CANADIAN NUCLEAR SOCIETY

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DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

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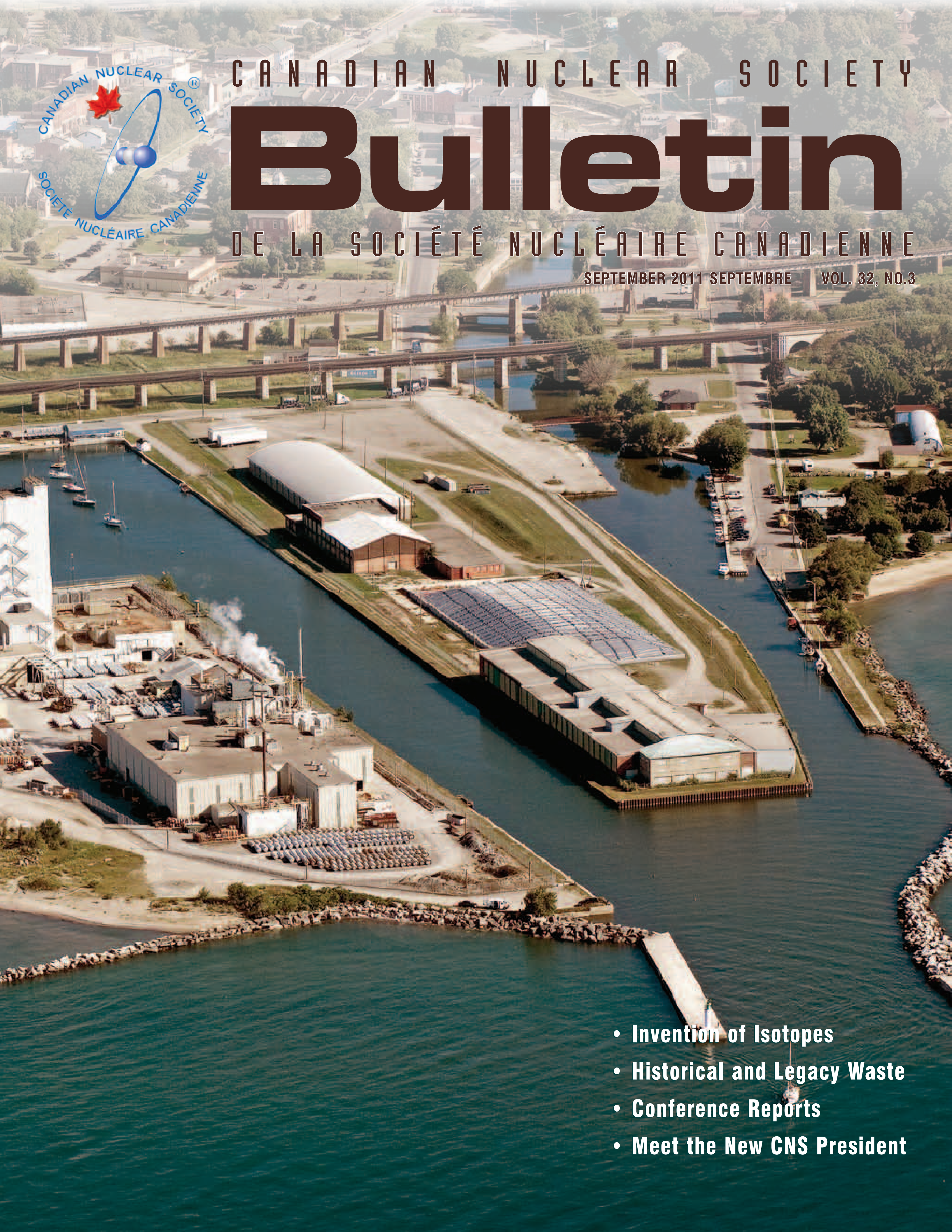

- Invention of Isotopes
- Historical and Legacy Waste
- Conference Reports
- Meet the New CNS President

Port Hope Area Initiative

The Port Hope Area Initiative is a 10-year project that represents the Government of Canada's commitment to ensure the cleanup and local, long-term, safe management of the historic low-level radioactive waste. It involves the construction of an engineered aboveground mound for its safe long-term management on a nearby site, away from its current lakeshore location.

"Historic Waste" refers to low-level radioactive waste generated by activities prior to the formation of legislation to control such activities. In Port Hope it began in 1932 when privately held Eldorado Gold Mines opened a Radium refinery near the lake. At the time radium was worth thousands more than its weight in gold. In refining high-value radium, one of the waste products was no-value uranium. Ten years later the price of uranium sky-rocketed – it had become a strategic material. For security and other reasons the Government of Canada took over the company. Unfortunately, between 1932 and 1970, the Town of Port Hope had become contaminated from spillage during transportation, diversion of contaminated fill and wind and water erosion of storage areas.

There is a long history of digging rocks out of the ground and converting them into valuable assets. This has been an economic success for many towns including Port Hope. Because it takes about one ton of pitchblende ore and ten tons of chemicals to produce only a few grams of radium, there is a lot of waste that has been buried, mounded or used as land fill. This contamination, unfortunately, has sparked controversy and is fodder for scare mongering anti-nuclear activists like Dr. Helen Caldicott who has warned the residents to evacuate the town immediately for reasons that are explained [sic] when you buy her book.

Why is Port Hope the target of such nonsense from coercive utopians with hidden agendas?

When rocks are dug up to make steel, the slag waste is more radioactive than the ore because the process concentrates the radioactive material into the waste. When coal is burned to produce electricity the fly-ash waste is more radioactive than the coal because the process concentrates it into the ash. When pitchblende is dug up to make uranium, the waste is more radioactive than the uranium product because the process concentrates the radioactive materials into the waste. Waste products such as slag, ash and the waste in Port Hope are similar – they contain radioactive and toxic materials. Historically they have been treated in the same way by burial in land fill or piled in mounds or used in other forms of construction such as road beds. It just so happens that our planet is filled with radioactive material, recently dubbed Naturally Occurring Radioactive Material (NORM).

The reason Port Hope is the target of controversy is, in my opinion, not because there are low levels of radioactive contamination in the area, but because Port Hope is a town where uranium is produced and used to manufacture fuel for our nuclear power plants. It is yet another tactic by coercive utopians who want to put a stop to clean, safe generation of electricity from our successful fleet of CANDU nuclear reactors.

It is right that the Government of Canada has taken responsibility to move the historic waste from its present location, where wind and water erosion and extreme weather events threaten to disperse it, to a modern secure facility where it can be sequestered and monitored for hundreds of years.

Port Hope is a beautiful place – take a visit some time!

In This Issue

Once again we apologise for the delay in getting this edition of the Bulletin to you. Aside from my computer crashing [ughgh!] it was partly planned in order to report on the several conferences held late in September. One such conference was the *Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities*. A large name, and also a large attendance! One of the technical papers is included in this edition of the Bulletin.

We are also pleased to present another history item, "The Invention of Isotopes" by CNS member **Michael Attas**. He reports on the work of Frederic Soddy 100 years ago. We also have an introduction of **Frank Doyle**, our new CNS President. General and CNS News is also presented.

Sadly, nuclear pioneer and former senior vice-president of AECL **George Pon** passed away on August 9, 2011. An obituary in his honour is provided.

Half last but never half least is **Jeremy Whitlock's** half full account in **Endpoint**! Enjoy half of it.

As always, we welcome your comments and letters!

The Society

This fall has become a very active period for the Canadian Nuclear Society. There were two large conferences in September, another intermediate size one scheduled for early October and a major one focussed on Maintenance to be held in December.

The first week of September saw the first conference on waste management in six years with the expanded title of *Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities.* There is a report on that event in this issue.

There are two large programs underway, titled *Legacy Wastes* and *Historic Wastes.* The former encompasses the radioactive waste that has accumulated from the 70 years of Canada's nuclear program. Much of that is at the Chalk River Laboratories. *Historic Wastes* are those that resulted from dealings in radioactive materials before there were appropriate regulations or government oversight. It is reassuring to have the federal government assume the responsibility for these wastes.

The second conference in September, which took place just as this issue of the *CNS Bulletin* was going to press, was a major international one, *NURETH 14*. That title stands for *The 14th International Topical Meeting on Nuclear Reactor Thermalhydraulics*. Despite the limited focus of the meeting it drew close to 500 attendees of which more than 80 percent were from outside North America.

Unlike these two, which were held in downtown Toronto, the third event, scheduled for the first week of October, is being held in Ottawa. The topic is *The Future of Heavy Water Reactors.* At the time of writing the attendance at this event, despite its broad focus, looks to be significantly smaller than the two earlier ones.

The last conference of this calendar year is the *9th International Conference on CANDU Maintenance,* to be held in Toronto in early December. It deals with the important challenge of keeping CANDU units functioning at high capacity. Like all nuclear plants CANDU units are complicated and maintaining them is not easy. If you are involved with the operation of a CANDU unit, this conference will provide an opportunity to share your experience and knowledge.

Then, in the midst of all of this conference activity, the governing Council of the Society decided to hold an introspective session on the future. This will include members of the "Extended Council", bringing in the Chairs of Branches, Divisions and Committees. The two-day event will take place October 21 and 22 in Toronto.

A major focus will be on implementation of at least part of the Strategic Plan that was accepted in principle two years ago. The most contentious proposal of that plan is the engagement, initially part-time, of an Executive Director. A full report on the outcome of that event will be in the December 2011 issue of the Bulletin.

The Nuclear Scene

The fallout from the Fukushima event in Japan last March continues. Although, as the Canadian Nuclear Safety Commission pointed out in a recent summary, there have been no deaths due to radiation, while 20,000 or more died due to the tsunami, the general media, anti-nuclear extremists and politicians in many countries refer to the event as a nuclear disaster.

Of the various national reactions that of Germany is the most intriguing. Its political leaders have decided to shut down all nuclear power plants. To replace the lost generation they have stated that more electricity will be imported from Polish coal-powered units. That is in addition to depending on natural gas from Russia for about a third of the country's overall energy needs. There has been no mention of the considerable amount of electricity Germany imports from France, generated by that country's large nuclear fleet.

Yet, "renewable" advocates still tout Germany as the "greenest" country and are urging our governments to emulate that model.

Domestically, even before the ink dries on the deal to sell Sheridan Park (AECL's CANDU engineering group) to SNC Lavalin for a paltry sum, that company has announced a very large contract with Argentina to assist in the refurbishment of the Embalse unit. It is generally known that AECL was ordered not to pursue any such ventures since the CANDU unit was put up for sale roughly two years ago. It would be interesting to know which business school the members of our federal government attended.

At the same time the Saskatchewan government is pursuing several, admittedly more modest, nuclear-related ventures which could lead that province to be a major producer of medical isotopes and possibly even join the ranks of the many groups pursuing designs of small power reactors.

Finally, a personal reaction to the many presentations at the Waste Management conference mentioned earlier, that is where the money is. And not just in Canada. One author from the USA noted that they had already spent over $200 million in decommissioning a small reactor that had been built for $15 million, 50 years ago.

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~ Cover Photo ~

Town of Port Hope, Ontario.

Photo courtesy of Cameco

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

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WMDER Conference

Expanded waste management meeting draws large participation

by FRED BOYD

The full title of the first Canadian conference on nuclear Waste Management in six years was: ***Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities.*** Despite its unwieldy title, or because of the wider scope implied by it, this event drew close to 400 participants to the Marriott Eaton Centre Hotel in Toronto, September 11-14, 2011.

The conference provided both concise overviews of the programs underway in each of the areas identified in the title and a large number of excellent papers on various technical aspects. The wide-ranging topics went from deep geologic disposal to clean-up of the Port Hope harbour.

Adding to the typical participants from related areas of the Canadian nuclear program there were over 40 representatives from communities in northern Ontario and northern Saskatchewan which have indicated an interest in hosting the proposed deep geologic disposal facility for high-level waste. They were sponsored by the Nuclear Waste Management Organization. These community representatives showed strong interest by attending all of the plenary sessions and many of the related technical presentations.

The conference was preceded by a reception on the Sunday evening at which **Frank Doyle**, president of the Canadian Nuclear Society, welcomed the delegates.

Other social events were an exhibitors' reception on the Monday at the end of the technical sessions and the conference banquet on the Tuesday evening. Typical of CNS conferences, lunches were also included.

Frank Doyle opened the conference proper on the Monday morning with a welcome and a brief overview of the Canadian nuclear program before introducing **Colin Allen**, the conference chair.

Allen noted this was just the second conference on the issue of management of the radioactive waste from the Canadian nuclear program, the first being held in 2005 in Ottawa. There has been much progress since then, he stated, which would be reported in the conference. Although the plenary sessions have a number of speakers, he promised ample time for questions.

The plenary sessions were focussed on three broad themes: the overall Canadian program; low and intermediate waste; and, international perspectives.

