants. All of the following methods require thoug design of nuclear facilities and supporting progra

(1) The main fire *prevention* requirement is to e nate combustibles, hazards, and other ign sources. Good fire prevention design also red the probability of common mode failures, w allow a single type of fault to fail the overall sys This is accomplished by designing diverse redundant safety systems so that there is a back default mechanisms fail [7]. Fires occur when tion sources come into contact with combus materials. The ideal fire prevention objective sh be to eliminate the chances of fires ever occu and should therefore serve as the primary fire tection goal of all nuclear power plants.

(2) Early *detection* of fires improves chances of cor ling an event when the fires are small. The so a fire is discovered, the quicker the response achieve this objective, pull stations, convent detectors and special incipient detectors are ti central fire alarm systems that notify operato precise locations of events in the plant.

(3) Fire *barriers* isolate fires, protect personnel critical equipment from fires. One example o riers is wrapping electrical cables that contr power safety equipment. Another example is ing penetrations in fire walls to prevent the from spreading, especially in stairwells that e the safety of plant staff during egress.

(4) Sprinkler systems, deluge systems, water systems, gaseous discharge systems, fire blan and fire extinguishers are examples of *suppre* While suppression systems are highly effecti most non-nuclear applications, their use in a r ar plant must be carefully balanced against the imposed on safety systems due to inadvertent c tion. For example, the control equipment roon the main control room should not have spri systems because of a high likelihood of dam critical safety monitors and controls. Therefo is vitally important that suppression systems d damage safety critical components when activ

(5) Emergency *response* consists of a team of h trained professionals tasked to respond to nu emergencies. It is clear that time is of the es in a fire and rapid response will often mea difference between a small fire with little sequence and a large fire that does signi damage to the plant. Nuclear power plan

brigades in conjunction with their Municipal counterparts need thorough training in plant layout and fire fighting techniques required for successful intervention and mitigation of nuclear plant fires.

3. Fire Protection Operational Experience (OPEX)

Nuclear fires are quite prevalent. As an example, between 1995 and 2008, there were over 125 fires reported in nuclear power plants [2]. Some of those fires damaged critical safety equipment. A short summary of selected incidents and accidents with strong links to fire protection of nuclear power plants is presented here to reinforce its importance in nuclear safety.

(1) On January 1990, the East German Government reported that it had concealed a serious nuclear incident in December 1975 that may have had "Chernobyl like" consequences [5]. The event was initiated by a short circuit in the standby power distribution system, which sparked a fire in the cable that damaged critical safety components that subsequently shut off five of the six cooling pumps [5][6]. Initially, thermosyphoning (natural convection) removed decay heat from the fuel rods in the primary loop. Nearly 8.5 hours later, a single emergency pump was activated on the secondary side for continuous cooling of the core. Human error, poor prevention of common-mode failure in the design, and poor spatial separation were cited as the causes of the event [6]. Some of these issues touch upon the five key aspects of fire protection discussed earlier.

(2) On October 19th, 1989, a serious fire occurred in Spain's Vandellòs-1, a gas cooled reactor [8]. Turbine blades separated from the rotor, penetrated the turbine casing, and severed a lubricating oil line. The oil line caught fire and burned a neoprene bellow on one of the main cooling water intake pipes to the turbine condenser, which resulted in the basement flooding rapidly. The flooding caused major electrical failures, including a loss of cooling for the reactor core. Although the reactor was ultimately shutdown safely, public demonstrations and high repair costs forced the plant to be decommissioned. Vandellòs-1 was safely laid up, and now serves as a painful relic of the loss of public confidence in nuclear safety.

(3) On March 13th, 1993, Unit 1 of the Narora Atomic Power Station (NAPS-1) in Northern India experienced a major fire due to a rupture of the turbine blades in the last stage of the low pressure turbine. The resulting imbalance in the turbine created vigorous vibrations that ruptured (a) the seals in the hydrogen cooling system, and (b) the lubricating oil tank placed above the turbine. A spark in the rotating turbine blades ignited the hydrogen, which then came into contact with the lubricating oil that subsequently overhead and created a large fire in the turbine hall. The resulting smoke polluted the main control room and compelled operators to vacate the premises. Less than one minute after the initiating event, the fire spread through the generator bus and cables into the control equipment room. The reactor shutdown systems functioned per design. Cooling and containment were not compromised. There were two root causes associated with this accident: (1) rupture of the turbine blades, and (2) inadequate fire resistance in the cable insulation [9].

(4) On March 28th, 2010, the H. B. Robinson plant in South Carolina experienced a short in a 4,160 Volt cable that caused a fire. A series of other faults, such as a breaker failure and main transformer damage caused power outage in half of the equipment. The situation exacerbated by failures in indicator bulbs and poor training of operators. The event was finally controlled, but subsequent NRC investigations uncovered some deficiencies – a major one being inadequate fire barriers, which likely caused the initial fire to spread along the cable [10].

(5) On June 8th, 2010 at the Surry plant in Virginia, a maintenance worker accidentally dropped a tool that shorted an electrical circuit controlling the feedwater system in Unit 1. Ninety minutes after shutdown, a resistor-capacitor (RC) filter in the main control room overheated, causing a fire that blew fuses to instruments monitoring important safety parameters. A similar RC filter in Unit 2 had caught fire only seven months earlier [10]. Although power was restored and the overall situation was controlled, there were two important lessons learned: (i) although the event was not initiated by fire, it could have escalated because of one; and (ii) known fire related deficiencies continue to threaten nuclear safety.

(6) There have been cases where materials or services were supplied to utilities bearing false promises. One example is the usage of Thermo-Lag 330 in the 1980s and 1990s to protect safety system cables in nuclear facilities from fire. In 1992, it was found that the required protection level was not met by this material because it degraded cable insulation, which could potentially cause fires and compromise the integrity of safety systems. The NRC recommended that all utilities using Thermo-Lag 330 implement compensatory fire watch and replace the poor product with approved fire barriers [11]. This experience stressed the importance of utilities and suppliers honestly pulling together to ensure that advertised safety ratings are in fact met.

(7) On March 11th, 2011, a 9.0 magnitude earthquake

rattled Japan, causing a 14 meter Tsunami to douse the entire Fukushima nuclear facility [12]. This wrecked the backup diesel generator, thereby debilitating all active cooling capabilities, and unleashing an unforgettable sequence of events that placed this disaster amongst the top of the list of all significant nuclear disasters. There were specific events within the larger calamity that were linked to fire protection and can therefore offer some lessons learned. These are summarized here:

- On March 12th, 14th, and 15th, Units 1, 3, and 4 experienced massive explosions, respectively, that injured 15 people and caused significant damage to the reactor building. Each of these explosions were caused by hydrogen, which is explosive when concentrations are high enough and it is exposed to either oxygen or a spark. It accumulates when the Zirconium fuel sheath absorbs oxygen from steam as its temperature rises above 1,200°C [13]. The Narora event described above also suffered from an inadvertent hydrogen explosion in the turbine. Both Fukushima and Narora serve as reminders of the potentially disastrous effects of ignition sources nearing hydrogen sources. Therefore, a key fire protection design objective is to keep ignition sources away from hydrogen sources. Isolating hydrogen from oxygen is not directly a fire protection objective, but one that also warrants attention since explosions create a flurry of unexpected fires in unpredictable areas of the plant.
- On March 15th, a fire ignited in Unit 4, which also contained the spent fuel. Spent fuel was stored in tanks and required cooling that was disabled due to a loss of primary and backup power [13]. The fire, coupled with a loss of cooling capability for the highly radioactive spent fuel, may have posed severe radiological consequences. The emergency response crews were tasked with the dangerous responsibility of not only manually cooling the reactor core, but also the spent fuel pool [13].
- On March 15th, high radiation levels (approximately 400 mSv in some areas) prompted the evacuation of all personnel who were not directly required to mitigate the accident. Only the emergency response crew of 50 people, dubbed popularly by the media as "Fukushima 50", was retained at the plant to control the event [13].
- On March 17th through 20th, there were several smaller explosions and hydrogen fires that were fought by the emergency response crews [13].

The Fukushima experience has taught two very important lessons with respect to fire protection: (i) hydrogen explosions are highly unpredictable, extremely powerful, and may occur during accident scenarios due to sparks/fires, or may create u pected fires post-explosion that may then sprea highly vulnerable areas of the plant; and (ii) due t unpredictable nature of fires during accidents, e gency response is the last line of defense and ther should not be underestimated.

The nuclear industry understands these p and is working towards establishing benchm through post-Fukushima assessments conducte the World Association of Nuclear Operators (WA – Significant Operating Experience Report (SO Each WANO member is undertaking its own au The Canadian Nuclear Safety Commission (C Fukushima Task Force has offered recommenda for hydrogen accumulation and also for emerg response for its CANDU licensees [14]. The Kc inspectors have also offered a few key fire prote recommendations, which include [15]:

- Simplifying fire protection plans.
- Higher level of cooperation between interna external fire stations.
- Adopting performance-based fire protection ph phy, which is briefly summarized in the next sec

There is compelling evidence supporting the n that nuclear safety and fire protection at nuclear f ties are inextricably linked. The seven events revi here are to serve as reminders for nuclear profes als to not minimize the threats posed by fire on r ar facilities. Each of the events discussed here e slightly different vulnerabilities and characteristi nuclear power plants. From Browns Ferry in 19 Fukushima in 2011, the unifying thread amongst of these events over the past 37 years is that wh or not a fire initiated the event, it certainly pla major contributing role in cascading it.

4. Key Challenges and Suggestions

The nuclear industry faces enormous threats factors that are highly complex and extremely dif to control, such as the inflated public perceptio the short term promises of alternative energy so negative public perceptions of the costs and bene nuclear power [16], and most importantly, the th each utility poses on the other if it experienc calamity like Fukushima. The last item is partic relevant in the context of fire protection becaus severe fire in a nuclear facility, such as those disc in the previous section, have a potential of ca severe core damage and listing the event in the ra Chernobyl, Three Mile Island, and Fukushima. N history has demonstrated that a disaster in on ity will have ramifications on the rest of the in and thereby jeopardize its growth. It follows that

disasters will also jeopardize access to affordable energy that humanity depends so heavily upon. Since this causality will not change in the future, it is crucial for the industry to respond to the challenges that lay ahead if it wishes to survive. Some of the challenges the nuclear industry faces with respect to fire protection are summarized here, and suggestions based on industry experience are provided for moving forward.

(1) Fire protection is complex, and the exodus of senior fire protection specialists in the coming years will leave a wide knowledge gap. Fire protection programs may be weakened without careful succession planning, thereby exposing nuclear facilities to additional risks. It is important for young leaders in the nuclear industry to rise to this challenge. Though complex, fire protection is a rewarding field that lies at the intersection of human response and technology – where creative solutions are sought for unique problems. Opportunities range widely from laying plans, modeling fires, mitigating hazards, interfacing with regulators, to designing fire prevention, detection, and suppression systems. Accordingly, there are substantial growth opportunities in both technical and non technical areas of a field that is critical to nuclear safety, not very well understood, and is currently under high scrutiny by regulators. There are six innovative ways recommended here for aspiring fire protection professionals to bridge the knowledge gap:
   - Finding mentors who can help chart a path to the various roles a professional in the field of fire protection may assume is likely the most efficient way of understanding both the requirements and the outcomes.
   - Requesting work assignments in the field of fire protection by supporting experts in preparing fire safety assessments, such as code compliance reviews, fire hazard assessments, and fire safe shutdown analyses is a low risk hands-on way of learning the nuances of the profession. These reports are typically prepared every three to five years depending upon the licensing requirement, so opportunities for getting involved arise periodically – at least in theory. Depending upon the requirement of the jurisdiction, the gaps arising from these reviews must be resolved by either performing the action (i.e. eliminating the hazard), or providing a performance based alternative solution. There are ample learning opportunities in either direction.
   - Reading industry journals and OPEX is an effective way of receiving key industry insights and reinforcing lessons learned from other facilities. The Fire Protection Magazine is published by the Society of Fire Protection Engineers (SFPE), and serves as a great inlet to the broader industry. There are also local chapters of SFPE that offer various forums to network with industry professionals and to learn.
   - Enrolling in colleges and universities for additional certification in fire protection on a part-time basis will help develop a strong theoretical base without forgoing the industry experience. This will inevitably help fire protection professionals craft creative solutions to a wide array of problems they may see. Most professionals with a technical degree already have the prerequisites for these courses.
   - For professionals who are already working in the area of fire protection but wish to specialize can do so by taking additional training on specialist topics such as fire modeling and sprinkler design (NFPA-13).
   - Joining technical codes and standards committees, which develop the rules for authorities having jurisdiction (AHJs) to enforce with respect to fire protection, is a great way to learn the technical, legal and regulatory nuances of the profession. Currently, these committees consist of seasoned experts who are in a position to mentor aspiring committee members. Over time, as experts disengage from committees, it will be much more difficult for aspiring fire protection professionals to harness their knowledge.