The opening plenary session offered perspectives on a number of issues: Building Public Confidence; Regulatory Issues; Environmental Stewardship; the NWMO program; Waste and Restoration Challenges in the Uranium Mining Industry and the waste management program of Ontario Power Generation.

The first presentation was a broad overview by **Mark Corey,** Assistant Deputy Minister at Natural Resources Canada, with the long title of *Canadian Radioactive Waste Management: Building Public confidence for the Future through our Actions and Achievements.* He began by commenting that Canada is blessed with a diversity of energy resources and noted a number of diverse projects, including: Darlington; Cigar Lake; Peace River; Lower Churchill Falls. The critical factor for nuclear projects, he said, is building public confidence. The progress on waste management, he asserted, is a good news story. He noted, in particular, the development of programs for Legacy Waste and Historic Wastes; the former being associated with the Canadian nuclear program, the latter with wastes left behind by activities before there was adequate regulation.

Regulation was the topic of the next speaker, **Michael Binder**, President of the Canadian Nuclear Safety Commission. He pointed out that, as Canada's "nuclear watchdog", the CNSC regulates nuclear activities from "cradle to grave". He referred briefly to the Fukushima incident in Japan in March 2011 which has forced nuclear regulatory bodies around the world to conduct extensive reviews. In the area of waste management, he referred to the recent CNSC document RD-370 on Management of Uranium Mine Waste Rock and Mill Tailings. CNSC will be following international best practices, which, ne noted, included accelerating decommissioning.

Next was **Robert Walker**, Executive Vice President of AECL Nuclear Laboratories (formerly known as the Chalk River Laboratories), who titled his presentation, *Nuclear Environmental Stewardship – the Social Contract.* The event at Fukushima in Japan in March is a challenge to that social contract, he stated, and requires an integrated response from all players in the nuclear field. It has implications for nuclear science and technology, for industry, for governments and for society. The new program for AECL's National Laboratory, he said, will be focussed on six themes: industry capability; safety and security; clean safe energy; isotopes; environmental stewardship and innovation.

Ken Nash, President, Nuclear Waste Management Organization, provided an update on the programs of that central agency. He began by referring back to the "Seaborn" environment panel that, after eight years of hearings reported in 1998 that the science of handling nuclear waste had been demonstrated but the public was not convinced. That led to the establishment of the NWMO in 2002. It proposed, in 2005, an "Adaptive Phased Management" approach which was accepted by the government in 2007. In 2008 NWMO issued its Implementation Plan and, in 2010, began a site selection process. That process has involved extensive consultation with the key being building relationships with Aboriginal groups and interested municipalities. At this time eight communities have expressed interest in hosting a deep geologic repository. The timeline is not definite, he said, but he did expect to see a repository in operation by 2035.

Reporting on *Challenges in Waste Management and Environmental Restoration in the Uranium Mining Industry*, **John Jarrel**, executive advisor, Cameco Corporation, began with the challenges at the company's mines in northern Saskatchewan. The tailings from the mines are classified as "low level radioactive waste". They are large in volume, chemically inert and contain from 0.02 to 0.05 % uranium. He noted that the mines are regulated by both the provincial and federal governments. In addition, there can be multiple municipal rules and some of the land is privately owned. The company conducts on-going dialogue with communities and is taking steps to lower its environmental footprint. In closing he noted there were a number of related papers being presented in the technical sessions.

Closing this first plenary session was **Tom Mitchell**, president and CEO, Ontario Power Generation, who titled his presentation, *Providing Value to Ontario: OPG's Approach to Nuclear Waste Management.* OPG is Canada's largest manager of nuclear waste, he noted. (OPG operates the Western Waste Management Facility located on the Bruce site and handles waste from Bruce Power.) Mitchell stated four "values" which guide their waste management activities: excellence; accountability; responsibility; openness. Nuclear waste is much more than a technical problem, he stated in closing.

The Tuesday morning plenary period was devoted to a panel on **Low and Intermediate Waste.** There were seven presenters:

Dan McCauley, Natural Resources Canada: *Canadian Approaches and Strategies for Low and Intermediate-Level Radioactive Waste in Canada*

Don Howard, Canadian Nuclear Safety Commission: *Canada's Regulatory Framework*

Pauline Witzke, Ontario Power Generation: *OPG's Deep Geologic repository for LILW - Facility Scope*

Joan Miller, Atomic Energy of Canada Limited: *Managing Wastes from the Atomic Age and into the Future: Programs, Plans and Challenges*

Charles Hickman, New Brunswick Power Nuclear: *Refurbishment Implications on Long-Term Waste Management strategies at Point Lepreau*

François Bilodeau, Hydro Québec: *Hydro Québec's Long-Term Strategy for Low and Intermediate Waste Management*

Karen Chovan, Cameco Corporation: *Waste Management Practices at Cameco*

The conference banquet, preceded by a reception in the exhibitors' area, was held on the Tuesday evening and featured duck as the main entrée, a change from the usual fare. After dinner **Dan Gardner**, an author and columnist with the Ottawa Citizen, spoke on the theme of his popular book: *Risk: the Science and Politics of Fear.* There is perception and reality he emphasized. Emotion precedes thought, he stated, and our view of risk is influenced strongly by whether the subject is familiar or novel.

He concluded with some suggestions to the audience on speaking about nuclear risks. These included: be accurate and honest; get ahead of the information cascade (respond quickly); try to find the real sources of fear and address them; use language that will respond to both the mind and the "gut'.

Although it was titled as a panel, the Wednesday morning plenary was basically four speakers providing international perspectives.

Hans Riot, of the OECD Nuclear Energy Agency, spoke on the *Status and Challenges for Radioactive Waste Management.* He noted that in 1998 his agency concluded that the technology for disposal of low and intermediate level radioactive waste was well developed. But, the situation for high level waste varied widely. He noted that now some countries, notably

Finland, France and Sweden expect to operate geologic repositories within a decade. Radioactive waste repositories are as much a socio-political challenge as a technical one, he commented in closing.

The situation in Sweden was presented by **Anders Ström**, Director, Nuclear Fuel Programme, SKB in a presentation entitled *The Licence Application for the KBS-3 System as a Step Towards Implementation of Final Disposal in Sweden.* As background he noted that there are three nuclear power sites in Sweden which produce about 45% of the country's electricity. SKB is the abbreviation for Swedish Nuclear Fuel and Waste Management Company formed by the Swedish utilities in 1976. Site selection for a final repository was begun in 1992 and SKB announced in 2009 that Forsmark had been selected. An application to the government has now been submitted. It is planned to begin construction of the repository in 2015 and the encapsulation plant in 2016.

The major "legacy" wastes from the UK's earlier programs was the major focus of the presentation by **Adrian Simper**, Strategy & Technology director, Nuclear Decommissioning Authority, entitled, *A Brief Review of Decommissioning and Waste Management in the UK.* The Authority now owns 19 legacy sites and the associated nuclear liabilities, he noted. The NDA has six strategic themes:

- Site Restoration
- Spent fuels
- Nuclear Materials
- Integrated Waste Management
- Business Optimisation
- Critical Enablers

The Legacy Ponds and Silos program at Sellafield poses the most significant challenge, he stated. That program focuses on retrieval of waste from the four main plants on site that had been used to prepare fuel for reprocessing or storage.

The final plenary speaker of the conference was **Tom Isaacs**, Lead Advisor to the US "Blue Ribbon Commission on America's Nuclear Future". That Commission, he explained, was formed in 2010 by the Secretary of Energy at the request of President Obama to conduct a comprehensive review of policies for managing the back end of the nuclear fuel cycle and recommend a new plan. The commission delivered a draft report on July 29, 2011, with the final report due 29 January 2012. It has a website: www.brc.gov

The draft report recommends:

1. A new approach that would be adaptive, staged, transparent and science based
2. A new single-purpose organization for transportation, storage and disposal
3. Assured funding
4. Development of a (new) deep geologic disposal site
5. Development of one or more interim storage facilities
6. Long-term, stable, fiscal support for research, development and demonstration
7. International leadership (with reference to the IAEA).

Although the conference continued with six parallel technical sessions on the Wednesday afternoon, conference chairman, Colin Allen, took the opportunity of the last lunch to offer some closing remarks. He thanked all involved, especially the organizing committees, speakers, chairpersons and the many sponsors who made the event financially feasible.

Each of the afternoons was devoted to technical presentations, in two sets of six parallel sessions, before and after a break. On the Monday the topics were:

- OPG's Deep geologic Repository for Low and Intermediate Level Waste
- Stakeholder Interactions
- Decommissioning Projects
- Uranium Mine Waste Management
- Used Fuel Repository – design and safety assessment
- Federal Policies, Programs and Oversight

The Tuesday sessions were:

- OPG's Deep geologic Repository for Low and Intermediate Level Waste
- Regulatory Considerations
- Aboriginal Traditional Knowledge
- Geological Disposal – CRL Site Classification
- Geological Disposal – Modelling and engineered Barriers
- Port Hope Area Initiative

The Wednesday topics were:

- Waste Characterization
- LILWM - treatment and Processing
- Decommissioning Projects and Information Management
- International Experience
- Environmental Remediation
- Fuel Cycles and Waste Processing

The sponsors (who made the event financially feasible) and most of whom also exhibitors, were (in alphabetical order):

AECL; Aecon; Babcock and Wilcox; BPR; Cameco; CNSC; Canberra; CH2MHill; EcoMetrix; Energy Solutions; Pico-Envirotec; Geovariances' Kinetrics; NAC International; NWMO; Nuvia; Ontario Power Generation; PermaFix; Promation Nuclear; Quantum Murray; Rolls-Royce; Safety* Ecology Corporation;

SRC; SNC-Lavalin; USEcology – Stablex; Unified Engineering; WorleyParsons.

Many people were involved in the organization:

Conference chair:	Colin Allen
Plenary chair:	Ken Dormuth
Technical chair	Alan Melnyk

Organizing Committee: Barbara Gray; Kathleen Hollington; Don Howard; Jamie Robinson; Dave McCauley; Joan Miller; Benjamin Rouben; Judy Ryan; Tracy Sanderson; Pauline Witzke; Tom Kotzer.

Technical Committee: François Bilodeau; Mark Chapman; Lauren Corkum; Ken Dormuth; Jo-Ann Facella; Daniel Grondin; Sarah Hirschorn; Don Howard; Helen Leung; Kris McIntyre; Alan Melnyk; Doug Metcalfe; Bob Pollock; Judy Ryan; Michael Stephens; James Walker.

The conference administrator was Elizabeth Muckle-Jeffs' company, the Professional Edge, while the registration was handled by Denise Rouben and Bob O'Sullivan of the Canadian Nuclear Society office.

A CD with all of the presentations will be available from the CNS office.

Scenes from the Conference

NURETH 14

International conference brings many specialists from around the world to Canada

(An overview by FRED BOYD)

NURETH 14 is the abbreviation for *The 14th International Topical Meeting on Nuclear Reactor Thermalhydraulics* which was hosted and organized by the Canadian Nuclear Society and held in the Toronto Hilton Hotel in downtown Toronto, Ontario, September 25 – 30, 2011. This was truly an international event - more than 80 per cent of the almost 500 attendees were from outside North America.

The NURETH series of conferences is co-sponsored by the Thermalhydraulics Division of the American Nuclear Society, which assigns the venue, and is supported by the International Atomic Energy Agency and the OECD Nuclear Energy Agency. This was the first time it has been held in Canada. Since the first one, held in Saratoga Springs, USA, in 1980, the conference has been held in a number of countries besides the USA, including, Germany, France, Japan, and Korea

This was a very focussed and specialized conference. Although it was billed as a "plenary" session the two opening presentations on the Monday morning followed that approach. They were:

- *Development of Interfacial Area Transport Equation, Modelling and experimental Benchmark,* by Mamoru Ishii of Purdue University in the USA, and;
- *Status and Perspective for a Multiscale Approach to Light Water reactor Thermalhydraulic Simulation,* by Dominique Bestion of the Commissariat á l,Ènergie Atomique, France.