(2) The Browns Ferry accident sprang an era of deterministic fire protection requirements, which were prescriptive rule-based requirements imposed on all utilities to ensure the latest fire protection codes and standards were implemented. The introduction of the rule-based requirements was appropriate for the time because it forced the industry to focus on fire protection at nuclear power plants, but over time, there were three issues that emerged with this approach [17]:
   - Prescriptive requirements came into play long before risk-informed and performance-based analytical techniques were developed. Therefore, they do not adapt well to the state of the art understanding of fire protection.
   - Prescriptive requirements did not take advantage of probabilistic risk assessment (PRA), which accurately facilitates a comparison of relative risks between multiple fire hazards.
   - Risk-based assessments have the potential for generating significant insights regarding fire risks, whereas prescriptive methods are much more static in nature. Thus, prescriptive methods are not able to take advantage of the operational experience gained from utilizing risk-based assessments over time.

Prescriptive requirements also do not adapt well to all plants, particularly those that are aging. This reality compels utilities to repeatedly request for concessions from regulators [1]. This lengthy process not only diverts focus away from higher risk items, but also erodes the trilateral trust between the regulator, general public, and utility when there are many open actions on public record that utilities are simply unable to complete [19]. In 1996, the Nuclear Regulatory Commission (NRC) of the United States stated that "a revised fire protection rule that would allow flexibility and facilitate the use of alternate approaches to meet the fire safety objectives may reduce the need for exemptions" [17]. Thereafter, the NRC, NFPA, and the nuclear industry converged around the view that risk-informed, performance-based processes should be introduced as an option for licensees while also maintaining the rule-based requirements of the past during the transition phases. In February 2001, NFPA 805 "Performance-based standard for fire protection for light water reactor electric generating plants" was issued in the United States to offer licensees an option to adopt this method [17].

An industry shift from deterministic methods to performance based risk informed (PB/RI) methods holds promise. It is expected that with this shift, utilities will be able to focus attention on areas that pose the greatest risk to nuclear safety, providing an appropriately customized solution for each plant. Tools such as NFPA 805 are already in place to aid light water reactor operators in shifting to PB/RI methods [18]. There are other utilities around the world using other types of reactors who also intend to follow suit [15].

In Canada, fire protection for nuclear power plants is governed by the CSA N293 Standard, which offers licensees the latitude to choose performance based approaches provided that the AHJ concurs with the approach [20]. As such, a prescriptive requirement may be satisfied by an alternative solution provided that a third party and the AHJ review it. This way, innovative solutions to complex fire protection problems can be found by trilateral dialogues between utilities, industry experts, and regulators. Such conversations promote transparency and build trust between the utility and the regulator, which would be difficult to build if the standards were highly prescriptive without providing an option to propose performance based solutions.

(3) The 2011 Fukushima disaster raised concerns regarding the adequacy of emergency response, which is a vital component of fire protection. Fire behavior is difficult to predict in accident scenarios despite robust analyses and strict adherence to fire codes, leaving emergency response as the last line of defense. Thus, utilities must fortify emergency response programs and partner with municipalities [14].

5. Conclusion

The aftermath of Fukushima is drawing atte
from regulators, placing high financial and resou
pressures on utilities to evolve their safety stand
This evolution is achievable in the area of fire pr
tion, but because of its multidisciplinary natu
requires relentless cooperation between fire pr
tion program owners and all other departments.
protection program managers must offer guid
and support to other departments to help them u
stand their role in supporting the five aspects o
protection: prevention, detection, suppression, l
ers, and emergency response.

The OPEX presented in this paper underscore
importance of fire protection at nuclear facil
Irrespective of the precise root cause of the e
presented, fires broke out in all of them and ex
bated the situation. Each event highlighted diff
vulnerabilities and characteristics of nuclear p
plants, but together, they told a single story tha
protection and nuclear safety are inextricably linl

On the regulatory front, utilities must strive to
only the commitments that they can, and more i
tantly, should meet. By relying on modern risk-infor
performance-based tools and striving for a trustin
transparent relationship with the AHJ, utilities
the opportunity to propose solutions that may me
exceed the minimum requirements stipulated i
governing codes/standards. As more facilities op
performance based approaches to solving fire p
tion problems, more risks will get characterized. W
strong understanding of the relative risks between
ent fire hazards, utilities will be able to ensure that
is not diverted away from the most important upg

The departure of senior fire protection speci
will require careful succession planning, and y
leaders are well poised to respond to the chall
ahead. Aspiring fire protection professionals
work with management to bridge the knowledg
and qualify themselves by:

- Finding mentors to help chart a path towards a
ing fire protection expertise.
- Supporting fire protection experts in preparin
safety assessments and also by closing the gap
emerged from the assessments.
- Getting involved with the fire protection indus
reading journals, magazines, relevant fire prote
OPEX, joining associations (SFPE), and atte
conferences.
- Enrolling in certificate and diploma progran
fire protection to lay a theoretical foundation.
- Enrolling in specialized professional training
es.
- Joining technical committees for codes and
dards that are applicable to fire protection.

Nuclear utilities currently play a major role in securing energy in both developed and developing countries. Furthermore, nuclear power holds tremendous promise for securing the world's energy requirements in the future while simultaneously reducing harmful environmental effects. However, in order for the nuclear industry to succeed, the public must be convinced that all contributing risks to nuclear safety are minimized – including those stemming from fires.

6. Acknowledgements

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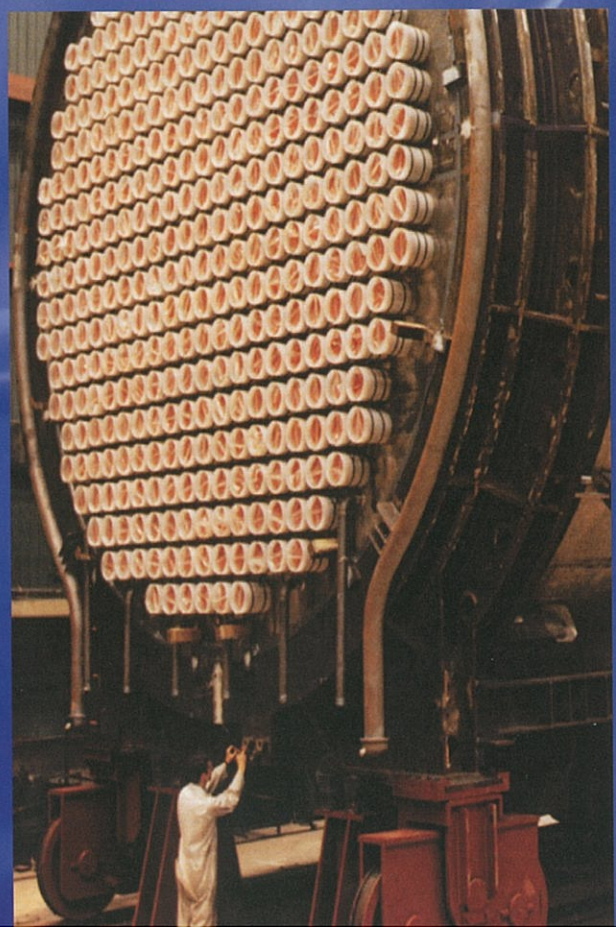

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Canada's Early Research on Nuclear Energy From Thorium

By MICHAEL ATTAS

Recently we have heard numerous presentations on the promise of molten-salt and other designs of nuclear reactors that can use thorium as a fuel. This chemical element can generate fission energy after it has been transformed by in-reactor irradiation into a synthetic isotope of uranium. It is well known that experiments were done in the 1950s and 1960s in the USA and Canada, but interest in thorium as an energy source goes back considerably farther than that. In fact Canada was extracting that synthetic isotope, U-233, as early as 1944, before we even had an operating nuclear reactor!

During World War II, the secret Manhattan Project in the USA led intense research to develop a bomb based on nuclear fission. At the same time in Montreal, an international team of scientists began to conduct longer-term research on nuclear fission, with intermittent co-operation from the Americans [1]. By mid-1943, the Montreal Laboratory had found a home in a previously unoccupied wing of the Université de Montréal. The scientists, engineers, and technicians there investigated both theoretical and experimental aspects of the new field, also in secret, as the war was very much on their minds. Key components of the research were chemical and physical experiments to establish conditions conducive to controlled nuclear fission.

Thanks to the efforts of the CNS and AECL, early documents from the Montreal Laboratory and the subsequent Chalk River installation have been made available to people studying Canada's nuclear history [2]. The documents shed light on the activities of our wartime researchers, whose goal was to understand and exploit nuclear technology.

One aspect of that broad goal was to see how thorium could be used as a nuclear fuel. The scientists understood that it first needed to be transformed into U-233, and they understood the basics of that nuclear transformation. Demonstrating it could be done was another matter, so effort was devoted to development of efficient production and extraction methods for U-233. To extract the small quantities of U-233 from the bulk irradiated thorium, laborious radiochemical efforts were required. The starting point was to arrange for irradiations of thorium rods in the prototype U.S. plutonium-production reactor, X-10, at "Site X" (Oak Ridge, Tennessee).

A formerly classified report from the Montreal Laboratory describes the process in dry, scientific terms [3]. Its title, "Extraction of 23 from irradiated thorium carbonate slugs," indicates the need for secrecy and code words, with "23" standing in for uranium-233. The thorium rods had been irradiated starting in December 1943 – only a month after the Oak Ridge reactor began operation! They were shipped back to Montreal under armed guard, as described by Bothwell [4].

Several options for chemical manipulations are described in the report, with the goal of finding the most appropriate reagents, concentrations, and timings to dissolve the rods and extract the U-233. In the end, several kilograms of irradiated thorium yielded several milligrams of fissile U-233, separated from most impurities. This precious material was then used for experiments in both the USA and Canada to pin down its nuclear and radiochemical properties.

The need for secrecy was not superfluous, and despite precautions the project was eventually compromised somewhat. One of the British physicists, Alan Nunn May, was later found to be passing secret information to members of the Soviet embassy in Ottawa. In fact, there is evidence that he provided them with samples of the uranium-233, and tried to make up the missing U-233 solution by replacing it with natural uranium. This attempt at substitution stymied the project, since the solution then did not behave as expected in their experiments [5].

Work on uranium-233 continued at Chalk River after the end of the war. The NRX reactor was designed to include irradiation sites for thorium rods, as was NRU in the 1950s. The "J-rod annulus" of NRU was the location for those thorium irradiations, with the old wartime code "J" for thorium still being used. ("X" was the wartime code for uranium, and the original meaning of the X in NRX.)

These days, of course, interest in thorium conversion to U-233 has increased dramatically all over the world, since this alternative energy source has advantages in nuclear safety, waste management, security, and economics. The CANDU reactor design, with its inherent fuelling flexibility and neutron economy, was developed with possible thorium fuel cycles in mind,

and it is well positioned to participate in use of thorium as an energy source for the future.

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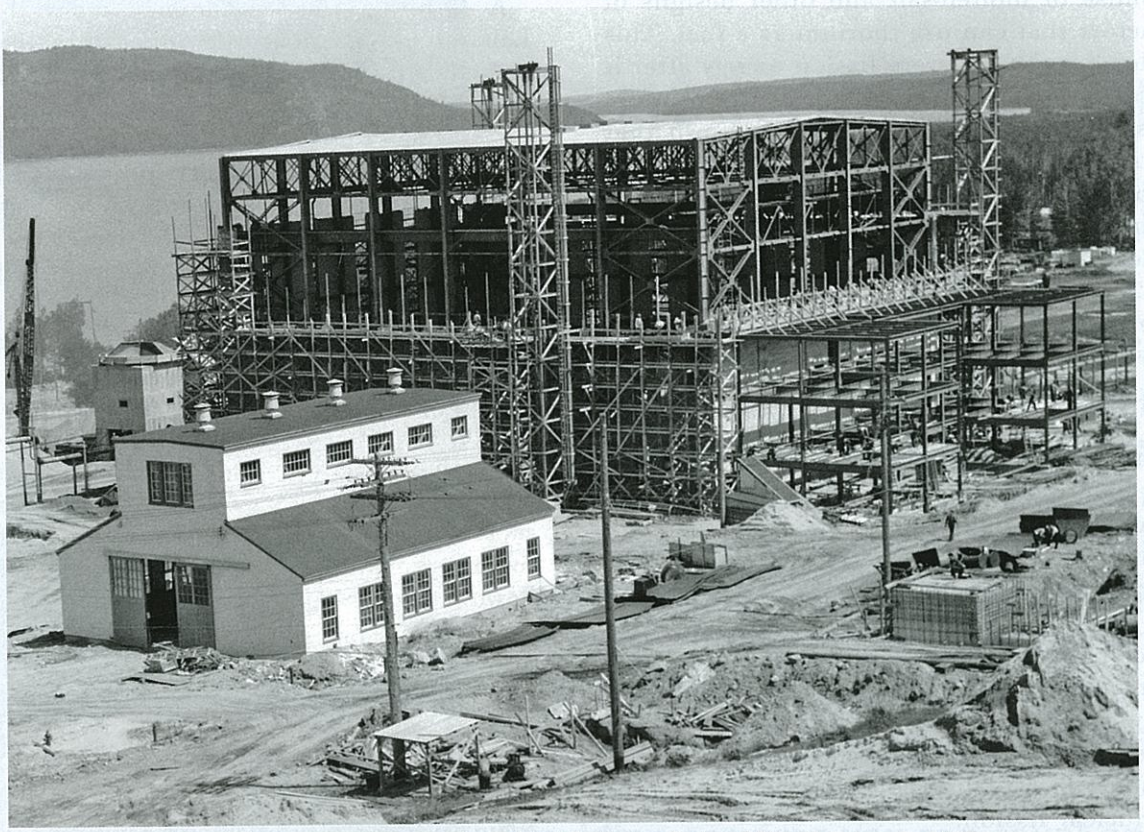


View of the construction of the NRX building (behind ZEEP), taken in 1945.