The presentations over the 4 ½ day conference followed this example. Some of the session titles indicate the scope of the presentations:

- Boiling and Condensation Fundamentals
- Core Thermalhydraulics and Subchannel Analysis
- Molten Core Natural Convection, Physico-chemical Phenomena and Direct Containment Heating by Dispersed Molten Fuel
- Thermalhydraulics of Low Prandtl-Number (Liquid Metal) Flows
- Multifield Two-Phase Flow and Flow Regimes Identification
- Supercritical Water Reactors
- Computational Fluid Dynamics, Mathematical Modelling and Verification

There were some panel sessions on broader themes, such as:

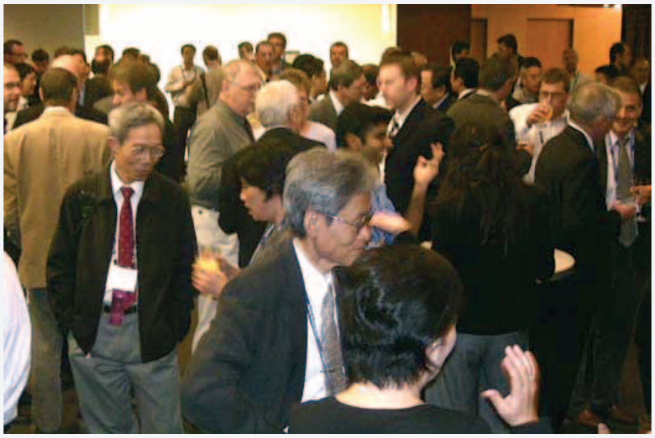
- Global Cooperation in Nuclear Engineering Cooperation
- Issues and Future Directions of Thermal Hydraulics R & D
- Lessons Learned from the Fukushima Accident

More than one participant in the Fukushima panel suggested that it would be analysed for years.

The conference did open with a reception on the Sunday evening and held a banquet on the Tuesday evening.

The General Chair for the event was John Luxat of McMaster Univeristy, while the challenging task of heading the Program Committee fell largely on Jovica Riznic, of the Canadian Nuclear Safety Commission and his co-chair, there were over 100 members of the international program committee.

A technical report on the conference is planned for the December 2011 issue of the *CNS Bulletin.* Most of the papers are on a CD which is available from the CNS office.



Frederick Soddy's Invention of Isotopes in 1911

by MICHAEL ATTAS

A hundred years ago, the mysterious world of sub-atomic science was illuminated by not just one, but two striking discoveries. The idea of the nucleus had been conceived by a physicist, Ernest Rutherford, as described in the March 2011 issue of the *CNS Bulletin*. But it took a chemist, Frederick Soddy, to make chemical sense of the zoo of recently discovered radioactive elements, by inventing the idea of isotopes.

Professor Frederick Soddy, c. 1900-1903. Photo reproduced with kind permission of the Frederick Soddy Trust.

Fifteen years previously, in 1896, Henri Becquerel had found that uranium gave off invisible rays, somewhat similar to the X-rays discovered the previous year. This discovery launched a period of furious research in Europe and North America, aimed at understanding this phenomenon of invisible rays. Thorium was found to be also radioactive, in 1898. That same year Marie and Pierre Curie discovered two new elements that were even more intensely radioactive; they chose the names polonium and radium for them. By 1911, researchers had compiled a list of over thirty substances that gave off alpha, beta, or gamma rays. Rutherford had worked out the theory of radioactive transmutation during his stay at McGill University in Montreal from 1898 to 1907. With several collaborators, including Soddy from 1900 to 1903, he showed how one radioactive substance transformed itself spontaneously into another, following mathematical laws of exponential growth and decay. This work earned Rutherford the Nobel Prize for Chemistry in 1909.

The large number of radioactive substances had properties that hinted at organization of some sort. Rutherford himself set up parallel charts of substances in sequences of decays from parents through several generations of descendants. For example, in 1905 he published the chart in Fig. 1, showing how the long-lived radioactive elements uranium, thorium, actinium, and radium each transform themselves into sequences of shorter-lived products. The chemical properties of these products showed distinct similarities from one decay series to another. The most obvious similarity was the existence of gaseous "emanations" from thorium, radium, and actinium, gases that we now identify as isotopes of the element radon. These radioactive gases were completely unreactive, just as the recently discovered noble gases (neon, argon, krypton, and xenon) were, and in common with them they could be condensed at low temperature. The emanations from radium and thorium had different half-lives, but in each case they transformed themselves into solids, which then underwent a sequence of complex transmutations.

How many radioactive elements were there? And where did they fit into Mendeleev's Periodic Table? Indeed, what did it mean to call a substance an element? In discussing Marie and Pierre Curie's publications, Professor Alfred Romer has pointed out that "The standard procedure to prove the existence of a new element was to purify the working material repeatedly until it showed an unchanging atomic weight and an unchanging spectrum, both different from all the known elements. Since the known vacancies in the periodic table lay mostly in the neighbourhood of uranium, it was to be expected that the element the Curies were naming radium would be a good deal heavier than barium." The two radioactive substances the Curies had isolated from the uranium ore pitchblende, polonium and radium, each had chemical properties similar to, but not identical with, known elements, namely bismuth and barium respectively. For radium, at least, they could eventually (in 1902) determine the atomic weight, and identify a new line in the light emission spectrum. But the other radioactive substances were too fleeting for these properties to be measured. The researchers could determine their chemical properties, though, such as solubility in acids and bases, and ease of precipitation in conjunction with other elements (co-precipitation). Other discoveries were made of distinct species with chemical similarities to known elements, named radio-lead, radio-tellurium, mesothorium, radiothorium, and so on.

In 1911 Frederick Soddy, who by then was teaching at the University of Glasgow, published two works that brought order to this assortment of properties. In his book *The Chemistry of the Radio-Elements,* Soddy compiled complete descriptions of the physical and chemical properties of each of the radioactive substances. He organized their sequences of transmutations by the similarities in their chemical properties, so that the emanations, for example, were all side-by-side in a chart (Figure 2). This alignment highlighted the chemical similarity – indeed the chemical indistinguishability – of the predecessors and some of the successors of the emanations. He emphasized the chemical relationships in his discussion of that chart in general terms. In his other 1911 publication, "The Chemistry of Mesothorium," he described in great detail the chemical manipulations that led him to conclude, unequivocally, that mesothorium is chemically identical to the Curie's radium, despite their different half-lives. (We now call "mesothorium" radium-228; "thorium-X," also chemically identical, is radium-224.) Soddy realized the implications of these results, in stating, "It appears that chemistry has to consider cases, in direct opposition to the principles of the Periodic Laws, of complete chemical identity between elements presumably of different atomic weight, and no doubt some profound general law underlies these new relationships." He listed other examples of chemical identity, between radiolead (Pb-210) and lead, and between thorium (Th-232), ionium (Th-230), and radiothorium (Th-228). Going beyond the radioactive elements, he speculated that stable elements themselves might be "mixtures of chemically non-separable elements in constant proportions, differing step-wise by whole units in atomic weight."

Soddy and others filled in gaps in this theory in the ensuing years, and by 1913 he introduced the term isotope (from the Greek for "same place"), as well as hinting at the priority of atomic number (a brand new concept at the time) over atomic weight in determining the order of the elements in the Periodic Table. His Nobel Prize acceptance speech in 1922 was generous in noting the many contributions of other researchers to the task of fitting the many radio-elements into the last line of that Table.

Sources

Alfred Romer, *Radiochemistry and the Discovery of Isotopes,* Dover Publications, New York 1970, contains a detailed historical essay by the author as well as reprints, (with commentary) of key papers in the field published between 1898 and 1913, including Frederick Soddy, "The Chemistry of Mesothorium," from *Journal of the Chemical Society,* 72-83, 1911. The figure by Rutherford can be found in Alfred Romer, *The Discovery of Radioactivity and Transmutation,*

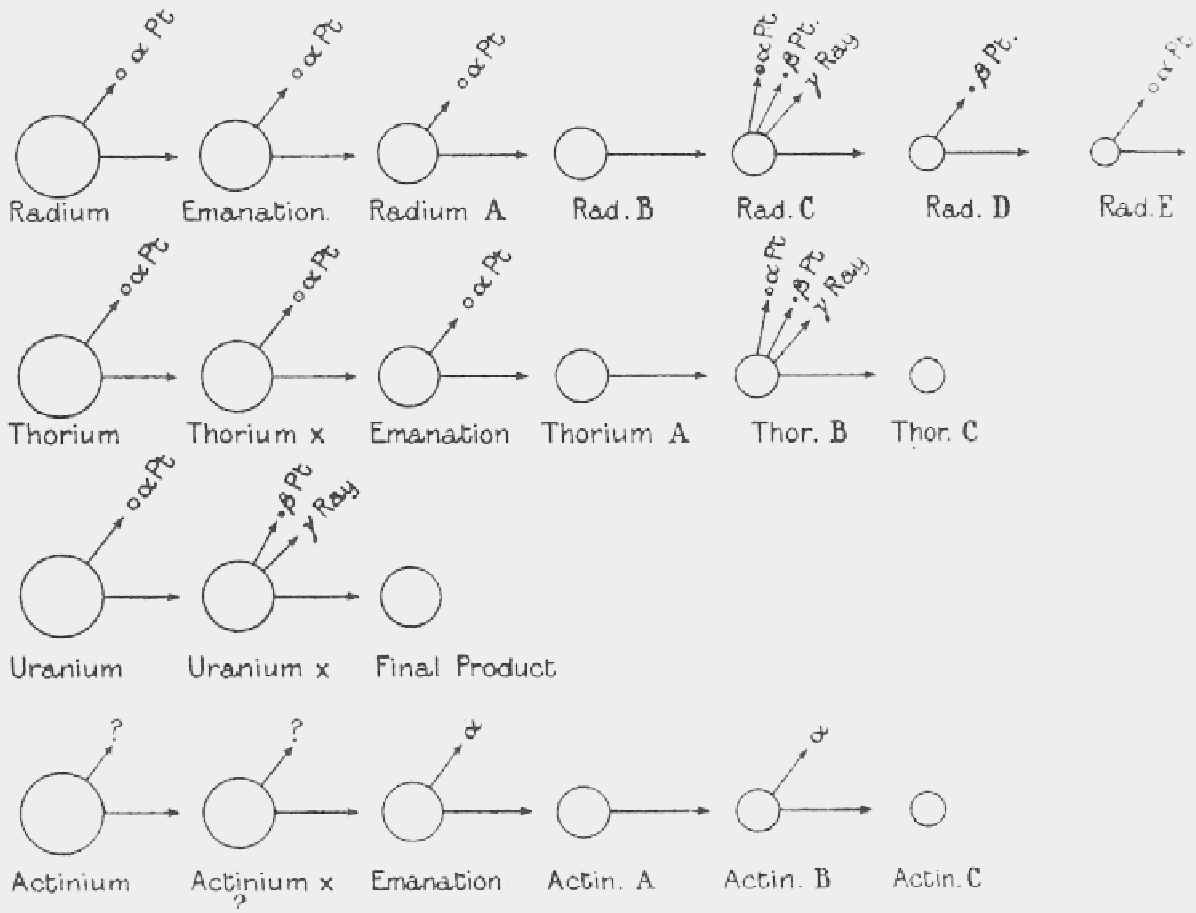


Figure 1. Rutherford's set of radio-elements in 1905.

Dover Publications, New York 1964, in E. Rutherford, "The Succession of Changes in Radioactive Bodies," reprinted from *Philosophical Transactions of the Royal Society of London*, A, 204, 169-219, 1905. The figure by Soddy can be found in Frederick Soddy, *The Chemistry of the Radio-Elements,* Longmans, Green and Co., London 1911. See also his Nobel Lecture, "The origins of the conceptions of isotopes," available at nobelprize.org/nobel_prizes/chemistry/laureates/1921/soddy-lecture.pdf

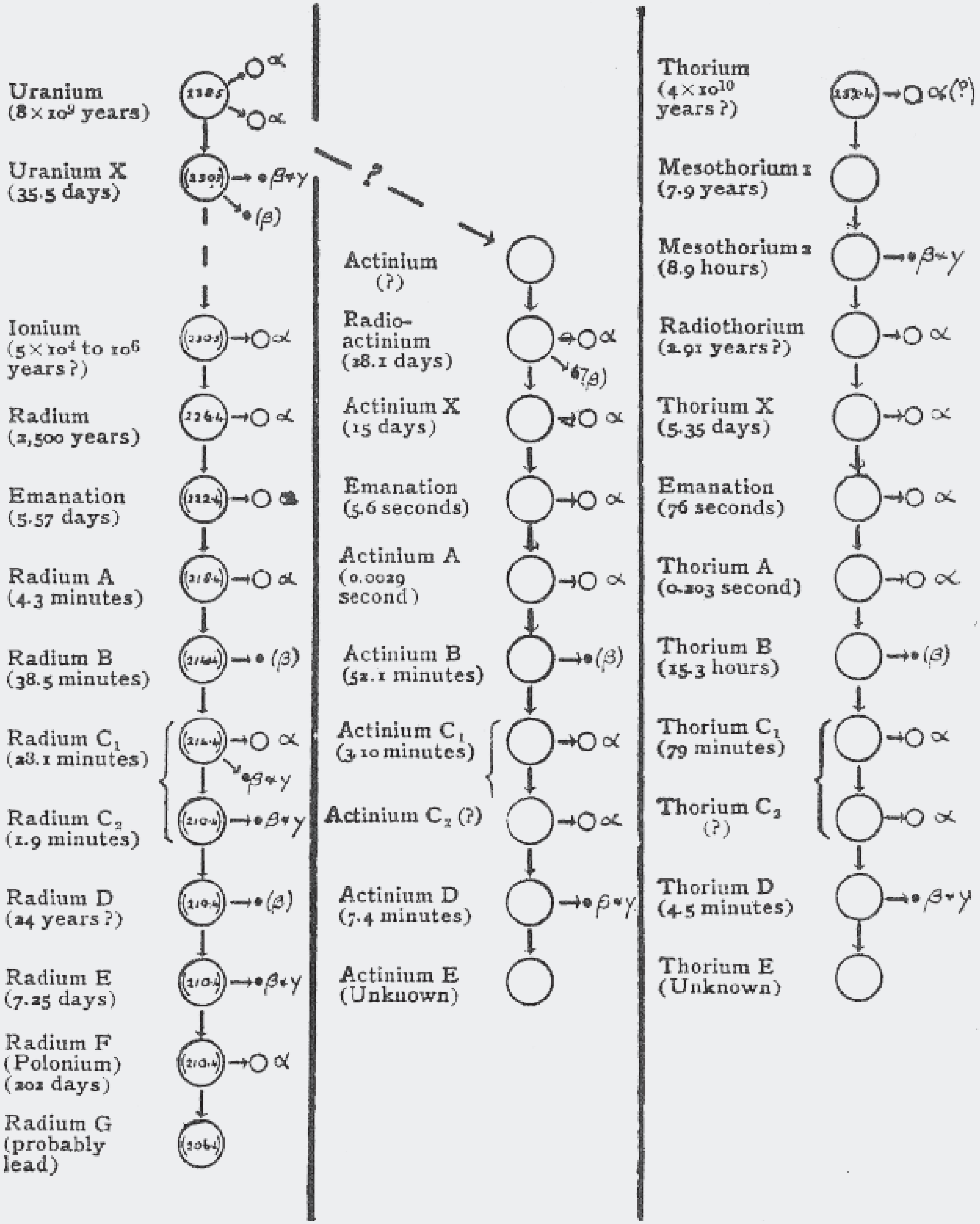


Figure 2. Soddy's set of radio-elements in 1911.

History Repeats: A Personal Reminiscence

by J.T.ROGERS[1]

[Ed. Note: The following article is a personal account of the author. Any opinions expressed are those of the author and not necessarily held by the editor or the CNS.]

Introduction

The decision of the federal government to split Atomic Energy of Canada Ltd. into a privately owned CANDU technology company and a publicly owned Nuclear Laboratory has resulted in the purchase by SNC-Lavalin of the AECL's Sheridan Park operations, now called Candu Energy, and the re-organization of Chalk River operations as a national Nuclear Laboratory.

This is the third time in my experience in the nuclear field in Canada that a successful nuclear organization with which I have been associated has been significantly disrupted by forces or circumstances outside its control. The other two experiences are briefly described below.

Canadair Ltd. Nuclear Division

Following the 1954 Atoms for Peace Conference in Geneva, the Canadian government encouraged Canadian industries to become involved in the nuclear energy field and, in particular, provided a contract in 1955 to Canadair Ltd. Canadair, earlier a crown corporation, was then a successful military aircraft manufacturer owned by General Dynamics Corp., a large American company. The contract was for the design, construction and commissioning of the low power (100 Watts) Pool Test Reactor (PTR). PTR was intended to meet the needs of Atomic Energy of Canada Ltd to measure accurately key characteristics of irradiated nuclear fuels in order to provide information needed for the design and operation of CANDU reactors. I joined the Canadair Nuclear Division in May 1955, was sent with other new employees to North Carolina State College for a one-month crash course in nuclear engineering, and was appointed liaison engineer at Chalk River Laboratories for the PTR contract. The design, construction and commissioning of PTR progressed well and it went critical for the first time at 12:05 pm on November 29, 1957. We used some unorthodox procedures in the construction and commissioning of PTR, including a personal swim under the reactor core to put clamps on a pipe whose vibrations were causing excessive noise in reactivity signals.

PTR provided AECL with essential data, such as fission product cross-sections, for the successful design and operation of CANDU reactors until it was permanently shutdown in 1990. PTR is now being de-commissioned. I had the pleasure of presenting a paper on Engineering Aspects of the Pool Test Reactor at the CNS Technical Meeting in Ottawa on Low-Power Critical Facilities and Small Reactors in November, 2010.

Canadair ND also undertook the design, engineering and fabrication for a sub-critical reactor for teaching and research at the University of Toronto and for the Beta Ray Spectrometer for basic nuclear physics research at CRL. I was also involved in the design of the cooling system for the BRS.

Buoyed by the success of the PTR contract, Canadair ND responded to a Request for Proposal from a consortium of Japanese universities for a pool-type reactor similar to the PTR but intended for a range of uses in teaching and research and operating at a much higher power. Canadair ND produced a proposal, with which I was involved, and confidently awaited the Japanese consortium's response. However, on learning of our proposal, General Dynamics became upset because the Japanese consortium had not requested such a proposal from its own nuclear subsidiary, General Atomics (GA), located in San Diego, California. As a result, Canadair was ordered to shut down its Nuclear Division early in 1959.

A few of the nuclear division employees were offered positions at General Atomics. I accepted an offer and spent about the next one and a half years as a research engineer at GA working mainly on the thermalhydraulic design of the graphite-moderated, helium-cooled Maritime Gas-Cooled Reactor (MGCR), intended for the propulsion of commercial oil tankers, as well as on a beryllium oxide moderated reactor design.

Of course, Canadair itself eventually became a part of Bombardier which has remained a very successful aircraft manufacturer.

Canadian General Electric Civilian Atomic Power Department (CAPD)

At the end of August 1960, I was lured back to Canada by an offer of a position at CAPD in Peterborough, Ontario, to work on the design of an organic-cooled CANDU reactor. I spent the next 10 years as leader of

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a specialist Heat Transfer & Fluid Dynamics section of CAPD dealing with many of CAPD's nuclear projects. During this period, CAPD successfully undertook the following major projects:

1. Completion of the design, development and construction of the 25 MWe Nuclear Power Demonstration reactor, the first CANDU reactor, which started up in 1962 and operated successfully until 1987, proving the feasibility of the CANDU design and acting as an effective test bed for larger CANDU reactors while feeding electricity into the Ontario grid.
2. Design, development and construction of the WR-1 research reactor, a 60 MWth heavy-water moderated, organic liquid-cooled design. The coolant consisted of a mixture of terphenyl isomers which permitted operation at low pressure (2.15 MPa) and a high temperature (400 oC). It was intended as a test-bed for a CANDU Organic-Cooled Reactor (OCDR) design for power generation. WR-1, located at AECL's Whiteshell Nuclear Research Establishment (WNRE) at Pinawa, Manitoba, started up in 1965 and functioned in this role until 1972, when the CANDU OCDR project, unfortunately, was terminated. WR-1 then continued in operation until 1984, providing in-reactor irradiation facilities for conventional CANDU designs as well as providing heating for the WNRE site. WR-1 is now being decommissioned.
3. Design, development and construction of the KANUPP reactor, a CANDU type, 125 MWe reactor, for the Pakistan Atomic Energy Commission. KANUPP (Karachi Nuclear Power Plant), located near Karachi, Pakistan, on the Indian Ocean, started operating in 1971 and is the oldest CANDU reactor still in operation.
4. Design and construction of a small heavy water production plant using the Girdler Sulfide (GS) process at Port Hawkesbury, Nova Scotia. This plant operated successfully for a number of years until its production was no longer needed after the much larger GS plants at Bruce came on line.
5. Development of facilities for the large-scale production of CANDU fuel elements and fuel bundles and for the production of fuelling machines for CANDU reactors.

I was involved in design issues and R&D associated with each of these projects.

In an effort to market CANDU reactors internationally, CAPD formed the Venture Project, that brought engineers from many countries to participate in a program that provided them with a soundly based knowledge of reactor and, in particular, CANDU technology. CAPD also submitted proposals to build CANDU reactors in Finland and in Romania that were, unfortunately, unsuccessful.

In the late 1960s, it became evident that Ontario Hydro would not consider new reactor proposals from CAPD, preferring to deal directly with AECL. CGE decided to get out of the reactor design business and to focus on its successful nuclear fuel and components business. The reactor design activities became part of AECL and most of the engineering and technical personnel gradually moved to Sheridan Park. The nuclear fuel business still flourishes at the plant in Peterborough, but now as a part of General Electric-Hitachi.

Finally, I decided to make a move to academia from industry, a move that I had planned earlier after gaining a couple of years experience as an engineer in industry so as to have a better basis for teaching young engineers-to-be. The "couple of years" had extended to 15 years when I joined the Department of Mechanical and Aerospace Engineering, as it is now known, of Carleton University in 1970, and focused my research on reactor engineering, in particular on thermalhydraulics in CANDU reactor fuel bundles, CANDU reactor safety and severe accident behavior and non-power applications of reactors. I also undertook consulting work on CANDU reactor safety for the Atomic Energy Control Board, now the Canadian Nuclear Safety Commission, and also served on the Advisory Committee on Reactor Safety of the AECB. These activities helped to lead to an appointment to the Research and Development Advisory Panel to the AECL Board of Directors on its formation in 1991 and on which I still serve.

Conclusion

As outlined above, the outcomes of the two previous disruptions were different. Canadair's Nuclear Division completely disappeared and, while the role of CAPD as a reactor designer disappeared, it and its successor organization continued and grew as an important component of Canada's nuclear industry. With the re-organization of AECL, we can only hope that the successors to AECL, Candu Energy and the Nuclear Laboratory, will cooperate to ensure that the Enhanced CANDU 6 reactor design will remain a viable choice for application around the world to produce safe, reliable and economic electricity. Eventually this cooperation should extend to the completion of the development of the Advanced CANDU Reactor (ACR)-1000 design, now in a managed completion status, to serve the same purpose.

In addition, the unique capabilities of the CANDU design to extract additional energy from discharged LWR fuel, to play a key role in the closure of the LWR fuel cycle and to facilitate the use of thorium as a nuclear fuel, ensuring energy for Canada and the world for thousands of years, must continue to be recognized by CANDU Energy and the Nuclear Laboratory and exploited for the benefit of Canada and the world.

Pre-Project Activities Related to the Remediation of Fissionable Materials Contained in Standpipes at Atomic Energy of Canada Limited's Whiteshell Laboratories

by TERENCE M. STEPANIK, HEIDI McILWAIN, JAMIE EDWORTHY, SHAMSUL ALAM, ALEX MAN, and JASON MARTINO[1]; PETER TAYLOR[2]

*[**Ed. Note:** This paper was presented at the conference on "Waste Management, Decommissioning and Environmental Restoration for Canada's Nuclear Activities", held 11-14 September 2011 in Toronto, Ontario.]*

Abstract

AECL® is presently decommissioning Whiteshell Laboratories (WL), a former nuclear research site. Some Fissionable Materials (FM), arising from operation of Whiteshell Reactor-1, an experimental organic-cooled 60 MW reactor that ran from 1965 to 1985, are stored in 69 in-ground standpipes in the WL Waste Management Area (WMA). The standpipes (171 in total) were used to store mainly intermediate level waste over the period 1967 to 1986.

AECL has committed to remediate the 69 standpipes containing FM. This work, under the auspices of the Nuclear Legacy Liabilities Program, is presently in the pre-project phase, which is focussed on developing an optimum remediation strategy. It includes assessing the condition of the standpipes, the environment inside the standpipes, and possible remediation options. This paper describes the standpipe designs, approaches for determining their fitness for purpose, and steps being taken to determine what radiological or industrial issues may be associated with the stored material. In addition, potential remediation strategies identified to date, and technology that must be developed for conditioning the contents of the standpipes for remediation are discussed.

1. Introduction

In 1999, AECL received government concurrence to plan actions for closure of the Whiteshell Laboratories site. The goal is to safely and effectively transition the WL site to a shutdown and decommissioned state that meets regulatory and Federal policy requirements. Remediation of standpipes containing reactor fuels located in the WL WMA is required to meet this goal. The Standpipe Remediation Initiative was established to conduct the pre-project planning and development work necessary to address the need for remediating these standpipes.

2. Standpipes

The WL WMA contains 171 in-ground standpipes; 95 are covered by 50 cm of earth or less, and 76 have their top portions exposed about 50 cm above ground. Of these, 69 contain FM[3].

The standpipe area and the rest of the WL WMA is underlain by 0.5 m of organic rich soil horizons, then 1.5 m of silt, followed by 2.5 m of clay, 5 m of clayey glacial till and 3 to 5 m of stratified basal sands. The area lies in a groundwater discharge zone. Groundwater from the basal sand aquifer flows vertically upwards, through the silts and clays and discharges at the ground surface. The water table is generally within 1-2 m of the surface.