Montreal Laboratory

After the outbreak of the Second World War in 1939 and, particularly after the invasion of France a year l a number of European scientists who were pursuing research related to the 1938 discovery of fission made way to the United Kingdom and continued their research. The wartime conditions made this difficult.

In 1942, the Prime ministers of the UK and Canada together with the President of the USA agreed to se a laboratory in Canada to pursue that research, with a focus on a natural uranium fuelled, heavy water m ated reactor as a further alternative for the production of plutonium. That had been the focus of the work o group of UK and European scientists.

The group were housed in a new building of the University of Montreal and soon joined by Canadian s tists, led by Dr. G. C. Laurence (who, many years later became the first full-time president of the Atomic Er Control Board, now the Canadian Nuclear Safety Commission). The operation became known as the Mon Laboratory.

Starting from first principles, in two year the Montreal Laboratory group developed the basic design o NRX reactor. That led to the choice of Chalk River as a site and the beginning of construction of NRX in 1

For several years after its start-up in 1947, NRX was the most powerful research reactor in the world and r advanced research was conducted, such as described in the article by Michael Attas.

GENERAL news

(Compiled by Fred Boyd from open sources)

Government to Increase Nuclear Liability Limits

On June 10, 2013 Joe Oliver, Minister of Natural Resources, announced that the Government of Canada intends to proceed with increasing liability limits for Canada's nuclear industry and related measures to strengthen Canada's nuclear liability regime.

[The announcement was made at the Annual Conference of the Canadian Nuclear Society.]

The proposed new legislation will increase the amount of compensation available to address civil damage from $75 million to $1 billion, replacing outdated legislation that is almost 40 years old. It will broaden the number of categories for which compensation may be sought; and improve the procedures for delivering compensation. It will also maintain the key strengths of the existing legislation, including making nuclear operators absolutely and exclusively liable for nuclear damage - meaning there would be no need to prove fault and no one else could be held liable.

Minister Oliver also confirmed that Canada intends to join the International Atomic Energy Agency's (IAEA) Convention on Supplementary Compensation for Nuclear Damage (for consequences beyond Canada's borders). Participation in this convention would bolster Canada's domestic compensation regime by bringing additional funding for compensation provided by member countries up to $450 million. In Canada, this would bring total potential compensation up to $1.45 billion. Participation would also facilitate nuclear cooperation and trade in nuclear products and services with the United States and other global partners.

The Government expects to table the proposed legislation in Parliament in the fall of 2013.

CNSC Extends Operating Licences for Pickering A and B

On June 24, 2013 the Canadian Nuclear Safety Commission (CNSC) announced its decision to extend for a period of two months the power reactor operating licences issued to Ontario Power Generation Inc. (OPG) for the Pickering A and B Nuclear Generating Stations.The current licences, which were set to expire on June 30, 2013, will be amended and remain valid until August 31, 2013.

In its licence renewal application, OPG requested that the two licences be combined into a one-site licence and renewed for a period of five years. Based on the information presented, the Commission has decided that it requires more time to render its decision. Given the imminent licence expiry, the Commission has determined that a two-month licence extension is appropriate to allow it sufficient time to deliberate and carefully consider all of the information on the record before issuing a final decision.

In making its decision, the Commission considered information presented at a public hearing held on February 20, 2013 in Ottawa, Ontario and from May 29–31, 2013 in Pickering, Ontario. During the public hearing, the Commission received submissions from OPG and 136 intervenors, as well as recommendations from CNSC staff.

Aerial view of the Pickering NGS

CNSC Issues Licence for Cigar Lake Project

On June 13, 2013, the Canadian Nuclear Safety Commission (CNSC) announced its decision to issue a uranium mining licence to Cameco authorizing the construction and operation of its Cigar Lake Project located in northern Saskatchewan. The licence will be valid from July 1, 2013 until June 30, 2021.

In its application, Cameco sought authorization to complete the final stages of commissioning at the facility, transition into operations, and commence shipping uranium ore slurry for further processing. An environmental assessment was completed in the 1990s and a construction licence was issued in late 2004

and renewed in January 2010. The licensed facilities include underground mine workings accessed by two mine shafts, a surface load-out facility, waste management systems, a mine water management system and associated site facilities.

Cigar Lake (Image: Cameco)

The company plans to begin production by jet boring ore this summer. Ore from the mine is to be processed through a toll-milling agreement at Areva's McClean Lake mill, and the first packaged yellowcake is expected in the fourth quarter of the year.

Cigar Lake is the world's second largest high-grade uranium deposit, with grades that are 100 times the world average. The orebody is being frozen prior to mining to improve ground conditions, prevent water inflow and improve radiation protection, and the ore will be removed by a jet boring system, using water under high pressure to carve out cavities in the orebody and then collecting the resulting ore slurry through pipes. The ore will then be taken to underground grinding and thickening circuits and then pumped to surface as slurry, which will be loaded into special containers for the 70 kilometre journey by road to McClean Lake.

L-3 MAPPS to supply simulator to Candu energy

At the end of May, 2013, L-3 MAPPS announced that it has signed a contract with Candu Energy Inc. to supply an engineering simulator for its Enhanced CANDU 6® (EC6®) power plant development project. The simulator will be used at Candu Energy's EC6 mockup facility to develop and validate the main control room (MCR) and to design and test programmable electronic systems (PES) and human-system interfaces.

L-3 MAPPS will provide Candu Energy with a full real-time simulation of a CANDU 6 plant operating on a PC/Windows platform powered by the industry-leading Orchid simulation environment. The simulator will be equipped with interactive soft panels representing the MCR and a dual Digital Control Computer (DCC) emulation. The interactive soft panels will be en on multiple video display units to represent the MCR. The emulated DCC will be used as a bas to iteratively change out control programs and with new PES control software modeled and ve in L-3's Orchid Modeling Environment. In add L-3 MAPPS will provide training and suppo ensure that all of Candu Energy's objectives are

A month earlier L-3 MAPPS announced the Embalse full scope simulator it develope Nucleoeléctrica Argentina S.A. (NA-SA) was pu service on March 22, 2013 at the Embalse ı ar power station in Córdoba Province, Arge L-3 MAPPS and NA-SA representatives gather Córdoba to celebrate this significant success, a p milestone known as "Ready for Training."

The simulator will support enhanced operator ing for the single unit at the Embalse site – a CA 6 pressurized heavy water reactor with a net outp 600 MWe, which went into commercial operati January 20, 1984. The last full scope CANDU simulator L-3 MAPPS developed was for the Qi Phase III plant in Zhejiang, China, which er service in the first quarter of 2003. Since ther MAPPS has introduced significant technology de ments, all of which have been applied to makir Embalse simulator completely state-of-the-art.

New cover for Fukushima Daiichi 1

A four-year process is planned to rebuild the over Fukushima Daiichi 1, equipping it to remov reactor fuel still stored there. Tokyo Electric Company (Tepco) will take away the roof of the porary cover structure that was put in place to r radioactive emissions after the accident in 2011 will give the company's engineers vertical acc the reactor service floor, from which they will r the steel debris left behind by the hydrogen exp - some of which lies in the used fuel storage po is a priority to remove.

Tepco will then install equipment for handli used fuel before strengthening the surroundin for heavy machinery and rebuilding a new vers the cover. The entire process is planned to st the middle of 2013 and continue for some four before the removal of used fuel actually begins.

Containing the vast majority of radioactivity site, the stored used fuel at each reactor unit is e ally to be placed into containers and transferred site's shared fuel pool. This is a common prior all four damaged reactors, each of which is proc at a different pace towards the goal due to each unique circumstances.

Seen here during construction in September 2011 the cover was made from pre-fabricated panels attached to a steel frame enveloping the reactor building and the remaining steel supports of its roof. (Image: Tepco)

UNSCEAR report on Fukushima – negligible radiation effects

At the end of May 2013 the UN Scientific Committee on the Effects of Atomic Radiation (UNSCEAR) issued a report prepared by some 80 international experts on the health effects of radiation from the accident.

It concluded *"Radiation exposure following the nuclear accident at Fukushima Daiichi did not cause any immediate health effects. It is unlikely to be able to attribute any health effects in the future among the general public and the vast majority of workers."*

The report concluded that the only observable health effects from the Fukushima accident stem from the stresses of evacuation and unwarranted fear of radiation.

The only exception was the emergency nuclear workers that received radiation doses of over 100 mSv during the crisis triggered by the 15 metre tsunami that struck the plant on 11 March 2011. Records show that 146 workers fall into this category. They will be monitored closely for "potential late radiation-related health effects at an individual level."

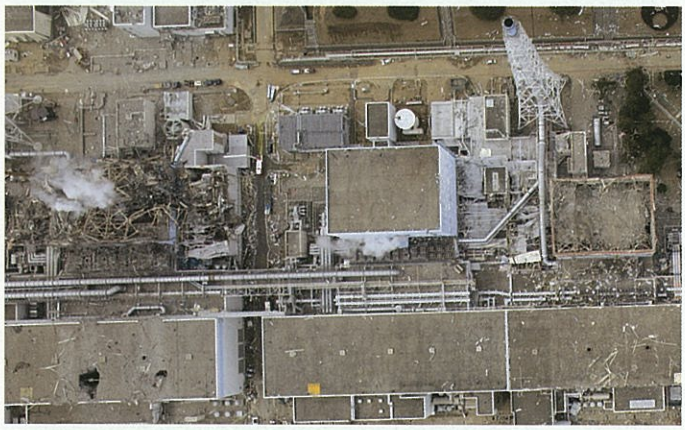
By contrast, the public was exposed to 10-50 times less radiation. Most Japanese people were exposed to additional radiation amounting to less than the typical natural background level of 2.1 mSv per year that comes mainly from the ground and from space. People living in Fukushima prefecture are expected to be exposed to around 10 mSv over their entire lifetimes, while for those living further away the dose would be 0.2 mSv per year.

Social and societal effects

The emergency situation at Fukushima Daiichi began on 11 March 2011 but it was not until 15 March that the accident sequence culminated in its most significant emission of radioactivity. Japanese authorities used the intervening days to evacuate residents from a 20 kilometre radius and advise those in a further 10 kilometre zone to remain indoors when possible. A further area to the northwest was evacuated on a longer timescale. UNSCEAR said that these actions taken to protect the public "significantly reduced exposures."

It is this upheaval to people's lives that has brought real health effects, and these will need "special attention" in coming years, said Carl-Magnus Larsson, chair of UNSCEAR. "Families are suffering and people have been uprooted and are concerned about their livelihoods and futures, the health of their children... it is these issues that will be the long-lasting fallout of the accident."

UNSCEAR's report "will be the most comprehensive international scientific analysis of the information available to date" when published in full later this year at the UN General Assembly.



Fukushima Diachi plant after explosion in Unit 3.

Thorium fuel being tested in Halden

Thorium fuel is now being tested in the Halden research reactor in Norway. It was loaded in the last week of April, defining the start of a physical test program that will simulate how it operates in a power reactor.

Led by Norwegian company, Thor Energy, the test will provide unique information necessary for qualifying this new fuel material for commercial use in current reactors.

The thorium fuel is in the form of ceramic pellets composed of a dense thorium oxide ceramic matrix containing about 10% of finely blended plutonium oxide as a 'fissile driver'. As a mixed-oxide (MOX) fuel variant it is familiar to the nuclear industry, but thorium-MOX fuel has certain advantages compared to the uranium-MOX fuels in use at some reactors around the world. It promises higher operating safety margins

due to higher thermal conductivity, a higher melting point, and produces no new plutonium as it operates. Thor Energy pointed out that thorium-plutonium fuels therefore provide a new option for reducing civil and military plutonium stocks.

The irradiation test will run for around five years after which the fuel will be studied to quantify its operational performance and gather data to support the safety case for its eventual use in commercial reactors. Areas for study include a range of chemical and physical changes in the fuel related to high temperatures, neutron flux, interactions with fuel cladding and changes in ceramic structure.

U of S builds Cyclotron Centre

On June 6, 2013 the Board of Governors of the University of Saskatchewan announced that it had approved construction of Saskatchewan's first cyclotron and associated laboratory–a multi-purpose facility for advanced research, training and the production of medical imaging agents for use at the PET-CT scanner at Royal University Hospital (RUH).