2.1. Standpipe Design

There are two basic standpipe designs; the "Early" or prefabricated standpipes, and the "New" standpipes, which were poured-in-place. Early standpipes were prefabricated using 2-3 sections of unlined concrete pipe and a base (Figure 1, total length of the uncapped standpipe: 3.66 m). The sections were assembled with offset connections that were sealed with a gasket. Two steel strands run through the solid bottom section and through tubes embedded in the walls of the pipes (sections 2 and 3 in Figure 1). Upon assembly, these strands were tensioned and tied off in a recessed pocket at the top of the upper section. These standpipes were damp-proofed by coating with asphalt. They were suspended in augered holes on top of a freshly poured concrete base and kept in this position for 48 hours while the concrete base set (Figure 2). Common backfill was used to fill in the annulus of the augered hole.

After the full complement of waste was added, these standpipes were apparently filled with sand or gravel, sealed with bitumen and capped with concrete.

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2 Acsion Industries Incorporated, 1 Ara Mooradian Way, Pinawa, Manitoba, R0E 1L0, Canada.

3 Broadly defined here to include thorium and all enrichment levels of uranium

Figure 1. Standpipe sections 1: base; 2 and 3: unlined pipe (circa 1966).

Figure 2. Installation of an early standpipe (circa 1966). Note work in the background on augering another standpipe hole.

Excavation work in 2009 on some standpipes to 1.2 m below grade showed that the shapes of the caps vary. Figure 3A shows a standpipe on which the cap covers only the interior diameter of the standpipe; the caps of other standpipes examined in 2009 were found to cover some of the standpipe top end wall, the entire top end of the standpipe, and in one case, extended beyond the outside diameter of the wall.

The 76 standpipes with tops exposed above ground are based on the new, poured-in-place, design shown in Figure 4. They were constructed by suspending a

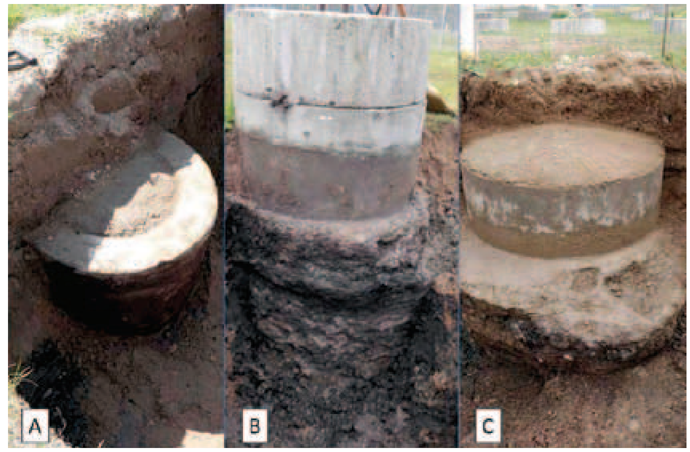

Figure 3. Standpipe Types: A- EARLY; B - exposed NEW; C - buried NEW (2009).

welded carbon steel pipe in an augered hole and backfilling around and under with concrete to a nominal thickness of 0.2 m. They are sealed with concrete shielding plugs that can be removed for inspecting the contents. Figure 3B shows one of these standpipes exposed to 1.2 m below grade. Some buried standpipes appear to be of this design (Figure 3C); however, instead of a plug, they are capped with concrete, like the early standpipes.

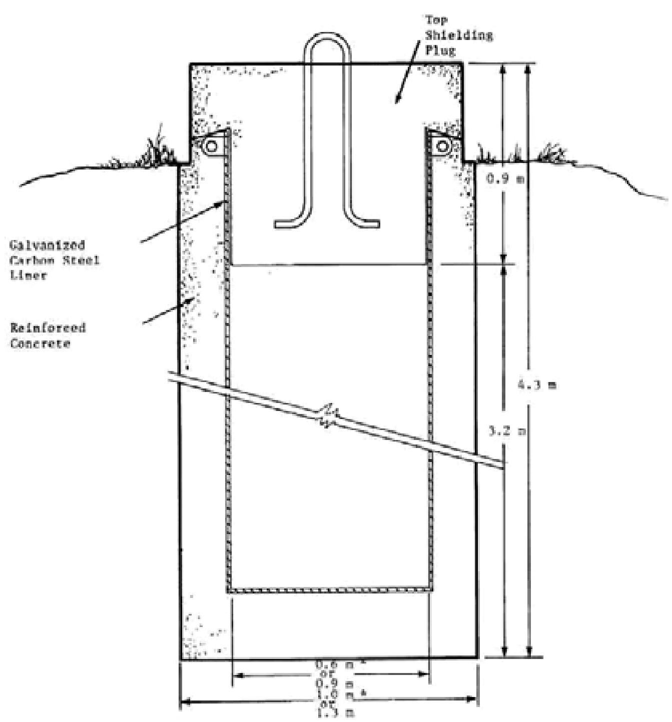

Figure 4. New, poured-in-place standpipe elevation drawing.

2.2. Standpipe Contents

The FM in the 69 standpipes selected for remediation include irradiated fuel from experiments and Post Irradiation Examination work conducted in the hot cells, surplus materials, and un-irradiated fuel materials used in some experiments. Most of the irradiated fuel originated from Whiteshell Reactor-1, with small contributions from several other Canadian experimental and power reactors. This material was in a variety of forms: cut sections, broken pieces, shavings, sludge, etc., and comprised 650 items of distinct FM. Some of these items were cut to fit into their transfer containers (e.g., fuel bundles cut into many element sections) before emplacement.

The waste consisted of uranium and thorium oxides, uranium carbide, uranium metal and various alloys, uranium silicide and uranium-silicon-aluminum and graphite-based composite materials. Most of the 69 FM-bearing standpipes contain two or more different fuel types.

In addition, some standpipes contain non-FM waste (e.g., scrap metals from experiments, filters).

The FM-bearing standpipes were filled between 1967 and 1977 except for two emplacements in 1985 and 1992. Thus, most of the FM has been in storage for 30 to 40 years. Due to the nature of the site and storage conditions, water ingress into the standpipes is expected to have occurred.

3. Standpipe Remediation Pre-Project Plan

The WL Standpipe Remediation Initiative is in the pre-project phase. This phase involves gathering the information required to develop a plan for remediating the FM-bearing standpipes. The main foci are: 1) determining the condition of the standpipes and their contents to define the issues related to remediation, and; 2) assessing potential remediation options.

3.1. Condition Assessment

3.1.1. Past Activities

The following have led to the present understanding of standpipe conditions and potential issues:

- An electronic database of standpipe contents has been established.
- The chemical and physical properties of the emplaced FM have been documented.
- Burnup data have been compiled, with conservative estimates where necessary, for all irradiated FM, providing a basis for estimating radioactive inventories and hazards.
- The likely present conditions of the FM, the potential presence of combustible gases and pyrophoric material, and a relative hazard ranking have been assessed.
- Inspections of standpipes exposed to 1.2 m below grade indicated the condition of the concrete was very good. As no seals between sections of any early standpipes were exposed, deeper excavation is required for complete assessment.

3.1.2. Present Activities

Present activities include: 1) planning to conduct non-invasive material density profiling, and; 2) planning to drill through standpipe plugs/caps to sample for gas and water content.

3.1.2.1. Material Density Profiling Using Radiography

The objective is to locate emplaced material, sand, water, gas, and the approximate length of the poured-in-place concrete caps. The procedure involves installing investigation tubes on opposite sides of selected standpipes down to the same level as the bottom of the standpipe (Figure 5). A 100Ci Cobalt-60 gamma source will be placed in one tube; a detector configured with a narrow window to detect unscattered high-energy gamma rays from the Cobalt-60 source will be in the other tube. The detector and source will be raised and lowered such that when readings are taken, they will be located at the same relative depth. Background readings using the high-energy gamma ray window in the detector will be obtained prior to using the Co-60 source. Following compensation for background, data obtained using the Co-60 source will produce a profile of relative density as a function of depth. By comparison with similar data obtained using a mock standpipe (Figure 6), the material located at different depths may be identified.

At present, the mock up work has been successfully completed, and investigation tubes have been installed at selected standpipes in the WMA. Radiography work is scheduled for 2011.

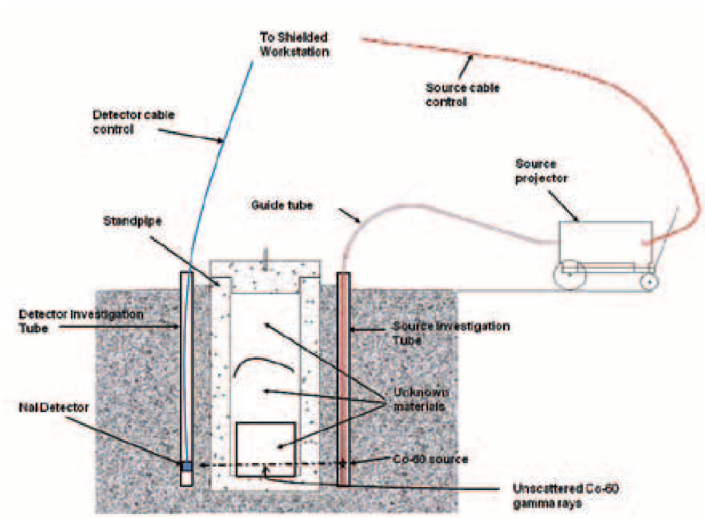

Figure 5. Set-up for axial material density profiling of standpipes.

Figure 6. Mock standpipe and shielded enclosure set-up for axial radiography trials.

3.1.2.2. Drilling Through Standpipe Plugs/Caps to Sample for Gas and Water

No empirically-derived data exists on the current physical or chemical conditions of the FM, the extent of gas accumulation within the standpipes, or the presence of water. Expectations based on inference from available data are:

- Fuel corrosion will generate hydrogen gas, and/or methane and other hydrocarbons;
- Anoxic corrosion of metallic objects such as steel cans and the aluminum-based cladding materials from some fuels can produce hydrogen;
- Radiolysis of water and organic compounds may be another gas generation source;
- Certain radionuclides, such as Cs-137 and Sr-90, in oxide fuels will have been significantly leached by water intruding into the standpipes.

Uncertainties regarding the extent of gas accumulation after 30-40 years storage and the extent of Cs-137 and Sr-90 dissolution into water in the standpipes need to be resolved before a remediation option can be chosen.

Figure 7. Demonstration of drilling through a mock standpipe cap/plug (2009).

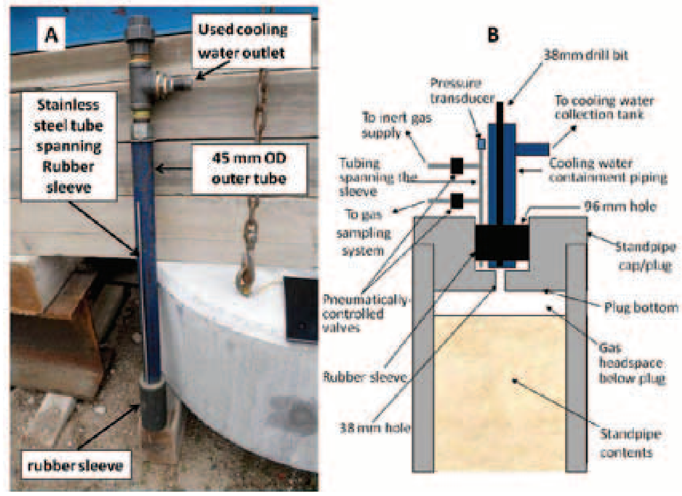

Figure 8. A: 38mm drill bit modified with a packer assembly. B: Schematic of the modified 38mm drill bit in the standpipe cap with tubing connected to inert gas source, pressure transducer and gas sampling system (Note: Drawing not to scale).

Available data shows the buried standpipes contain poured-in-place caps, which do not contain lifting bolts. The standpipes do not contain any ports for sampling or venting. Thus, drilling through the cap appears to be the best alternative for accessing the internal environment.

A diamond drill will be used to drill through the standpipe caps/plugs. Figure 7 shows a trial conducted on a mock concrete cap/plug (for work on actual standpipes, the drill will be on a mobile platform and not in direct contact with a standpipe).

The drilling procedure is based on one used at AECL's Underground Research Laboratory for concrete buffer interface gas sampling [1]. A 96 mm-diameter hole will be drilled part way into the cap/plug (the radiography work discussed in Section 3.1.2.1 should provide information on the depth of the poured-in-place caps). A modified 38 mm drill bit will then be used to drill the remaining distance through the standpipe cap/plug. The modified bit will include a packer assembly (Figure 8 A and B), which will capture used cooling water and maintain a barrier between the atmospheres inside and above the standpipe. The outer 45 mm tube will contain and direct the used cooling water to a collection tank. The compressible rubber sleeve will provide a pressure seal against the walls of the 96 mm-diameter hole; this will constitute the barrier between atmospheres inside and above the standpipe.