With $25.5 million in total funding (includes equipment, construction, regulatory approvals, and other costs) from the Government of Saskatchewan and Western Economic Diversification Canada, the facility will be located in the former Animal Resource Centre on campus between the Canadian Light Source and the Western College of Veterinary Medicine. PCL Construction Management Inc. is the successful bidder to renovate and expand the building to accommodate the cyclotron, which will be supplied by Advanced Cyclotron Systems Inc. of Richmond B.C. Site preparation will start this month.

The Sylvia Fedoruk Canadian Centre for Nuclear Innovation, a U of S subsidiary, will manage and operate the U of S-owned cyclotron and lab facility, engaging researchers, students and industry partners from a broad range of disciplines to address human, animal, and crop/plant diseases and other molecular imaging applications.

The facility is expected to be operating for research purposes by 2015, and by 2016 will be fully operational, including supplying medical isotopes for the new PET-CT (Positron Emission Tomography – Computed Tomography) scanner at RUH. For many types of cancer, a PET/CT scan is the most effective way to identify the disease. The facility will provide Saskatchewan-based researchers with the state-of-art resources they need to develop new radiopharmaceuticals–drugs containing radioactive materials–that can be used to detect and diagnose diseases such as cancers, Alzheimer's, Parkinson's and multiple sclerosis, as well as to guide treatment strategies for these diseases.

Cyclotrons have been in use around the world since the 1940s to produce radioisotopes for hospita major urban centres. As the isotopes produced away in a matter of hours, extraction and researc best done in adjacent laboratories, specially des to enable researchers to work safely.

Nuclear Terrorism Act Recei Royal Assent

On June 19, 2013, Rob Nicholson, Minist Justice and Attorney General of Canada, annou that the *Nuclear Terrorism Act* had received Assent. The legislation amends the Criminal Co provide greater protection from nuclear terrorisr

The *Nuclear Terrorism Act* creates four new *Cri Code* offences related to nuclear terrorism:

- making a device, or possessing, using, transfe exporting, importing, altering or disposing of ı ar or radioactive material or a device, or comm an act against a nuclear facility or its opera with the intent to cause death, serious bodily or substantial damage to property or the en ment;
- using or altering nuclear or radioactive mater a device, or committing an act against a nı facility or its operation, with the intent to con person, a government or a domestic or interna organization to do, or refrain from doing, any
- committing an indictable offence for the purp obtaining nuclear or radioactive material or a d or to obtain access to a nuclear facility; and
- threatening to commit any of these offences.

These amendments will permit Canada to the Amendment to the Convention on the Ph Protection of Nuclear Material and the Interna Convention for the Suppression of Acts of N Terrorism.

The new legislation will come into force on a be fixed by order of the Governor in Council.

Second arch section for Chernobyl cover

A steel arch weighing 3800 tonnes is being lif the Chernobyl site in Ukraine, the second such stone for the New Safe Confinement project.

When complete the NSC will cover the broker tor building of Chernobyl 4 as well as its 'sar gus' shelter. Airtight to protect the environmen radioactive dust within, it will contain remot dling equipment that will enable engineers to e ally dismantle the remains of the reactor.

The new arch was made in segments, no together, is set to be lifted to a height of 85 me

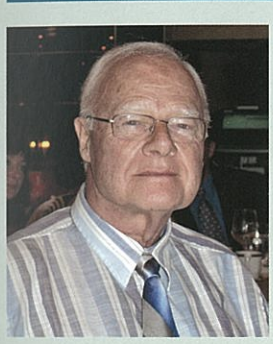
Workers walk among the red beams of the arch and the white columns that will support it when raised (Image: Chernobyl NPP)

The NSC will be assembled in two halves, each comprising several of these arch sections. The first half will be completed and then pushed into a holding area in front of unit 4 while the second half is assembled. The two sections will then be joined together by the end of 2014 and fitted with cladding, cranes and remote handling equipment during 2015.

The entire completed structure - weighing some 31,000 tonnes - will be pushed over unit 4 and part of its turbine hall using hydraulic jacks in a three-day sliding operation scheduled before the end of 2015. End walls will then be built to strengthen and seal the NSC, creating a means of confining dust and debris from dismantlement while protecting it from harsh weather. However, the structure is not designed for radiation shielding: gamma radiation doses outside of the NSC will be about the same as they are now.

Researched and written by World Nuclear News

Obituaries



John Sainsbury

John David Sainsbury died peacefully Friday May 10, 2013, at the Gatineau hospital following a brief stay. He was 76. He graduated from the University of Toronto (Engineering), the University of Birmingham, and the London School of Economics prior to joining AECL.

John started his diverse and distinguished career at AECL in 1961 at Chalk River as an engineering analyst, and held progressively more responsible positions at AECL CANDU culminating in his retirement in December 1993. In 1978 John became Manager of the Safety Analysis branch. This branch had the responsibility for performing most of the accident analysis required for the Bruce A, Bruce B and Pickering B (initial stages), Gentilly 2, Point Lepreau, Cordoba, and Wolsong projects. During 1977, he represented AECL on the Inter-Organizational Working Group formed by the AECB to review reactor licensing and to recommend solutions to many issues. In 1980, he became the Manager of the newly formed Licensing Department with responsibilities for all AECL regulatory interfaces, AECB and MCCR, plus pioneering the use of Probabilistic Safety Assessments for CANDU. During this period, the Department obtained the first power operating licences for all CANDU 600s for their clients (Gentilly-2, Point Lepreau, Cordoba) and assisted with obtaining the licences for Bruce B, Pickering B and Darlington.

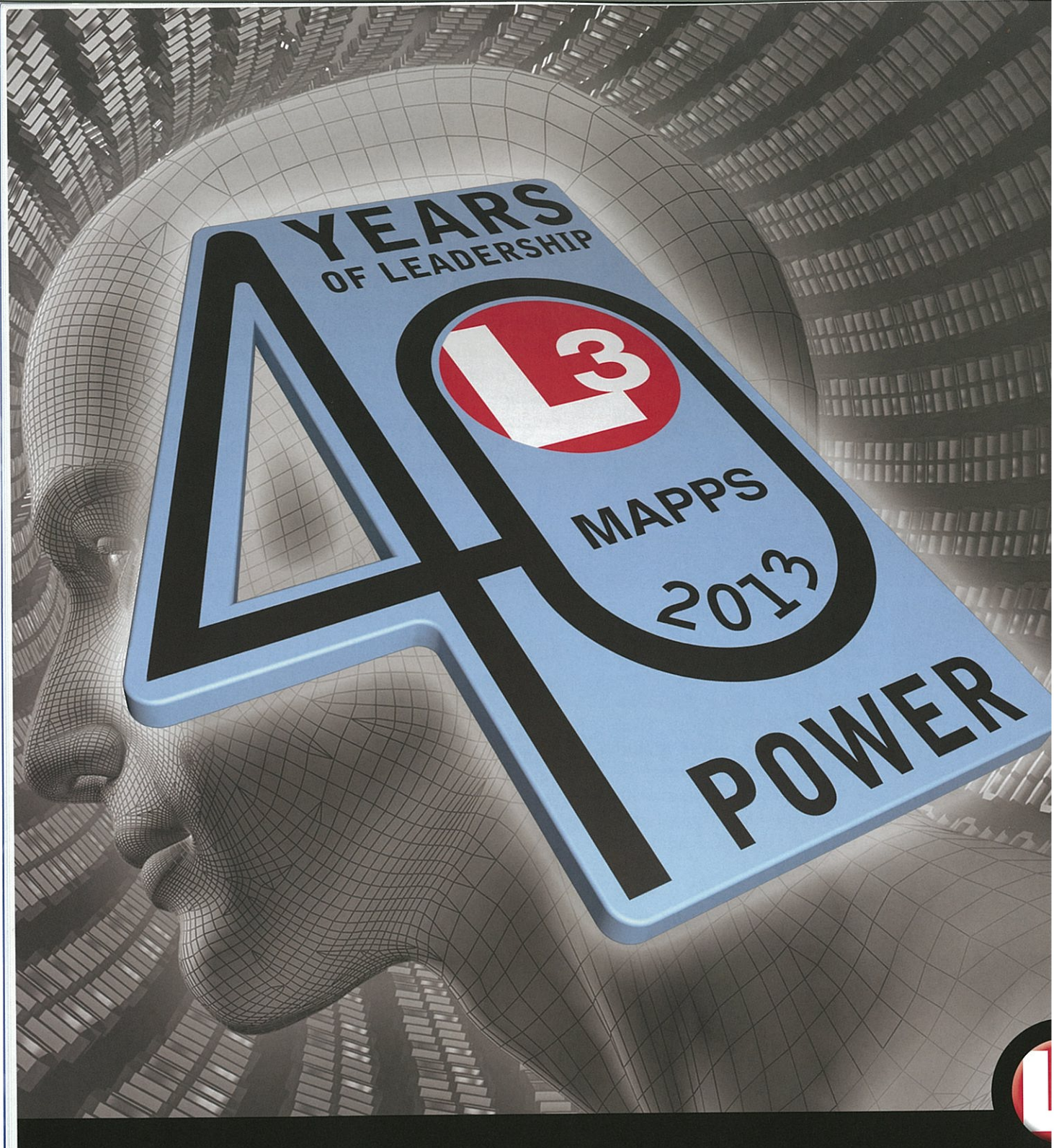
The Licensing Branch also played an important role in CANDU international marketing in countries such as Turkey, Romania, Korea and Egypt. From April 85 to October 1987 he participated in a task team studying ways to improve capital cost and construction methods for CANDU. From then until June 1988 he was the Assistant Technical Manager in the AECL team assigned to the Canadian Department of Defense during their evaluation of the British and French nuclear submarines.. From June 1988 to June 1989, he returned to be the Manager of the Licensing Department for the CANDU 3.

From June 89 to August 91 he was the Science Counselor at the Canadian Permanent Mission to the UN in Vienna responsible for the IAEA and IIASA.. From August 91 to December 1993, he was appointed Specialist, Safety and Licensing at AECL CANDU working primarily with Ontario Hydro as a safety advisor to the Pickering Engineering Dept. developing a strategy for safety upgrades on the Pickering NGS A stations. On returning to Sheridan Park, lead a team preparing a power reactor proposal for Indonesia, and a team studying the option of amalgamating the safety analysis resources of AECL and Ontario Hydro. Following retirement, he took on varied consulting roles in the nuclear industry and pursued his passion for photography and travel.

At his wish, there was no memorial service.

He is survived by his wife Lise and their families. Friends may send condolences and remembrances to lise.madore@bell.net .

By Don Rennick



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CNS news

Annual General Meeting

The 16th Annual General Meeting of the Canadian Nuclear Society as an incorporated organization was held Sunday 9 June 2013 at the Marriott Downtown Eaton Centre hotel, immediately prior to the opening of the CNS Annual Conference.

With over 30 members present and a number of proxies received, Secretary Colin Hunt declared a quorum existed.

Outgoing president, John Roberts presented his report on the period June 2012 to June 2013, the operating year for the Society. *(By law, the CNS fiscal year is the calendar year.)* His report is reprinted in this issue of the *CNS Bulletin.*

Past President Frank Doyle then presented a slate of nominees for the CNS Council for the 2013 – 2014 operating year. He noted there were just enough nominations to fill the Council and called for nominations from the floor. Receiving none, he declared the presented slate elected by acclamation. *(See list in the CNS News section of this issue.)*

Then two motions were tabled to enable the CNS to proceed with its transition to incorporation under the recent federal Not for Profit Corporations Act. One motion deleted section 4(b) of the CNS By Laws which allowed two classes of membership, and replaced it with a new section specifying just one class, as recommended by Industry Canada and by the lawyers retained by the CNS for the transition.

The other motion empowered two officers or members of the CNS Council to submit the above motion to Industry Canada.

Both motions were passed. (This will permit CNS Council to apply for what is called "Continuance" under the new Act which will follow a Special General Meeting to be held during the CANDU Fuel Conference in September.)

Treasurer Mohamed Younis presented his report but reported that the Auditor's report was not yet available. It will also be presented at the Special General Meeting.

Then a number of reports from Divisions, Committees and Branches were presented. *(An edited version of the extensive one on Branch activities is reprinted in this issue.)* All of the submitted reports will be posted on the Members section of the CNS website.

With the essential business completed, John Roberts passed the traditional gavel to Adriaan Buijs and Buijs reciprocated by presenting Roberts with a plaque commemorating his period as President.

Adriaan Buijs then spoke briefly about his vision for the coming year. *(His address is reprinted in this issue.)*

THE AGM was then adjourned, just in time for attendees to go to the Conference opening reception.

Incoming President, Adriaan Buijs (R) presents outgoing President, John Roberts with a plaque in recognition of his services as CNS President for 2012 – 2013.

New Role for Eric Williams

Eric Williams, a Past-President of the CNS and still an active member has taken on a new role following his relatively recent retirement from Bruce Power.