A stainless steel tube will span the rubber sleeve (Figure 8 A and B). This tube will be attached to an inert gas supply, a pressure transducer, and a tube leading to an evacuated gas sampling system. When the standpipe cap/plug is breached, any gas pressure inside the standpipe is expected to be relieved by expansion along the path taken by the used cooling water, which leads to a cooling water collection tank. Once pressure inside the standpipe is deemed acceptable, a valve on the line leading to the gas sampling system will be opened and the vacuum inside the sampling system will assist in collecting up to four replicate gas samples.

After gas sampling is complete, an inert gas atmosphere will be established inside the top part of the standpipe and in the 96 mm- and 38 mm-holes in the plug/cap. The condition of the interior walls of the standpipe near the bottom of the cap/plug will be examined using a bore scope. A probe will then be used to detect water in the top 10 cm of the contents of the standpipe. If present, water will be sampled only from that top 10 cm so no potentially reactive material is disturbed. A vacuum-assisted procedure will be used to collect a water sample. Finally, equipment will be installed in the 38 mm- and 96 mm-diameter holes to allow venting, flushing and sampling in the future, if required. This equipment will be protected by a removable all-weather cover.

At present, a detailed design of the components involved in the drilling and sampling and a safety analysis of the proposed procedure are in progress.

3.1.3. Future Activities

Dewatering is anticipated to be a major component of any final remediation strategy. The equipment inserted under the removable all-weather protective cover after the drilling and sampling process (see previous section) will provide the portal for dewatering fieldwork.

Dewatering technology used at AECL's Chalk River Laboratories (CRL) will be assessed in 2011. At CRL, vacuum assistance is used to remove water from tile holes (similar to standpipes), circulate it through a filter and ion-exchange column, and then pump the water into drums for processing at the Waste Treatment Centre.

Technology will need to be developed for safely inserting water removal equipment into the standpipe without disturbing potentially reactive material.

3.2. Assessing Remediation Options

A survey of remediation work conducted in Europe and North America indicated that the remediation of tile holes at Bruce Power in Ontario was the only technology with potential for use with the WL standpipes. This technology involved encapsulating tile holes in concrete, *in situ*, then lifting and transporting them to a storage location [2]. Evaluations of the different soil conditions at WL, and of the worst-case radioactive fields anticipated to be encountered at WL, indicated that, with some modification, this technology had potential. Currently, work is in progress to determine costs and requirements for testing this technology at WL.

Another potential remediation option involves using WL's Shielded Facilities to separate, characterize, passivate and package the contents of the FM-bearing standpipes for long-term storage. A preliminary evaluation was conducted on the possibility of extracting the standpipe's contents *in situ*, transferring the contents to the Shielded Facilities, sorting and repackaging the waste, and decommissioning the empty standpipe.

The third remediation option identified involves using a new, possibly mobile, shielded facility located at the WMA. A preliminary assessment of this option has been completed. Once information has been collected on costs and requirements for testing the tile hole remediation technology used at Bruce Power, a comparison of the three options will be conducted to define all the issues and prioritize the options for further assessment.

4. Summary

Standpipe Remediation Initiative pre-project activities involve evaluation of standpipe condition, potential issues that may be faced during remediation, dewatering techniques, and potential remediation options. Work is underway to examine concrete surfaces outside and inside the standpipes. Plans for drilling through standpipe caps/plugs are underway to test for gas and water, and to examine the interior walls at the top of the standpipe. Development of suitable dewatering techniques will begin next year. Finally, a comparison of the three potential remediation options identified to date will be completed in 2012.

The output of this pre-project work will be a recommendation of a remediation technology, definition of the requirements for the remediation project, and provision of a clear set of expectations and acceptance criteria.

5. References

[1] Stroes-Gascoyne, S., Hamon, C.J., Vilks, P., Gierszewski, P. "Microbial, Redox and Organic Characteristics of Compacted Clay-Based Buffer after 6.5 Years of Burial at AECL's Underground Research laboratory", *Applied Geochemistry* Vol. 17, 2002, pp. 1287-1303.

[2] A. Buchnea, M. Cleary, P. Szabo and M. Cahill, "Worker Dose Reduction During Removal of Tile Holes Containing Intermediate Level Radioactive Waste by Steel and Concrete Encapsulation", Paper 5e1, *Proceedings, 11th International Congress of the Radiation Protection Association*, Madrid, Spain (2004).

UNENE: An Update on Nuclear Education and Research

by DR. B.A. SHALABY[1], DR. V.G. SNELL[2] and DR. B. ROUBEN[3]

Abstract

University Network for Excellence in Nuclear Engineering (known as UNENE) was created in 2002 as a partnership between Industry and universities with the objectives of establishing a nuclear R&D program in universities to train and develop Highly Qualified Personnel (HQP) to address the demographic gap and to create a sustainable source of expertise for independent industry and public consultation. Seven years into its creation, UNENE is now a well established and fully functional framework with programs mainly focussing on education and research serving the industry at large .The educational component is in the form of an M. Eng program mainly catering for working professionals by being offered on weekends and using distance learning tools .It is intended to enhance competencies and build knowledge for students. The R&D programs are lead by Industrial Research chairs (IRCs) and other prominent researchers in areas of importance to the industry. This paper examines the above topics and its outcomes as of March 2010.

1. Introduction

UNENE (University Network for Excellence in Nuclear Engineering) was established in 2002 as a partnership between the nuclear industry and universities with the objectives of:

1. Establishing university research in key areas of interest to the nuclear industry.
2. Developing a sustainable supply of Highly Qualified Personnel (HQP) to address demographic gaps in the industry.
3. Providing an independent university–based source of scientific expertise for public and industry consultation.

UNENE members are listed in Figure 1

UNENE Members

▪ Atomic Energy of Canada Limited	▪ McMaster University
▪ Bruce Power	▪ Queen's University
▪ Ontario Power Generation	▪ University of Ontario Institute of Technology
▪ Canadian Nuclear Safety Commission	▪ University of Saskatchewan
▪ CANDU Owners Group	▪ University of Toronto
▪ Nuclear Safety Solution	▪ University of Waterloo
▪ CAMECO	▪ University of Western Ontario
▪ University of Windsor	
▪ University of New Brunswick	▪ Ecole Polytechnique
▪ University of Guelph	▪ Royal Military College

Figure 1: UNENE Members listed by Government / Industry and Academic

2. UNENE: A Partnership

The industry members, (namely Ontario Power Generation (OPG), Bruce Power (BP) and Atomic Energy of Canada Ltd (AECL)) initiated UNENE research by sponsoring Industrial Research Chairs (IRCs) in many of the UNENE Universities. These chairs are held by world-class scientists with considerable industrial experience and they are well respected in the industry, both nationally and internationally. These IRCs became anchors for establishing research programs and competent research teams within their respective universities. Industry funding of the IRC programs has also served to leverage additional funds from federal and provincial research grants, thus widening the scope and size of these programs – which have allocated $50M (Canadian) to date.

UNENE is a non-profit organization governed by a Board of Directors (BoD) with member representation from the funding industrial partners and universities. Two Advisory Committees, one on Education (EAC) and one on Research (RAC), manage and oversee the respective programs. The EAC and RAC committees consist of both Industry and University members. Both committee chairs report quarterly to the BoD on the status and results of research and educational activities (Figure 2).

3. UNENE and Current Industry Challenges

Canada's nuclear industry is well established as a $6B industry with nearly 60,000 jobs. It started in 1945 with the ZEEP (Zero Energy Experimental Pile),

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3 UNENE Secretary-Treasurer, email: rouben@alum.mit.edu

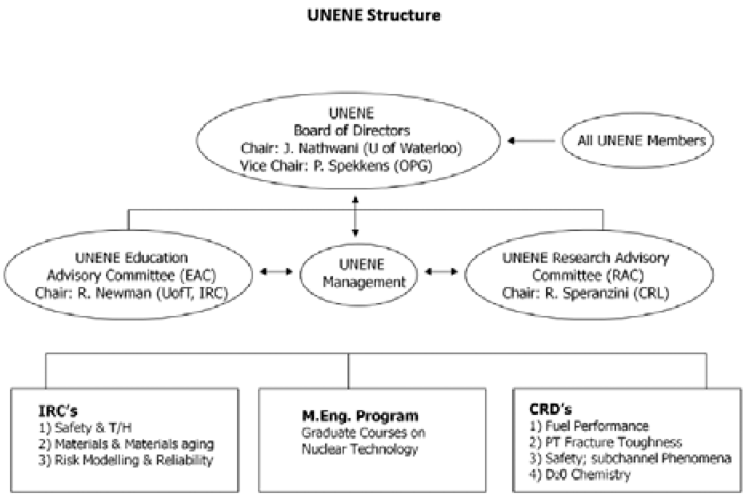


Figure 2: UNENE Structure

followed by the early nuclear research reactors (NRX and NRU), and continuing to the established CANDU - PHWR (Pressurized Heavy Water Reactor) technology – with a current market share of 8-10% of the world-wide commercial NPP's (Figure 3).

Nuclear power in Canada now provides 15% of the national electricity supply, and 50% of the electricity supply in the most industrialized province of Ontario.

Most of the plants are Generation II vintage, coming on stream from the mid-1970s (Pickering A Units 1 to 4) to the mid-1990s (Darlington Units 1 to 4). Some of the CANDUs have been life-extended beyond their 25-30-year design life while others are being (or are planned to be) refurbished for a 50 to 60-year life. Future nuclear construction of Generation III and Generation III+ plants are expected to replace retired nuclear capacity and to meet clean energy targets (Figure 4).

As with any industry, an NPP is a complex project with long lead times, and is multifaceted and multi-disciplinary in nature, making knowledge one of its key enablers and a vital component over its entire lifecycle: design, licensing, construction, operation, decommissioning and long term waste management. This is even more crucial in view of life extension or

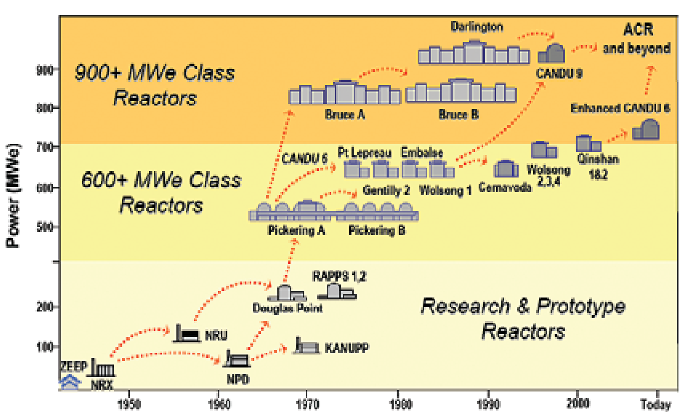


Figure 3: CANDU Genealogy

life doubling: nuclear competencies and continuity in knowledge need to be maintained for two to three generations.

So for the industry to secure safe and economic long term operation of the current CANDU fleet, it recognises the role of knowledge preservation and continuous competence-building in order to meet the following strategic priorities:

1. Maintain the safe and economic Long Term Operation of its current nuclear plant fleet.
2. Maintain knowledge of the design and licensing basis of current plants.
3. Advance knowledge and tools towards successful design and licensing of future Gen III+ plants (such as the Enhanced CANDU 6 and the ACR-1000).

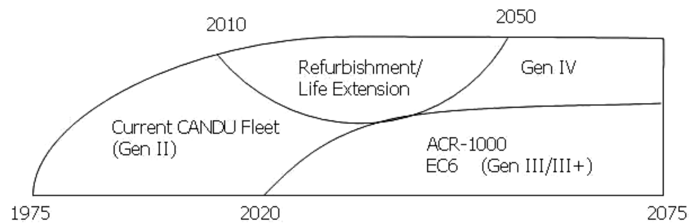


Figure 4: Nuclear R&D and Industry Challenges

With these priorities, the UNENE partnership between Industry and Academia focuses on two key aspects: Education and Research.

4. UNENE Educational Program

A graduate level Master's program was set up by UNENE in collaboration with the member universities. Program courses from member universities, duly accredited in Ontario by the Ontario Council of Graduate Studies, allow UNENE to coordinate a joint course-based Master's of Engineering Program in Nuclear Engineering. The courses cover key areas fundamental to nuclear plant design, safety, operation and other related topics geared to enhance the knowledge and competence of students and other professionals working within the industry. Courses are offered outside working hours; acceptance is according to the normal graduate-level admission prerequisites. The courses currently offered are noted in the Table below.

The M.Eng Program continues to grow both in student enrolment and in the selection of courses offered, as shown below (Figure 5).

The UNENE M. Eng. offer many benefits to the industry such as:

- Development of HQP to meet industry needs.
- Assisting industry in knowledge transfer and preservation.
- Professional/career development of employees towards an effective and highly skilled workforce.

Table 1: Courses offered towards the UNENE M. Eng. in Nuclear Engineering

Course #	Course Title
UN0801*	Nuclear Plant Systems and Operations
UN0802*	Nuclear Reactor Analysis
UN0803*	Nuclear Reactor Safety Design
UN0804*	Nuclear Reactor Thermalhydraulics
UN0601	Control, Instrumentation an Electrical Systems in CANDU Plants
UN0602	Nuclear Fuel Waste Management
UN0603	Project Management for Nuclear Engineers
UN0701	Engineering Risk and Reliability
UN0702	Power Plant Thermodynamics
UN0805	Radiation Health Risks and Benefits
UN0901	Nuclear Materials
UN0902	Fuel Management
UN1001	Reactor Chemistry and Corrosion
UN0800	Industrial Research Project

*Core M. Eng courses

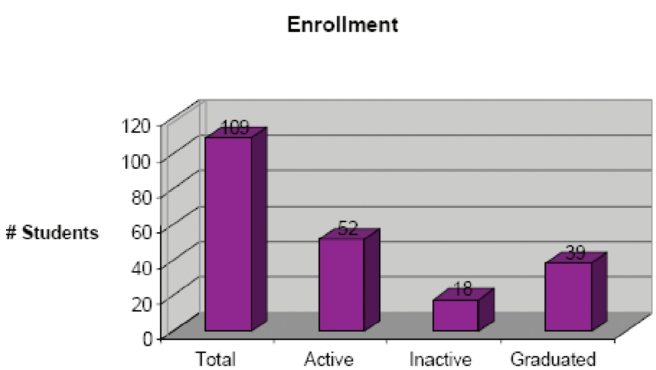


Figure 5: Chart showing Student Enrolment

- Lower cost than in-house training (employees take courses outside of working hours on their own time).
- Forum for employee's interaction with industry and university peers.

One utility explicitly recognizes the UNENE M. Eng. as an advantage when an individual applies to become a supervisor. Also some of the M.Eng course material is now being proposed for high-calibre non-accredited enhanced training to utility professionals.

To accommodate and attract students who work at sites distant from the greater Toronto area, synchronous distance learning over the internet is now routinely applied to all course deliveries through the use of the ELLUMINATE program. As of September 2009, student feedback with distance learning has been positive, and even "live" students appreciate and use the recording feature. New video conferencing systems are currently under assessment; with additional features such as enhanced visual capability, viewing of full screen lecture presentations by all students and ability to see all participants (real time) at different locations.

5. UNENE Research Programs

Since UNENE's inception, Industrial Research Chairs (IRCs) and Collaborative Research and Development (CRD) projects were established as the platforms for nuclear research in Universities. World Class IRCs were endowed in prominent Canadian universities to become anchors for research in key areas of the technology, while developing Highly Qualified Personnel for industry hiring. The IRCs established are:

- McMaster University: Safety and Thermal hydraulics
- Queens University: Material Sciences
- University of Toronto: Nano-engineering of Alloys
- University of Waterloo: Risk and Reliability
- University of Western Ontario (UWO): Instrumentation and Control, and Electrical
- Royal Military College (RMC): Fuel Technology
- University of Ontario Institute of Technology (UOIT): Health Physics

Most programs focus on key R&D in areas of interest to the industry such as safety analysis methodologies, phenomena and analytical codes; fuel channel material sciences; corrosion chemistry in nuclear materials; and probabilistic and risk modelling in support of Life Cycle Management in current plants.

To date many outcomes have been achieved.

- Nine (9) CRDs have been funded by UNENE/NRCan on topics closely tied to the IRC programs. The initial CRD projects are nearing completion with five (5) new ones being initiated in 2010 for a three year duration.
- UNENE program funding leveraged additional provincial and federal funding; making current available funds for UNENE universities in excess of Can $50M.
- The number of HQP developed by member universities has reached 100 HQP (PhDs, PDFs, MASc with most of them successfully recruited within the industry, research institutions, government and universities.

National & International collaborations are forged within the university itself across many engineering disciplines and scientific departments, among different universities, and with industry on specific research programs. Examples of such collaborations are the University of Toronto / University of New Brunswick / University of Waterloo study on corrosion chemistry; the McMaster / CANS (Centre for Advanced Nuclear Systems)work on Thermal hydraulics; Queens University / Kinetrics on pressure tube deformation;

McMaster / Chalk River Laboratories on fuel cycle and physics; and Royal Military College / Chalk River Laboratories on fuel performance.

International collaborations are established with many US universities and the US Department of Energy National Labs, and some European Union universities in areas such as thermal hydraulics (between McMaster / University of Pisa and Trinity College), and development of integrated fuel performance codes between Royal Military College and Oak Ridge National Laboratory.

Consultation /Interactions with industry:

Many technical exchanges, consultations and technical activities take place between industry and universities. IRCs' and Associate IRCs' expertise are sought by industry on resolution or regulatory queries; Life Cycle Management (LCM) decisions for optimal maintenance and risk-based inspections (OPG); NRU leak repair (AECL); ACR-1000 Independent Safety Review (AECL); OPAL Reactor (ANSTO); Pickering Unit 7 Calandria Tube crack (OPG), etc.

Equipment and Facilities:

- A High Performance Computing Center (HPCC) was set up at McMaster enabling Safety Analysis code coupling and code development. The HPCC is accessible by users University wide.
- A Nuclear Materials Testing Lab is being planned at Queen's with commissioning expected in 2012.

Other notable benefits and successful spinoffs to the industry are:

1. **Integration of research programs** among universities and institutions.
2. **Interaction of Universities with industry** through UNENE Technical Advisory Committee (TAC) (AECL, BP, OPG), resulting in detailed discussion on research directions and opportunities, ensuring industrial–university technical research objectives are met.
3. **Expansion of R&D base** with eleven (11) universities becoming players in research and knowledge building.
4. **Technology Transfer** on topical issues of critical importance to industry on operational, regulatory and new build such as Steam Generators, Fuel Channels, Feeders and MTS components, Regulatory and Operational Safety, Gen IV designs and risk-based inspection and maintenance.

6. Summary

UNENE continues to grow and provide technical and educational support to industry members in key areas of importance to industry. Establishment of research programs in universities has increased the knowledge base and facilitated integration of R&D among Universities and industry, making technology transfer viable and effective in all aspects of the technology. The UNENE M.Eng program has continued to attract students from industry and is expected to grow further now that Distance Learning has been further honed and become easier through the use of Elluminate Software through McMaster University. It is expected that further enhancements in these tools will attract more students from distant sites.

References:

[1] G. Bereznai, W. Garland: "New Postgraduate Programs in Nuclear Engineering to meet the needs of the Canadian Nuclear Industry" 16^{th} Pacific Basin Nuclear Conference (16 PBNC), Aamori, Japan, Oct 13-18, 2008, Paper ID P16P1343.

An aerial view of the Bruce A Station.

Inattentional Blindness: Present Knowledge, Recent Research and Implications for the Nuclear Industry

by JEFF BUDAU[1]

[Ed. Note: the following paper was presented at the 32nd Annual Canadian Nuclear Society Conference "Nuclear @ Niagara", 2011 June 5-8.]

Abstract

Inattentional blindness can occur when our attention has been assigned to a primary task and not enough attentional resources are left to detect what can be a very important unexpected event. This unexpected event is often something that would be detected under normal conditions. Recent research has shown that perceptual load, and qualities of the unexpected stimulus can impact the occurrence of inattentional blindness. As the nuclear industry has situations of high perceptual load, consideration should be given to the implications of this research.

1. Introduction

Inattentional blindness, sometimes also referred to as attentional blindness is the curious phenomenon of not visually perceiving something in your visual field that most people would view as being obvious. A memorable real world example is the year 2000 incident where an American submarine hit a Japanese fishing vessel even after the Commander did a visual sweep of the surrounding water through the periscope. The Commander had been informed that there were no sonar contacts and at the time of his periscope sweep there were several high profile visitors in the control room. There are numerous examples of drivers of cars and motorcycles pulling out in front of oncoming traffic, bicycles or pedestrians causing damage, injury or death. While none of these events may have obvious ramifications for the nuclear industry, this paper is meant to highlight present knowledge of, and recent research into inattentional blindness that may have implications for work done in our facilities. A brief primer into how we see things is given in the following sections followed by a deeper look into inattentional blindness.

2. The biology of sight

Figure 1 below shows a fairly remedial diagram of the human eye and is courtesy of the National Eye Institute. Light rays entering the eye are focussed on the retina by the cornea and the lens. The retina itself contains millions of Rods and Cones which transduce light into electrical signals that get sent from the eye to our brains visual processing centers.

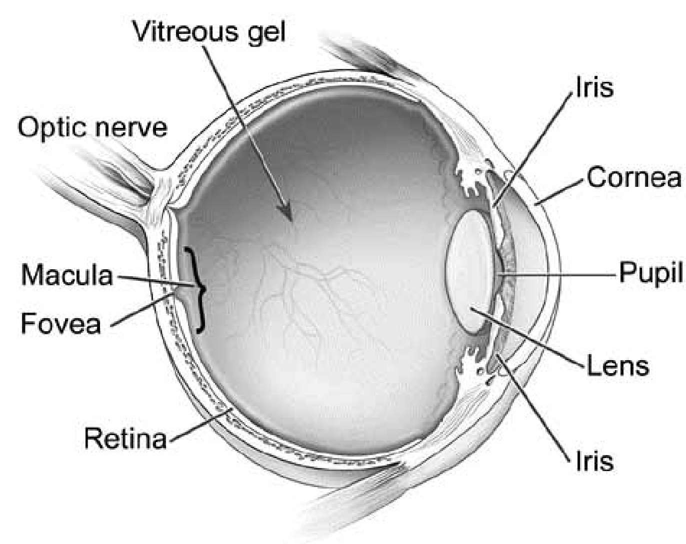


Figure 1: Diagram of the Human Eye

Rods are only black and white detectors and don't need much light to be activated, but because of the way the signals from them are collected, offer a fairly low resolution or grainy image. Rods are what we use to see in near dark situations. Cones on the other hand offer us much higher resolution scenes that are in colour, but unfortunately require more light to activate. Cones are what give us most of our visual information in well lit situations.

A part of our retina called the Fovea is the only place on our retina that contains ONLY cones. This small portion of the retina, which is about a millimetre in diameter and accounts for about 0.01% of the retina's surface area, is what we try to focus visual images on when we are paying close visual attention to them. The interesting part of course is that the fovea, representing only about 0.01% of the surface area of the retina feeds approximately 10% of the retinopic map in the visual cortex[1].

The cone of light coming into our eye that lands on our fovea, (that represents 0.01% of our retina's surface area), is roughly equivalent to what would come from a disc about 7-10 cm in diameter about 2 meters in front of us.

1 Bruce Power, Tiverton, Ontario, Canada

3. The psychology of seeing

While the biological underpinning of our sight is important to understand how we see things, the real magic occurs in the brain as these images are processed. While we may feel that what our eyes are receiving is flawlessly translated in pristine perfection to our consciousness, the reality is somewhat different. When we view a visual scene in front of us we point our fovea at various portions of the picture in what are called "saccades" which are 20-200 ms movements from one point to the next. We then stop for a brief period of time, typically about 250 ms, in what are called "fixations" and then our eye saccades off to the next fixation point. Our brains then stitch together the images from the multiple fixations into what is presented to our consciousness as a seamless, coherent "picture" [1].

It is important to remember that each of these fixations only grabs a snapshot of good detail from a small portion of our visual field, before we saccade off to the next fixation to grab another snapshot of a small portion of the visual field. If, for example an Authorized Nuclear Operator (ANO) is standing 6 feet away from the control panels, the fixations each grab only about a 7-10 cm diameter circle of good, detailed information at a time.

Studies with eye tracking machines have shown us that we actually only point our fovea at small, select parts of any given visual scene and our brains smooth out, or fill in what detail wasn't directly noted with what is expected so that the visual scene doesn't appear to have gaps in certain spots[1].

One of the underlying questions in all this of course is what determines where we point our foveal vision. The answer to this is that generally, our attention guides where we point our fovea. Our attention can be drawn towards something by certain qualities that we are programmed to pay attention to, like movement and flashing lights. Our attention can also be unconsciously directed by what our experience has taught us to look at. This happens when we drive cars and are scanning the road in front of us or when we look at someone's face to help ourselves interpret unspoken signs and signals. Finally we pay attention to things we are consciously driving our attention towards like when an ANO deliberately moves from one display to the next to check the status of some parameter they are interested in[1][9].