Eric has chosen to enter the ministry of the Anglican Church.

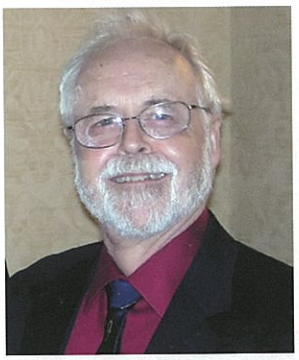
On Thursday, June 6, 2013, he was ordained as a 'Transitional Deacon' at the Cathedral of St. Paul, in London, Ontario, and licensed to the Circle of Faith Parish, Diocese of Huron, as "Deacon Assistant to the Rector". He expects to be ordained as a Priest in about a year.

Eric has been active in his Parish and, over the past few years he has been officiating at three or four Morning Prayer services per month in that four-point parish.

All this happened just three days before the beginning if the CNS Annual Conference in which Eric was very involved.

CNS President's Report

By JOHN ROBERTS



The past year has been a challenging one for the Canadian Nuclear Society (CNS), marked by signficant achievements both by Canada's nuclear industry and the Society. Perhaps the most outstanding achievements during the past year were the return to service of Bruce A Units 1 and 2, and the Point Lepreau nuclear reactors. In the case of Bruce, this is the first time ever that nuclear reactors of any kind have been returned to service after a prolonged shutdown of more than 10 years.

By contrast, the CNS was disappointed by the partly-political decision to close Gentilly 2 rather than undertake refurbishment. While the CNS understands the economic decisions at play, we are of the view that isolating itself from operating nuclear technology may not serve the province of Quebec well in the years to come.

During the past year, the CNS has held a number of successful events, perhaps most notably the Annual Conference in Saskatoon. Attendance at the conference was strong; the number of technical papers was high. This was in large part due to strong support from our corporate sponsors and the Government of Saskatchewan.

Also during the year, the CNS launched a new series of courses, Nuclear 101, a training course intended for communicators in the nuclear industry. Demand for this course has proven to be so strong that the CNS is striving to increase the number of these courses this year and for the years to come. There were a number of other successful conferences and courses during the year, details of which can be found in the Program Chair's report.

A new initiative on the part of the CNS began in 2012 with its participation in the federal government's request for expressions of interest in AECL. Based on that experience, CNS Council has decided that the Society shall become more active in participating in public hearings and licence procedings.

The CNS was also confronted during the year with the need to comply with new legislation – the Not For Profit Corporations Act. This statute requires some important changes in the CNS By-Laws. These changes will be proposed to the Membership during the Annual General Meeting and a special Meeting Membership during the fall.

The Society was greatly saddened by the death CNS members during the past year. Jim Harvie d 2012. Well known to all of the Society's member was a Past President of the CNS and former Di of Reactor Regulation at the Canadian Nuclear Commission. Paul Hinman, very active in the A branch was a stalwart and staunch supporter CNS, died in 2013.

For the past several years, the CNS has been ing to introduce new, younger members into C coming from a wide variety of professional grounds. I would like to thank the new membe volunteering their time and services to the S and the support of their employers, particularly the already extensive demands upon these indiv at the beginning of their professional careers.

Recently I was honoured to be invited to atte inaugural face-to-face meeting of the Alberta b held at the University of Calgary. With the ent lessening interest in nuclear within Al the branch has innovative ideas to rejuvena branch. I was invited to, and visited and add five of the seven active branches.

The recent "day 2" hearings for Pickerin B NGS gave the CNS an opportunity to int in favour of the relicensing. The excellent prepared by Colin Hunt, led to the commiss being able to immediately ask substantive tions. Our written and oral presentations we received and I believe the commissioners welcome future interventions by from CNS. were observers present from Bruce Power, wh been most complimentary on the CNS' presen and performance, and look forward to simila intervention in 2014.

In closing, I would like to thank the C Branch, Committee and Division Chairs, a CNS Staff for their hard work and dedication a demanding year. I would also like to thank Doyle for his leadership in securing PBNC for for 2014. And finally I would like to thank J Plourde, incoming 1st Vice President, for his v establishing the joint industry-Society task for

John G. Roberts. C. Chem., M.R.S.C.
President, CNS, 2012-2013

Address by incoming president Adriaan Buijs

For some of you, this may be a déjà vu all over again. It certainly is for me, as I had the pleasure to stand here in this situation two years ago. This is my second term as president and I am looking forward to it. I will be trying not to make the same mistakes as during my previous tenure, but instead make a whole new set of them.

Within the Canadian Nuclear Society's Council, we have been talking at times of extending the term of the president beyond one year. Past presidents have often felt that one year is almost not enough to be able to make an impact, even when one considers that the president has prepared himself for his task while being vice-president.

However, the presidency does require a significant time commitment and employers may be hesitant to release their employees for such an extended period of time. That leaves those of us who are retirees or employed in academia, who can dispose of their time more freely to take on this job for longer than a year. More generally, this touches on an important theme in the Canadian Nuclear Society, that of succession planning. It is one of the reasons why the theme of this conference is Nuclear, the Next Generation, and why we are so happy to have many students participate in the conference.

In my particular case, the reason for recycling the president was that the president designate, Len Simpson, who had served the society for a long time already, had to withdraw from the nomination for health reasons. I would like to thank him here for the work he has done for the society, notably as the secretary. I stepped in because I had the experience, the opportunity, and because I am happy to do it.

Since my previous term, we had two outstanding presidents, Frank Doyle and John Roberts. Past President Frank Doyle, who is still a pillar of the CNS executive and made great contributions to this conference, has been thanked for his activities in earlier occasions. Here, I would like to thank John Roberts for his leadership of the past year. In addition to leading the day-to-day activities he has initiated two notable activities: a revision of the by-laws, which was brought upon us by new government regulations, and much more importantly for our society, he initiated, with the help of Colin Hunt, CNS contributions to hearings by the CNSC. In the past, we had shied away from those, because we did not want to be seen as a lobbying organisation. However, John sought advice and ascertained that our intervening in these hearings, where we put forward our knowledge-based opinion, does not constitute a lobbying activity.

We will be pursuing this line of activities, as it is closely related to the health of the industry, the society and the Canadian people. However, I must stress that we do not employ people to do this, so all activity in this area will have to come from volunteers. The CNS is a society of volunteers.

At this point, I should look back at the promises I made three years ago. One of them was to get the Society under professional support by an executive director. Meanwhile that has happened, and we have Ben Rouben as our executive director now. Similarly, we have a communication director now, Jeremy Whitlock. For some time, we have had professional help for our website as well, in the person of Elmir Lekovic, which really improves the image of the society. There are a number of other areas in which we will need professional help in the future as well.

Other promises have not come to fruition yet: the establishment of a technical journal is progressing slowly, and has received an extra dimension by the establishment of a Journal by AECL. We have been in communication with AECL, and there will be a follow-up.

As for new promises, in the short and medium term, it will be important for the society to grow its member base. This can be helped by creating new initiatives and demonstrating the value of the society. New courses and conferences need to be established, and in particular need to address new sectors of the industry and even other industries. Many of our activities are directed towards the same people and the same industries. This affects our ability to attract attendees and monetary support. I see this as an important activity for the coming year.

So, in summary, I am looking forward to working with the new council to follow through on existing initiatives and to facilitate new ones.

CNS presents brief at CNSC hearing on Pickering NGS

The CNS Council decided to be an intervenor at the public hearing held by the Canadian Nuclear Safety Commission on the renewal of the Operating Licence for the Pickering Nuclear Generating Station held in Pickering, Ontario, May 29 – 31, 2013.

The Society was represented by President John Roberts and Secretary Colin Hunt, who prepared the written submission.

Following are John Roberts opening remarks.

The written submission will be on the CNS website.

John Roberts Opening Remarks

Good morning/afternoon, ladies and gentlemen of the Canadian Nuclear Safety Commission. My name is John Roberts, and I'm the President of the Canadian Nuclear Society. With me is Mr. Colin Hunt, Secretary of the Canadian Nuclear Society.

By way of introduction, the Canadian Nuclear Society is the learned society of Canada's nuclear science and technology community. We have over

1,000 members drawn from virtually all areas of Canada's nuclear science and engineering infrastructure. Our purpose is communication to aid the spread of accurate technical information about nuclear science and engineering technology among Canada's nuclear energy professionals and to interested members of the general public. As a volunteer society, we undertake this through a number of programs, including technical conferences, support for public and university education, and a small but effective scholarship program.

The purpose for which we are gathered today is the prospective renewal of the operating licences of the Pickering A and B nuclear power stations, and the combining of those licences into one operating licence.

I do not propose today to critique specific aspects of the technical safety performance of the Pickering A and B NGS. Ontario Power Generation has submitted its application along with the technical information to support it, and the CNSC staff has provided its response.

Instead, my purpose here today is to highlight the importance of Pickering NGS and the renewal of its operating licences. The safety decisions made by the CNSC should be made in the context of their importance and significance to the welfare of Canadians, to the economy of Canada and Ontario.

It should be clearly understood that all human activity contains some element of risk. An activity as simple as turning on a stove to boil water in a kettle contains some risk of injury. We tolerate these risks for two reasons:

1. That the risk is relatively low in absolute terms.
2. That the activity undertaken provides benefits.

This principle applies to the operating of the Pickering NGS as well. Our submission to you outlines in some detail the benefits provided by the operating of Pickering NGS, benefits which citizens in Ontario began to enjoy 42 years ago. And to this day, the absolute risk of operating the reactors has remained acceptably low, while the benefits have remained disproportionately large.

There are those who suggest that Ontario has alternatives to the use of nuclear power. Such a claim is false. Ontario, unlike British Columbia, Manitoba and Quebec, has no large, undeveloped hydraulic resources. Ontario, unlike Alberta and Saskatchewan, has no significant reserves of fossil fuels. In fact, since the early 1950s, Ontario has had only two significant sources of new electricity generation: imported fossil fuels, or nuclear power. These facts are just as true today as they were in the 1950s; geographic facts do not change except over geologic time.

The provision of reliable, economic electricity in large quantities has been and continues to be an essential component of Ontario's economic life. It is safe and clean kilowatt-hours, produced at competitive costs and to a despatchable schedule, which power Ontario's households. Reliable electricity constitutes a large part of Ontario's industrial strength.

So it is the view of our Society that the decisions made by the CNSC are not purely abstract questions of safety. These decisions made by you have direct economic and physical consequences for the lives of millions of people. Our Society accepts that the absolute risk of the operation of Pickering is acceptably low, and that the benefits provided by it are extremely high. I look forward to any questions you may have regarding our written submission or my statements here today.

2013 – 2014 CNS Council

The following members were elected to serve on the governing Council of the Canadian Nuclear Society for the 2013 – 2014 term.

Executive

President	Adriaan Buijs
1st Vice-President	Jacques Plourde
2nd Vice-President	Vinod Chugh
Past President	John Roberts
Treasurer	Mohamed Younis
Secretary	Colin Hunt

Members at Large

Parva Alayi	Tracey Pearce
Fred Boyd	Jadranka Popovic
Emily Corcoran	Ben Rouben
Ruxandra Dranga	Nick Sion
Dan Gammage	Ken Smith
Krish Krishnan	Aman Usmani
Laurence Leung	Jeremy Whitlock
Kris Moha	Alex Wolf
Dorin Nichita	Syed Zaidi
Peter Ozemoyan	

The Council members are listed on the CNS website, with photographs and brief description of background.

Annual Report from Branches

Following is a severely edited, for length, version of the report submitted by CNS Branch Affairs chair, Syed Zaidi, to the CNS Annual General Meeting, 9 June 2013.

ALBERTA Branch – Duane Pendergast

The Alberta Branch was established in 2007 and has reached a membership of about 50. Many members have been recruited from the student body at University of Calgary through the efforts of Jason Donev.

Branch members still communicate primarily via the Google Groups facility, email and the occasional teleconference. Membership in the Google Group is holding steady at about 80. Membership includes CNS members from outside Alberta as well as a few guest members with an interest in nuclear energy. A good mix of nuclear experience is thus available within the Group. A contact page for the Alberta Branch was established on the CNS website in 2012. Few inquiries have been forthcoming.

Economic conditions have temporarily changed the nature of Nuclear Advocacy Coalitions in Alberta. The Alberta Branch is tending to concentrate more on long term initiatives involving education to help ensure that future generations remain aware of the tremendous need for energy and the potential for nuclear energy. Some highlights of the past year's activities follow.

CNS Annual Conference 2012

The Alberta Branch was very well represented at the CNS Annual Conference and Western Focus Seminar in Saskatoon. Several Alberta based members presented papers and/or served as session chairs and organizers. Duane Pendergast posted the Western Focus Seminar presentations and papers on the "Guest" pages of his "Computare" website.

Student Tour to Saskatchewan Nuclear Facilities – September 2012

University of Calgary students, associated with Jason Donev's classes on energy organized a trip to visit nuclear facilities in early September. Cameco and CNS provided financial support for air transport to a Cameco mine site.

Alberta Science Teachers Conference – November 2012

Branch members manned a booth at the Alberta Science Teachers Conference in Banff.

CNA sponsored Small Reactor Workshop, November, 2012

Shaun Ward, Duane Bratt and Jason Donev all participated in a CNA sponsored Small Reactor Workshop in Calgary on Friday, **November 2, 2012**. Shaun reported that it was attended by 35-40 government of Alberta bureaucrats; U of C students and industry representatives.

Educator Initiatives

Jason Donev and Duane Bratt from University of Calgary and Mount Royal University, respectively, continue with their courses involving nuclear technology and engage others with nuclear educational opportunities.

Jason's introduction to nuclear power class at U of C has maintained last year's numbers (almost triple what it had been previously), and has started including students from engineering as well.

Duane Bratt is well known to the media and thus continues to be engaged in numerous radio and television interviews.

Canada Wide Science Fair

Duane Pendergast served as a judge at the Canada Wide Science Fair held in Lethbridge, Alberta from May 12-17. Some 550 student projects were on display involving about 750 students.

Alberta Branch Meeting – Calgary, May 23, 2013.

Members met with CNS president John Roberts in Calgary, hosted by Jason Donev at U of C.. John spoke on the importance of chemistry in nuclear plant operations. U of C students presented posters intended for the CNS Annual conference. Duane Pendergast spoke to the need to refocus Branch initiatives to concentrate on education. A committee was proposed to study a Branch organization structured to make the best use of member skills to help accomplish that goal. Jason Donev agreed to Chair the committee with Duane Pendergast serving as Secretary. Results are expected to be prepared for CNS Council by September, 2013.

BRUCE Branch – John Krane

The Bruce Branch held a dinner meeting on **October 23,2012**. The meeting featured two presentations by Juris Grava, on Fukushima and an update on emerging nuclear countries.

In March 2013 the Branch arranged a presentation by Julia Grein, a 16 year old high school stu-

dent from Hanover Ontario in the Bruce Power Auditorium. Her topic was: *Can Hydrogen (H-1) be Used to Determine Deuterium (H-2) Absorption into CANDU Pressure Tubes*?

The presentation was generally well attended by Bruce Power technical staff and CNS members. A follow-up article was published in the Bruce Power "The Point" publication.

The CNS Bruce Branch held a dinner meeting and presentation on Tuesday, **April 9, 2013** at which: **Sean Russell,** Director of Adaptive Phased Management Repository Research and Development at the Nuclear Waste Management Organization spoke on *Adaptive Phased Management- Canada's plan and the process to find an informed and willing community to host a used nuclear fuel long term care facility.*

The meeting was very relevant as a storage facility for low and medium waste is proposed for the Bruce site.

The CNS Bruce Branch presented two Achievement Awards at the April 2013 Bluewater District Science Fair.

CHALK RIVER Branch – Ruxandra Dranga & Bruce Wilkin

Branch Annual General Meeting 16 Oct 2012

A review of the events and activities held during 2011/2012 were discussed, along with a financial report, and elections for a new executive committee.

Seminars Held:

1. In **June 2012**, the CNS Chalk River Branch, PEO Algonquin Chapter and AECL teamed up to organize an evening event to celebrate the **50th Anniversary of NPD**. The speakers included: Lorne McConnell, Fred Boyd, Jon Jennekens, John Hilborn, JP Letourneau.

Over 60 people attended the event, including a number of past NPD employees. We displayed pictures and original NPD reports, and played the original NPD movie from 1962.

- Deep River Science Academy joint lecture series in **July 2012**:
  - o Jeremy Whitlock, Metin Yetisir, Ruth Brinston, Bill Diamond and John Katsaras (ORNL) presented lectures.
- PEO / CNS joined workshop: "Introduction to Transformational Leadership for Excellence". This event was attended by 30 – 40 people, eager to find out more about Transformational Leadership and learn some of the skills that advance people and organizations.
- Harry Peery- "An ancient disease in modern times – overview, update and future directions".
- Bruce Heinmiller – "A Critical Assessment of Radiation Folklore". This well-received one-hour talk was organized in collaboration with the ZED-2 Winter School.
- Ian Clark (professor at Ottawa University) - "Bury It - a Seminar on Nuclear Waste". This seminar was organized in collaboration with the PEO Algonquin Chapter
- John Roberts - "Overlook Chemistry at Your (Plant's) Peril". This talk was part of the Annual CNS President's Dinner organized by the Chalk River Branch.

Education and Outreach

The Branch sponsored a number of awards, scholarships and education programs.

Ionizing Radiation Workshop

Bryan White presented a version of the CNS Ionising Radiation Workshop to the DRSA students and tutors at the DRSA Residence cafeteria. Approximately 23 students were introduced to aspects of the science.

AECL Open House - 2012

AECL hosted its first Open House in over a decade. Over 2000 people attended. Jeremy Whitlock, Morgan Brown were among the speakers. The CNS and the CNS Chalk River Branch had a booth at the event providing information on the various courses and conferences taking place this year, basic information about the CNS and the activities that the Chalk River Branch is undertaking. Nuclear Canada Yearbooks and Bulletins were handed out to those dropping by the booth. The Rutherford Documentary DVD was played in the background and Bryan White performed Geiger counter demonstrations to a large crowd throughout the day.

Summerfest Planetarium – 2012

The wonders of space and some of the science behind them were brought to Deep River during the Summerfest events by means of the Science North Planetarium sponsored by the CNS – Chalk River Branch. Three shows were presented: **Night Sky Tonight; Our Celestial Neighbors; Space in the News**.

Essay Competition

This was the last year the Chalk River Branch organized an essay competition. This competition targeted graduating Grade 12 students who would be pursuing undergraduate studies in Engineering, Physics, Mathematics or Chemistry.

Renfrew County Regional Science Fair and Gr. 6- 8 Poster Contest

The Renfrew County Regional Science Fair (RCRSF) and CNS Elementary School Poster Contest took place on April 6th. Volunteers from the CNS CRB judged the

posters for the RCRSF "Nuclear Research Award of Excellence", provided by the CNS Chalk River Branch, and the Poster Contest for Grades 6 to 8.

NPD 50th Anniversary Celebration: Jon Jennekens, Lorne McConnell, Ruxandra Dranga, John Hilborn, J.P. Letourneau, Bryan White.

DARLINGTON Branch – Jacques Plourde

In 2012-2013, the Darlington Branch focused on:

1. Implementing the NOM Division's 'Operating Utility Engagement' initiative, and
2. Preparing a merger with the Pickering Branch to form a new Durham Branch.

In the process, a number of activities took place:

- The merger concept was presented at the CNS AGM in Saskatoon, Jun 2012.
- A communiqué was issued to senior management at OPG, explaining the merger and the 'Operating Utility Engagement' initiative.
- Face-to-face discussions ensued, resulting in the appointment of:
  - o Mark Elliott, Chief Engineer at OPG, as Executive Sponsor
  - o Leon Simeon, Pickering Branch Chair, as Interim Chair of the new Durham Branch
  - o Mayur Upadhyay and Polad Zahedi as Utility Representatives

Since the UOIT Branch is located within Durham Region, this year saw a renewal in collaboration:

- UOIT events circulated within the Darlington & Pickering Branch membership.
- Face-to-face discussions to determine the best way to interface.
- Support of UOIT events (eg, Energy from Thorium Session)

GOLDEN HORSESHOE Branch – Kurt Stoll

The Golden Horseshoe Branch continues to focus the majority of its time and funds on hosting 90 minute seminars.

On **February 26** Nick Sion presented a seminar titled "Radiation Hazards and Countermeasures in Space Missions." Nick discussed the challenges of long duration space travel and educated everyone on the doses expected for a mission to Mars.

On **March 5** Stephen Yu, Director of Candu Products Technology at Candu Energy Inc. spoke on "The Enhanced Candu-6 (EC6)" and discussed the various improvements which have become sales-points of the EC6. This was an especially interesting presentation for our members because the vast majority of them are familiar with OPG's ongoing reactor procurement process, and OPG's interest in EC6.

On **March 21** the Branch participated again in the Bay Area Science and Engineering Fair (BASEF). This year the fair was held at Hillfield-Strathallen College in Hamilton. The GHB presented $400 in the form of 4 special-awards to students in grades 7 through 12

On May 14 Dr. Jason Donev from the University of Calgary (and the Alberta CNS Branch) presented a seminar titled "How Science Fiction has Influenced Science and Technology." Dr. Donev has given this seminar to a variety of groups in the past and found it to be very well received – his presentation to our Branch was no different. A number of non-nuclear graduate students and science fiction enthusiasts attended.

MANITOBA Branch– Jason Martino

While the year was very busy at Whiteshell Laboratories with many ongoing decommissioning activities, the year continued to be quiet for branch activities.

We have plans to organize a few presentations during the upcoming year to hopefully generate some interest and gain new members.

NEW BRUNSWICK Branch – Mark McIntyre

The New Brunswick Branch was happy to resume operations following the Refurbishment at Point Lepreau. Our events in 2012-2013 included:

On Wednesday **March 27, 2013,** The CNS NB Branch travelled to the Radiation Oncology department at the Saint John Regional Hospital where Jon Dysart, PhD, gave a lecture discussing the various roles of Physicists, Radiation Technicians, and Radiation Oncologists to bring about the best treatment plan for each patient. The lecture was followed by a detailed tour of the Radiation Oncology department and the various equipment in their "arsenal" to treat and control cancer.

CNS President, John Roberts, was in New Brunswick **April 22-April 25, 2013.** to deliver lectures to UNB students (at the UNB campus in Fredericton) and to the NB Branch of the Canadian Nuclear Society in

Saint John. During his lectures, John shared some of his personal observations on how to ensure station chemistry receives the attention it deserves.

John was very pleased to have met Wade Parker, and to receive a PLGS pin.

Wade Parker presents a PLGS pin to John Roberts.

OTTAWA Branch – Mike Taylor

The Branch continues to operate effectively, with close to 100 members. Three long-time members of the Executive have retired, Ted Thexton, from the position of secretary (replaced by Jeet Khosla). Ron Thomas, from Program Convenor (replaced by Ruth Brinston), Christine McNally, from Education Officer and Webmaster (replaced by Satyen Baindur as webmaster).

Sadly, we also lost Jim Harvie, who died late last year, and had been Past Chairman as well as being a Past President of the Society.

Meetings

During the year, the branch presented:

October 2012: Dr. Bill Diamond on "Accelerator Production of Medical Isotopes".

November 2012: John Roberts "Observations on Nuclear Plant Chemistry and on the CNS".

January 2013: Joint meeting with the CNSC, addressed by Mr. Paul T. Dickman, Dr. Dale E. Klein, and Dr. Michael L. Corradini of the American Nuclear Society (ANS) who discussed their report on the incident at the Fukushima power plant.

February 2013: Mr. Ramzi Jammal, the CNSC's Executive Vice-President and Chief Regulatory Operations Officer; "Fukushima-Daiichi NPP Site Visit and Decontamination Tour of the Tohoku Region". This was a branch dinner event.

March 2013: Earth Sciences Professor Ian Clark on the geology of burying nuclear waste and the safety of proposed nuclear waste repositories.

May 2013: by Dr. David LeBlanc of Terrestrial Energy Limited on "The Curious Tale of Molten Salt Reactors".

Education:

Two members of the Executive acted as judges at the Ottawa Regional Science Fair, held at Carlton University on Saturday **7 April**. Unfortunately, only one of the approximately 200 entries mentioned 'nuclear' and this one was awarded our prize.

PICKERING Branch – Leon Simeon

Branch Activities & Presentations

1. The Pickering Branch attended the graduation ceremonies of 2 local high schools and award three awards of excellence on behalf of the CNS – Pickering Branch.
2. Scheduled a CNS presentation by Mike Soulard on **September 29, 2012** on "Enhanced CANDU 6 Design".
3. Scheduled a CNS presentation on **November 30, 2012**. The topic of the presentation was "OPG's Approach to Equipment Abandonment" by Gary Albert.
4. Meeting arranged with senior OPG personnel to discuss the merger of the Pickering and Darlington branches. Please see Darlington Branch Report for details.

QUEBEC Branch – Michel Saint-Denis

Events

The announcement of the closure of the Gentilly 2 plant was a shock to the Québec nuclear community. Several members participated to events / information sessions, in some cases with the support of CNS members.

- Michel Saint-Denis, as Québec Branch CNS president, participated at a public expert panel to provide information in Bécancour on **October 17th** 2012.
- Michel Saint-Denis participated to a college debate on nuclear energy, as Québec Branch CNS president, in Jonquière, October 30th 2012.

Other CNS members were very active in the media to educate the general population and to provide factual information on nuclear science.

SHERIDAN PARK Branch – Peter Schwanke

Summary:

Due to the 3-month long strike at Sheridan Park last year and with no venue being readily available for seminars, the Sheridan Park branch has not had any activity save for its involvement in the Peel Region Science fair that was held in April. We are currently in the process of revamping the executive committee following the departure of the chair and the treasurer from the branch executive in the winter.

Activities of Note:

- **Peel Region Science Fair** (Louise Arbour Secondary School: April 6th and 7th)
  - o A donation of $1000 was made to the Peel Region Science Fair to provide cash prizes as well as funding to support the organization of the event. The top winners in the regional fair will participate in the national-wide fair in Lethbridge.

- Three prizes were awarded on behalf of the CNS for projects concerning either aspects of nuclear energy or energy in general:

- **Executive Matters**
  - Peter Schwanke is currently the acting branch chair and acting treasurer and Raj Jain is the branch secretary. Efforts are underway to establish a new branch executive. A list of CNS branch members has been obtained to see who would be interested in becoming involved in the executive and in branch activities.

TORONTO Branch – Paul Gillespie

Summary

For the period of 2012-2013 the CNS Toronto Branch has held quarterly committee meetings to promote more seminars and additional means of outreach.

One seminar was held during 2012. **Jon Jennekens** gave a talk "*Celebrating 50 Years of Nuclear Power in Canada*", on **October 4, 2012** at the University of Toronto. 2012 marked 50 years since the first criticality of the Nuclear Power Demonstration (NPD) facility near Rolphton, ON in April 1962.. Jon presented an interesting and informative talk on the history and key players that led to this significant accomplishment.

Webpage

The Toronto Branch webpage has been maintained with the most current information regarding seminars to date.

UOIT Branch – Ray Mutiger

The CNS-UOIT Branch is a primarily student branch which begins its nominations for council positions in early October. The new council is elected for the end of October to facilitate a 2 months transition period. Terry J. Price ended his term in January 2013 and Ray Mutiger assumed the responsibility as branch chair.

A total of **26 activities** were conducted for the 2012 – 2013 year. This is an increase of **11 activities** from the **15 activities** conducted for the 2011 – 2012 year.

Membership

Registered Membership: 89 as of 2013/03/01
Facebook Membership: 265 members as of 2013/05/31

The CNS - UOIT Branch is one of the fastest growing branches. Increased awareness of registration and renewal of membership is required to increase its official membership. This is being done through outreach of Facebook, as well as the request for a message board in the Energy Research Center at UOIT. The CNS-UOIT Branch will be actively recruiting at the orientation session for the Faculty of Energy Systems and Nuclear Sciences in September to ensure that the first year students are aware of the society and have the opportunity to register.

The goal of the 2013 council is to see an increase in membership by 10% by the end of the 2013 year.

Website

Administrative control of the website has been granted to Patrick Dolloso, the branch webmaster, so that he can administer changes independently. He is working on updating the objectives of the branch, making information easily accessible, and keeping the website up to date.

Educational Outreach

The CNS – UOIT Branch has taken the initiative to start an educational outreach program. Contact has been made with Sandra McEwan, Director of Science and Ttechnology, Durham Region District School Board. She will help inform the local high schools of events at UOIT through the distribution of posters to the local high school teachers so that they are aware of the events taking place at UOIT. The attendance to these seminars is up to the discretion of the individual science teacher.

Also discussed was the organization of a 3 day camp at UOIT to showcase nuclear science and technology. This will be done similar to the Forensic Science camp (UOIT) and the Helix Project (University of Toronto), where the students will attend lectures, conduct laboratory experiments, and play sports to aid in their decision to pursue education in nuclear sciences and technology.

The CNS – UOIT Branch is creating an hour workshop for high school students on radiation consisting of a short lecture and a laboratory experiment conducted by the students. The experiment to be conducted is a cloud chamber made with dry ice, a radiation source, and isopropyl alcohol. The potential first school, pending approval, for this workshop will be Upper Canada College in Toronto.

2012 – 2013 Highlights in Picture

McMaster Nuclear Reactor & Tandem Accelerator Laboratory Trip

NEO Workshop 2013

The **2013 NEO Workshop** is the fourth of this series organized by the CNS Education and Outreach Committee.

It is aimed at improving the way we communicate the positive message of nuclear science and technology.

The 2013 NEO Workshop will be held, as for the previous ones, at the Sheraton Hotel in downtown Hamilton, Ontario, August 18 and 19, 2013.

The theme of this year's event is: ***Advocating the Benefits of Nuclear Technology – Engaging Industry and Government.***

Building on the experience of the previous three NEO Workshops this one will explore the best practices in the fields of communication, education and outreach and will address what the nuclear community has been doing right and where it should improve

A special "media training" workshop will be presented by Kevin Lennon of Trillium Corporate Communications (http://www.trilliumpr.com/). This workshop is ideal for people who have to interact with media and with the public but who haven't yet had formal media training. Kevin is a former Ontario Hydro employee and has extensive experience working with clients in the Canadian nuclear industry.

Who should attend NEO?

This workshop is a great opportunity for people who work in communications and public affairs. It is also a great opportunity for people who have technical jobs but who interact frequently with the public. AND this workshop would be of interest to people in academia who are regularly speaking about aspects of the nuclear industry.

Why should you attend NEO?

This is one of the few workshops dedicated to communications and public outreach related to nuclear.

The workshop is a great way to interact with colleagues with similar interests from within the nuclear industry to share information and best practices.

For more informational about the workshop visit the CNS website: www.cns-snc.ca

A view of a discussion session at the 2012 NEO Workshop.

10TH INTERNATIONAL CONFERENCE ON CANDU® MAINTENANCE

Revamping the Technical Strength of Our Industry

Metro Toronto Convention Centre, Toronto, Ontario, Canada **May 25-27, 201**

CALL FOR ABSTRACTS

CMC 2014 – Revamping the Technical Strength of Our Industry

CMC 2014 will bring together subject matter experts from Operating Utilities and Service Providers under the banner of CANDU® Maintenance.

With the objective of revamping the technical strength of our industry, CMC 2014 will focus on the following drivers that achieve and sustain high performance:

- **Policy and Vision,**
- **People and Skills,**
- **Processes and Tools, and**
- **Plant Equipment and Reliability.**

CMC 2014 will focus on future – making use of our past and present experience to meet the Needs and Interests of the Operating Utility (the NIOU concept introduced at CMC 2011). It will provide the ideal environment for open and free exchange of ideas, where industry experts will use past and current experience to identify, define and address tomorrow's challenges and opportunities.

Abstract Submission Deadline: October 4, 2013

Call for Abstracts

The Technical Program Committee invites the submission of abstracts of proposed presentations pertaining to the Technical Focus of the conference and the themes of the Plenary and parallel Technical Sessions.

Submission of full papers is optional, but PowerPoint slide presentations are required for inclusion in the Conference Proceedings.

Technical Focus

Abstract submissions are to address the themes of the four Plenary and parallel Technical Sessions:

Policy & Vision	People & Skills	Processes & Tools	Plant Equipment & Reliability
Regulatory Affairs	Succession Planning	Work Management	Nuclear & Support Systems
Standards	Training & Mentoring	Engineering Change Control	Primary Circuit Components
Business Strategies	Human Resources	Supply Chain Strategies	Secondary Circuit Components
Leadership	Human Performance	Tooling & Robotics	Electrical and I&C
Management Oversight	Staffing Strategies	Information Technology	Chemistry Control
Visions of the Future	Personnel Safety	Radiation Protection	Water and Air Systems
Refurbishment Strategies	Resource Modeling	Nuclear Safety	Maintenance Backlog Mgmt
New Nuclear Strategies	Maintenance Facilities	Process Mapping	Equipment Reliability
Continuous Improvement	Knowledge Transfer	Models & Simulations	Steam Generators & Heat Exchangers
Safety Culture	Teamwork	Life Cycle & Aging Mgmt	Valves
Learning Organization	Integrated Maintenance Planning	Obsolescence Mgmt	Pumps & Motors
Independent Verification	Contractor Management	On-Line Diagnostics/Testing	Emergency Water/Air/Power
		Maintenance Fundamentals	Reactor Control

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

Abstract Criteria and Submission

Abstract Criteria

Abstracts are to be no more than 300 words in length and submitting presenters must address the following criteria when preparing their abstracts:

1. Address the **Needs and Interests of Operating Utilities** (NIOU).
2. Be **forward looking**, using past & current experience to revamp the technical strengths of our industry.
3. **Identify, define and resolve** issues challenging the industry.
4. Address industry concerns around '**Policy & Vision**', '**People & Skills**', '**Processes & Tools**', and '**Plant Equipment & Reliability**'.
5. Strong preference will be given to Service Providers who **collaborate with utilities** as co-authors on submissions to demonstrate the value of their work to the industry.

These themes are broken down into potential subject areas in the table provided on the reverse side of this handout.

Abstract Submission and Presenter Notification

Details of how abstracts are to be formatted and submitted are on the conference website **www.cmc2014.cns-snc.ca**

Click on the link to CMC 2014, then go to the 'Presenters' Information' tab.

Completed abstracts are to be submitted online to: **https://www.softconf.com/d/cmc2014/**

All abstracts will be formally reviewed and assessed by the Technical Program Committee and presenters will be advised of the results of the Committee's review by **November 5, 2013**.

Conference Information

CANDU® Course

A CANDU® Course similar to that of CMC 2011 will be provided on Sunday, May 25, 2014 from 9:00 am until 5:00 pm. Details will be posted on the conference website.

Questions and Answers (Q&A)

Questions and answers will be formally documented during sessions for inclusion in the Conference Proceedings CD that registered participants will receive after the conference.

Trade Show

The conference will again include a Trade Show that will facilitate networking between the range of Service Providers and their utility customers. Details are on the conference website.

Sponsorship Opportunities

Conference sponsorship provides increased Corporate profile and visibility as "Leaders of the Industry", and recognition of your company as a supporter of the goals and objectives of the conference. Details are on the conference website.

Important Dates

Abstract Submission Deadline	October 4, 2013
Presenter Notification	November 5, 2013
Early Registration	March 21, 2014
Full Papers (optional) Due for Conference Proceedings	April 21, 2014
Hotel Reservation Cut-off Date	April 24, 2014
CANDU® Course	May 25, 2014
Conference Dates	May 25-27, 2014
Final PowerPoint Presentations (required) Due for Conference Proceedings	June 6, 2014

Registration Fees

Full Conference registration fees include HST and provide participation in the Sunday Welcome Reception, early morning refreshments, morning and afternoon beverage breaks, luncheons and a reception and dinner on Monday evening that includes a guest speaker. Registrations are to be completed online through the link on the conference website.

Full Conference	Early Registration *(paid by **March 21, 2014**)*
CNS Member	$700
Non-Member	$800
Full-time Student Member	$100
Retiree	$250
CANDU® Course Only	
CNS Member for CANDU® Course only	$300
Non-Member for CANDU® Course only	$350
Full-time Student for CANDU® Course only	$100

Hotel Accommodation

The InterContinental Toronto Centre Hotel is the official hotel for the conference and are providing guest rooms for CAD$185.00 (plus applicable taxes) for single/double occupancy. Details are on the conference website and reservations commence May 31, 2013.

Contact

If you have any questions about submission of abstracts, please contact the Conference Administrator:

Elizabeth Muckle-Jeffs
Conference Administrator
The Professional Edge
North America Toll-free: 1-800-868-8776
International: 1-613-732-7068
Email: Elizabeth@theprofessionaledge.com

For all conference details go to:
www.cmc2014.cns-snc.ca *or* **www.cmc2014.org**

Hosted by the Nuclear Operations & Maintenance Division (NOM) of the Canadian Nuclear Society

PBNC 2014

19th Pacific Basin Nuclear Conference

2014 August 24-28 Vancouver, Canada

Fulfilling the Promise of Nuclear Technology around the Pacific Basin in the 21st Century

CANADIAN NUCLEAR SOCIETY ® SOCIÉTÉ NUCLÉAIRE CANADIENNE

CALL FOR PAPERS

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Canadian Nuclear Associa

PACIFIC NUCLEAR COUNCIL PNC

Natural Resources Canada | Ressources naturelles Canada

Canada

PBNC-2014 will:

- *showcase the advancement of nuclear technology in power generation, health science, and environmental stewardship;*
- *discuss challenges facing nuclear technology;*
- *highlight future development.*

10 Technical Tracks, covering all aspects of nuclear technology

PBNC-2014 VANCOUVER 2014

Important due dates for authors:
Abstract: 2013 Sept. 01
Draft Paper: 2014 Feb. 28
Final Paper: 2014 June 01

www.pbnc2014.org

19th Pacific Basin Nuclear Conference
PBNC-2014
Hyatt Regency Hotel, Vancouver, British Columbia, Canada
2014 August 24-28

CALL FOR PAPERS - TECHNICAL TRACKS	
Track	**Suggested Technical Topics**
1. Enhancing Safety, and Security	**Safety Forum**: perspectives after Fukushima; extreme events; severe accidents; accident management; emergency planning; plant security; human performance; safety culture; stress testing; risk assessment; probabilistic analysis.
2. Improving Operation and Maintenance	**Industry and Operators Forum**: economics; maintenance; reliability; inspection; capacity factor; risk assessment; outage reduction; fuel performance; ageing and obsolescence; new developments; reliability enhancement; power uprating; component replacement; supply chain.
3. Facilitating Energy Policy and Global Consensus	**Policy Forum**: policy development; energy mix; sustainability; climate change; public acceptance; education; communications; international and regional cooperation; safeguards; proliferation-resistant fuels; managing R&D for emerging technologies.
4. Managing and Reducing Waste Streams	**Waste Management Forum:** decommissioning; waste management; progress in repository development; interim storage strategies; recycling opportunities and costs; reprocessing; environmental remediation; challenges in geologic disposal; new waste treatment and packaging technologies.
5. Deploying New Reactors and Building to Time	**New Build Forum**: establishing new-build programs; international collaborations; risk-informed safety regulation; policy; regulation and risk assessment; probabilistic & deterministic risk analysis; addressing life extension and licensing renewal; design and construction; economics and financing; new-site licensing; new developments and designs; Gen-III+ designs/ Gen IV and SMR concepts/ advanced systems and components; passive safety.
6. Mining Fuel and Fuel Cycles	**Fuel Forum**: Uranium and thorium mining; thorium and uranium fuels; fault tolerant fuel design; fuel fabrication; open and closed fuel cycles; milling and leaching; fuel enrichment; environmental stewardship.
7. Developing New Technology and Applications	**Technology Forum**: fusion; hydrogen production; advanced reactor physics; advanced fuel cycles; recycling and reuse; development of new materials; efficiency enhancements; Gen IV and SMR concepts; space, mining and military applications; new nuclear codes and standards.
8. Addressing Public Concerns about Radiation Impacts	**Public Forum**: lessons from Fukushima; social impacts; educating and partnering with the public; opinion surveys; radiation protection; linear-no-threshold issues; radiation health effects; lessons learned; outreach.
9. Facing Competitors and Reducing Cost	**Industry Forum**: design and construction; manufacturing and modularity; economics and financing; supply chain assurance; outage management; market and competitive challenges.
10. Acquiring Medical and Biological Benefits	**Medical Forum**: medical and biological systems; treatments and protocols; new isotope development; novel accelerators and target development; supply assurance; handling waste streams; economics; international trends; advanced reactor physics; isotope production and use; agricultural applications.

Calendar

2013

June 16-20 — **ANS Annual Meeting**
Atlanta, George
website: www.ans.org

July 29-Aug. 2 — **ICONE-21**
Chengdu, China
Contact CNS e-mail: cns-snc@on.aibn.com

Aug. 11-15 — **16th International Conference on Environmental Degradation of Materials in Nuclear Power Systems – Water Reactors**
Asheville, NC, USA
website:
www.nace.org/conferences/ed2013/index

Aug. 18, 19 — **NEO 2013 Nuclear Education and Outreach Workshop**
Sheraton Hotel, Hamilton, ON
website: www.cns-snc.ca

Aug. 18-23 — **22nd International Conference on Structural Mechanics in Reactor Technology SMiRT 22**
San Francisco, California
website: www.smirt22.org

Sept. 15-18 — **12th International Conference on CANDU Fuel**
Kingston, Ontario
website: www.cns-snc.ca

Sept. 29-Oct. 1 — **WiN Canada – 10th Annual Conference**
Best Western, Pembroke, ON
website: www.wincanada.org

Oct. 27-31 — **Joint International Meeting on Supercomputing in Nuclear Applications and Monte Carlo**
Paris, France
Contact CNS e-mail: cns-snc@on.aibn.com

2014

Feb. ? — **CNA Nuclear Industry Conference and Tradeshow**
Westin Hotel, Ottawa, ON
website: www.cna.ca

May 25-27 — **10th International CNS Conference on CANDU Maintenance**
Metro Convention Centre
Toronto, Ontario
website: cns-snc.ca

June 15-19 — **ANS Annual Conference**
Reno, NV, USA
website: www.ans.org

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

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

CNSC Report

Incidence of Cancer Around Ontario Nuclear Power Plants 1990 to 2008

The Canadian Nuclear Safety Commission (CNSC) has completed a groundbreaking ecological study on populations living near Ontario's three nuclear power plants (NPPs). The purpose of the ***Radiation and Incidence of Cancer Around Ontario Nuclear Power Plants from 1990 to 2008 study (the "RADICON" study)*** was to determine the radiation doses to members of the public living within 25 km of the Pickering, Darlington, and Bruce NPPs and to compare cancer cases among these people with the general population of Ontario from 1990 to 2008.

The most important finding of the RADICON study is that there is no evidence of childhood leukemia clusters around the three Ontario NPPs. The rates of cancer incidence for children aged 0–4 and aged 0–14 were similar to the general Ontario population.

Overall, for all ages, there is no consistent pattern of cancer across the populations in question living near the three facilities studied. Some types of cancer in the communities studied were higher than expected (excess cancer); however, many types of cancer were lower than expected.

The main strength of the RADICON study is the use of detailed public dose information around each NPP that was generated from radiological releases and environmental monitoring data. This methodology improves on recent epidemiological studies of childhood cancer that have used distance from an NPP as a substitute for radiation dose.

To conclude, public radiation doses resulting from the operation of the NPPs are 100 to 1,000 times lower than natural background radiation and there is no evidence of childhood leukemia clusters around the three Ontario NPPs. All cancers for all age groups are well within the natural variation of the disease in Ontario. Radiation is not a plausible explanation for any excess cancers observed within 25 km of any Ontario NPP.

(The full report is available through the CNSC website.)

Two CNS members honored by other societies

Mohinder Grover

Dr. Mohinder Grover has received the **2013 Meritorious Service Award – Community Service** from Engineers Canada.

Engineers Canada is the national association of Canada's engineering regulatory bodies.Its awards program presents nine awards nationally to celebrate outstanding contributions to the profession, the community at large and to the well-being of Canadians.

The **2013 Meritorious Service Award – Community Service** was awarded to Dr. Grover for exemplary voluntary contributions to community organizations and humanitarian endeavous.

The Award was presented at a ceremony on Yellowknife, NWT, on June 8, 2013.

Juris Grava

Juris Grava, a former member of the CNS Council, has been awarded a 2013 CSA AWARD OF MERIT.

It was presented at the CSA Annual Conference in Calgary on June 17, 2013.

The citation noted that over the past 12 years as a CSA member, Juris has demonstrated the following attributes

- served in various CSA committee activities and other associated standardization work
- showed leadership in Technical Committee activities
- published papers and made public addresses
- advanced the prestige and interest of CSA

Canadian Workshop on Fusion Energy Science and Technology

IEEE Advancing Technology for Humanity

CWFEST-2013

Friday, August 30, 2013, 8 am to 5 pm

UOIT – Oshawa, ON, Canada

Sponsors: Canadian Nuclear Society, CNS-UOIT Branch, IEEE-Toronto, PES / NPSS Chapters

Co-chairs: Professor Hossam Gaber (UOIT), Dr. Blair P. Bromley (AECL/CRL)

Contacts: Hossam.Gaber@uoit.ca, bromleyb@aecl.ca

Registration: $50 (discounts for SEGE'13 registrants, students, IEEE/CNS members)

To register: visit http://ewh.ieee.org/conf/sege/2013/CWFEST.html

CWFEST scheduled in conjunction with IEEE International Conference on Smart Energy Grid Engineering (SEGE'13), scheduled for Aug. 28-30, 2013 at UOIT.

Information and updates, visit: http://ewh.ieee.org/conf/sege/2013/ and also http://cns-snc.ca/home

Canadian Nuclear Society, IEEE-SEGE-2013

The Softer Side of Safety

by JEREMY WHITLOCK

It's official: public communication is now the single highest safety risk associated with nuclear power.

This situation has been suspected for some time by those in the know, but Fukushima has provided a rare opportunity for verification, albeit unintended (as the best social experiments often are). A number of heavyweights, most notably UNSCEAR (United Nations Scientific Committee on the Effects of Atomic Radiation) and WHO (World Health Organisation) have officially declared what knowledgeable observers noted in the chaotic days after March 11, 2011: there will be no health impact from the radiation released by the disaster at the Fukushima Daiichi nuclear plant.

There is no doubt that there will be a significant health impact, however, from the miscommunication and misunderstanding surrounding the radiation released from Fukushima. Hundreds have died, and thousands have suffered the stress of displacement – compounding the loss of friends, family, homes, businesses, and careers due to the tsunami itself.

This mortality and trauma is not just caused by an unnecessary evacuation of the surrounding region, but by the underlying dread of radiation that was there in the population long before Fukushima happened – now stirred up, like Godzilla from the deep. This same dread haunts the waking thoughts of folks in the contaminated regions around Chernobyl, who, like those around Fukushima, have been exposed to safe levels of radiation which the world has told them is a death sentence.

It's the same dread that sent thousands fleeing the Three Mile Island accident unnecessarily in 1979, with the usual heart attacks, traffic accidents, and other stress-related fallout. Counter-intuitively, that chaos in Pennsylvania, like the three meltdowns in Fukushima, was a testament to the safety of nuclear technology – which, despite egregious human error and flawed design, led to no direct health effect. Never in the field of safety engineering, has so much been owed by so many but appreciated by so few.

It wasn't always this way. The world's first major reactor accident, at Chalk River in 1952, occurred before the anti-nuclear meme began replicating. Something of a mini-Chernobyl in its own right, the NRX accident made an unassuming splash in the media of the day and quickly disappeared. No evacuation, no senior citizens left to die in gymnasiums, no children traumatized by men dressed head-to-toe in white Tyvek like something from the movie E.T.

The fear took over much later, when 60's/70's cold war activism turned its sights on the much softer target of nuclear power. It was a hair trigger, and a stuck-open pressure relief valve at Three Mile Island touched it off.

The public perception side of nuclear safety, and the legal world that feeds upon it, is what drives the "nuclear liability" regime that in many countries, including Canada, requires that absolute third-party liability be assumed by nuclear operators – basically "no-fault" insurance for the public to claim against following a nuclear incident. This has little to do with actual safety risk (which after all would be very difficult for actuarial science to tease out, given the almost zero global frequency). It has everything to do with litigation risk, and the resulting wariness of a small supplier industry which knows that perception is everything.

Liability, of course, is infinite (as the late Petr Beckmann, champion of the nuclear oppressed, liked to point out). Legal liability, however, needs a ceiling – and the new $1 billion cap recently announced by the Canadian government (with protocols for going beyond this if needed) allows the wheels of the industry to turn while also managing the public fear.

Other energy technologies with greater safety risk, like hydro, do not have to manage this public fear, are not legislated to obtain third-party liability coverage, and have no public perception in their safety equation. It is a fear tax, deservedly levied, only on nuclear power.

Why deserved? Because, despite public communication being the single highest safety risk associated with nuclear power, it is the one component of nuclear safety that, in a half-century of operation, we have done the least to address.

A new chapter in providing safe, reliable nuclear power.

Candu proudly announces that the Enhanced CANDU 6® (EC6) reactor has achieved Phase 2 pre-project design approval from the Canadian Nuclear Safety Commission. With the completion of this review, the 700MW class natural uranium EC6 has achieved an important milestone – meeting Canadian regulatory requirements for licensing.

Candu's EC6 achieves important design review milestone from CNSC.

This landmark step builds on the evolution and leadership of Candu innovation and safety in the global marketplace.

Candu Energy Inc. brings a new vision to Canada's role in nuclear energy and is dedicated to developing and maintaining a worldwide supply of safe, economical and reliable nuclear power.

www.candu.com

Candu EC6®
Powering prosperity.

Applying **nuclear science and technology** to the benefit of Canada

For more than 60 years, Atomic Energy of Canada Limited (AECL) has served the nation as Canada's premier nuclear science and technology (S&T) organization. AECL and its laboratories are a strategic element of Canada's national S&T infrastructure as well as its national innovation system.

Through the application of our unique facilities, expertise and experience, we work to ensure that Canada and the world benefit from nuclear science and technology.

AECL can help advance the innovation agendas of industry and academic partners, and we welcome opportunities to collaborate.

For more information, contact us directly or visit our website.

Application de la **science de la technologie nucléair** à l'avantage du Canada

Depuis plus de 60 ans, Énergie atomique du Can limitée (EACL) est au service du Canada à titre de princi organisation en science et technologie (S et T) dan domaine nucléaire. EACL et ses laboratoires constituen élément stratégique de l'infrastructure nationale en S et T Canada et de son système national d'innovation.

Grâce à nos installations uniques et à l'application de n expertise et de notre expérience, nous veillons à ce qu Canada et le reste du monde profitent des bienfaits d science et de la technologie nucléaires.

EACL peut aider à faire progresser les projets en innova de ses partenaires au sein des industries et des univers et est toujours prête à envisager de nouvelles possibilité collaboration.

Pour de plus amples renseignements communiquez nous directement ou visitez notre site Web.

AECL
EACL

communications@aecl.ca
1-800-364-6989
www.aecl.ca

AECL / EACL
1 Plant Road,
Chalk River, Ontario
K0J 1J0