4. What is inattentional blindness

The earliest research into inattentional blindness occurred in the 1990's and researchers have developed a series of ways to test for it. In a number of studies the subjects are asked to distinguish which arm of a cross is longer throughout a number of trials and every now and then an object is presented at the same time as the cross at some location in the subject's visual field and they are asked to identify this shape, or some quality of it, that they had not been warned about[2]. When subjects fall victim to inattentional blindness in these experiments they report that they saw no other "unexpected" object. Other studies like this use letters of different colours as both the primary task and the unexpected stimulus[3]. In one of the most famous examples of inattentional blindness research, the researchers had subjects view a scene where 3 students in white t-shirts and 3 students in black t-shirts were passing basketballs while weaving around each other. The subjects in this experiment were asked to count the number of passes made by the team in the white t-shirts. The whole clip is about 75 seconds long, but at about the 45 second mark a student wearing a Gorilla suit walked into frame proceeded to the middle of the screen, beat its chest a few times then walked off. To most viewers this would seem a fairly obvious, and rather odd, event; but the results showed that almost half the subjects didn't see the gorilla[4]. While the research delves into various factors surrounding inattentional blindness, the fundamental issue is that the subjects are regularly unable to report the presentation of what is objectively a fairly obvious stimulus.

Inattentional blindness then is when we are not consciously aware of an unexpected, yet otherwise noteworthy object, in our visual field. We essentially become "blind" to that object because we did not pay attention to it.

5. What the research is saying about inattentional blindness?

In that landmark study by Simons & Chabris (the one with the Gorilla)[4], they also had trials with a woman carrying an umbrella walking through the frame for a few seconds, again clearly visible. Of interest is that the subjects consistently noticed the woman carrying the umbrella more frequently than they noticed the gorilla. The authors in this study concluded from their series of experiments that there is no perception of objects without attention. They also suggest that inattentional blindness will occur more when the primary task the subjects are engaged in becomes more difficult and that the unexpected event may be more easily detected when it is more visually similar to the items in the primary task.

In a 2007 study, Cartwright-Finch & Lavie[2] ran four separate experiments to tease out the effects of perceptual load on the likelihood of the subject experiencing inattentional blindness. Their study used trials where the subject had to determine the colour of cross arms in a cross displayed on screen, other trials where subjects had to state which arm of the cross was longer and additional trials which required the subjects to perform a visual search in where they had to distinguish between an X and an N amongst some visual clutter. In all cases there was the occasional unexpected stimulus of a black square presented within the visual field. The authors in this paper took great trouble to carefully manipulate the amount of perceptual load in their trials (more or less clutter in the visual search, or easier/harder line length discriminations) and came to the conclusion that the amount of perceptual load had a direct impact on the likelihood of cases of inattentional blindness. The more perceptually challenging the primary task is, the more likely the subject is to miss an unexpected stimulus.

In a study with multiple individual experiments, Most et al[5] used a variety of experimental conditions to tease out some of the impacts of the visual qualities of the objects in the primary task and in the unexpected stimulus and how these qualities might impact inattentional blindness rates. What the authors found was that the unexpected stimulus would be more likely to be noticed if it was more visually similar, in some key parameter (shape or colour) to the objects in the primary task than if the unexpected stimulus was more unique. The researches put forward the possibility that we define characteristics for the set of information we are trying to extract from our visual field and these characteristics become a sort of filter for us to include or exclude objects from conscious consideration. The authors put forward the theory that the probability of someone noticing an unexpected stimulus is directly related to what they have set their minds to see.

In a series of related experiments Beanland & Pammer[3] used a computer based display where the primary task was for the participants to count how many "bounces" off the sides of the display were made by certain letters that were white. The unexpected stimulus was a dark grey coloured different letter or unique symbol. The interesting part in this experiment was that the authors used eye tracking equipment to see how close the subject's fixations got to the actual unexpected stimulus. The results of their experiments showed that while there is a slight tendency for people who notice the unexpected stimulus to spend a little more time fixated within 2 degrees of the object than people who don't notice it, they noted that people can fixate directly on top of the unexpected stimulus and still not notice it. Conversely, during their research they also found that some of the subjects that noticed the unexpected stimulus did not fixate on, or even particularly close to, the unexpected object that was noticed. Their experiments confirmed previous findings that the difficulty of the primary task has a direct impact on the likelihood the subject will notice the unexpected stimulus. The harder the primary task, the more likely they will suffer from inattentional blindness and miss the unexpected stimulus.

In another interesting experiment[6], the authors used a computer based trial similar to that used in several other experiments where white and black letters "bounced" off the walls and the subjects had to count the bounces. In their experiments the unexpected stimulus was a grey cross and there were also conditions with audio tasks added to increase the difficulty. While this experiment certainly showed many instances of inattentional blindness as participants missed the unexpected stimulus, the fascinating part was the effect the unexpected stimulus had on the accuracy of counting the bounces (the primary task). What the authors found was that the accuracy of the primary task (counting bounces) was better when the subjects **noticed** the unexpected stimulus than if they didn't notice it. There was a performance cost if the subject failed to bring the unexpected stimulus to conscious awareness. Just to be sure they hadn't messed something up, the authors ran variants of the experiments a few more times and found that the performance on the primary task was the same for people that noticed and didn't notice the unexpected stimulus on the trials when no unexpected stimulus was present but as soon as the unexpected stimulus entered the screen, primary task performance dropped only for the people who **did not** see the unexpected stimulus.

While the previous studies almost exclusively focussed on inattentional blindness when engaging in a primary task that was visually based Hyman et al[7] looked at several conditions in an observational study as subjects navigated their way across a large open square on the campus of an American university. The relevant part of their study had a unicycling clown riding next to the common pathways and had experimenters question people who had just walked across the square. The trained observers classified walkers as single, walking with one other person, walking while listening to an electronic device and walking while talking on the cell phone. As well as asking the subjects about noticing the unexpected stimulus, the observers also recorded how many direction changes were observed, walking speed and how many times they swerved to avoid obstacles. The authors in this study concluded that talking on the cell phone increased the likelihood of inattentional blindness based on the results that subjects talking on the cell phone missed the clown more (by a statistically significant margin) than all other walkers. They also weaved more and walked slower (though the subjects walking in pairs also walked more slowly as well). This study, while not being conclusive in and of itself clearly points towards the possibility that inattentional blindness may increase not only with higher visual demands, but possibly also with higher central processing demands.

6. General discussion

The theoretical framework which seems to most successfully integrate these results is the perceptual load theory proposed by Lavie[8]. In this theory, Lavie proposes that the early selection of which information gets processed is limited by attentional resources. When the perceptual processing capacity exceeds what is being demanded by the primary task then irrelevant stimuli will "capture" the remaining processing capacity, allowing the individual to notice the unexpected stimulus in the inattentional blindness trials. However, when the primary task at hand consumes the available processing resources, there is no more to perceptual capacity to capture and the unexpected stimulus and it goes unnoticed.

In a sense then, Lavie proposed that perception is a limited process, but that to the extent that there are uncommitted resources available, it is an automatic process. Another way to look at this is that perceptual processing is guided in a top-down manner until the necessary resources are allocated to the high priority task. The allocation of any leftover resources is then allocated in a bottom up manner, driven by the characteristics of the unexpected stimulus and the available perceptual resources.

Nearly all of the research noted in this paper showed that an increase in perceptual demands on the primary task led to an increase in the incidence of inattentional blindness. Consistently it was also shown in several experiments that the unexpected stimulus was always or almost always noticed in the very low demand trials. The research into the impact of the visual similarities between the unexpected stimulus and the primary task objects seems to imply that when our attention is "casting its net" to catch the necessary information to process for the higher priority or "primary" task, the unexpected stimulus is more likely to get caught in the net because of its visual properties and it is more likely to be consciously noticed.

Finally, the last study discussed in this paper[7] implies that the attentional resources directed at the perceptual load may also be limited by the attention directed at non-visual sources (talking on the cell phone). This view is consistent with the implications of the model of human processing put forward by Wickens and Hollands[9] in that when dividing the limited resources a subject may emphasize attention on one task (talking on the cell phone) reducing the resources made available to other tasks (noting the unicycling clown, or navigating around obstacles).

7. Implications for the nuclear industry

There are many cases when inattentional blindness can impact on an individual's life. Whether it is missing that there is a pot boiling on the stove because we are engrossed in the crime show on TV, or missing the presence of a dog at the side of the road while driving down the highway because we are trying to tune the car radio, there are many cases in a humans experience where the perceptual demands of the task we are undertaking helps us miss some unexpected, yet possibly important event that needs to be noticed consciously.

In a Nuclear Power Plant, it is fair to say there are times when perceptual processing demands can be fairly high on employees. Planned conditions such as coming down for an outage or coming up from one can still impose a significant demand on the ANO's resources and unplanned conditions such as the loss of grid event several years back can cross the line into extremely demanding. The theoretical frame work of perceptual loading as well as the results of the individual research projects discussed in this paper offer some guidance in how the possibilities of an inattentional blindness incident can be reduced.

One of the first steps that would be helpful to guard against inattentional blindness is to provide education about the phenomenon to the employees that are trying to defend against it. One of the points made in the Hymen et al study[7] was that research into drivers and cell phones showed that the drivers greatly over estimated their driving performance when talking on the cell. Most drivers reported no degradation at all even though in many cases they showed objective driving errors at a level similar to those made by drivers who were legally drunk. Helping employees understand the factors that lead to inattentional blindness will help them recognize situations where they might be more at risk. It may also help smooth the way for procedural or policy shifts meant to decrease the likelihood of such inattentional blindness events.

Reducing known irrelevant distraction sources during attention demanding tasks would be a useful practice. Recall that according to perceptual loading theory unexpected events are more likely to be captured when there are spare attentional resources left over after the necessary resources are tasked to perform the primary task. If a significant, yet unexpected stimulus must compete with a host of other attention seeking, yet irrelevant, stimuli then the unexpected event we would hope to catch will be less likely to get caught. In a practical sense this could mean identifying resource intensive tasks in the work plan for the day and restricting access to the employees performing the task for the duration of its' performance. This strategy could, for example, be used in the control room during shift turnover, during transients or during certain tasks like approach to critical or certain SSTs. In the field this could mean creating safe work areas restricting access to other employees not just for their safety, but to reduce distractions for the employees performing the work.

Adding a non-committed set of eyes (or maybe more accurately "adding a pool of uncommitted attention") to highly attention intensive activities would also be of benefit according to perceptual load theory. By suggesting this, I am proposing that there will be activities, planned and unplanned that require such a degree of attentional resources from the employee that there is benefit in having a like qualified employee standing back and observing. This less involved employee essentially is there to make sure the employee engaged in the primary task does not miss some important piece of information because they are attentionally "buried" by the task at hand. The employee standing back in this type of situation would need to be properly trained to understand they are not there so much to review the actions of the primary employee (and possibly becoming as attentionally consumed by the ongoing actions as the employee performing them) but to act as an attentional "crutch" to help ensure the "gorillas" don't get missed.

From a design perspective, there are some possible design cues that can be teased out of the present literature, or at the very least areas that have been highlighted for future study. Certainly, the ability to pause, silence or temporarily stop less important alarms during events that activate a large number of them would be beneficial as the ANO in such conditions will be experiencing a very high perceptual load thereby making them more likely to fall victim to inattentional blindness. Panel design may also be influenced with respect to the appearance and placement of displays in the sense that displays that will need to be compared for the same tasks may benefit from being an identical or at least similar design. Conversely, if two unrelated displays are located close to one another, one may act as a distracter to the other. Having their visual design differ significantly may provide a level of defence against distraction.

Finally, remember the observation from Simons and Chabris (1999) that there is no perception without attention. Adding the practice of "touch and talk", or possibly "point and talk" when undergoing certain activities, particularly panel monitoring, will help ensure attentional shifts to objects. As shown in the Beanland & Pammer (2010) study, landing your eyes on something does not ensure your attention is actually on what your eyes fixated on. By talking about the display or device being fixated on and by pointing at or touching it you help "force" your attention to the subject. While research has shown you can look at something without focussing your attention on it, it is much harder to talk about it and target it with your hand without driving you attention towards it. Similarly, silently looking at an equipment code is less likely to fully shift your attention to the multi digit number than would reading it aloud while running your fingers underneath (or over) the letters and numbers as they are spoken. These possible practices only serve as examples of some possibilities in helping to ensure that the person's attention is fully engaged in the task at hand. To bring this back to the perceptual loading theory put forward by Lavie (1995), remember that any attentional resources not consumed by the primary task (reading the label or the display) will be "captured" by irrelevant or unexpected stimuli. The risk when performing very simple tasks is that so little attention is required for some tasks that the majority of attentional resources can be "captured" by other events reducing our performance on what is meant to be the primary task. The goal then is to actually increase the attentional demand of some of the low demand tasks (by speaking about it or pointing at it) such that while it may not consume all of the attentional resources it keeps the majority of attentional resources engaged on the primary task.

8. References

[1] Goldstein, E.B. (2007). *Sensation and Perception.* Belmont, CA: Thomson Wadsworth

[2] Cartwright-Finch, U., & Lavie, N. The role of perceptual load in inattentional blindness. *Cognition, 102,* 2007, 321–340.

[3] Beanland, V., & Pammer K. Looking without seeing or seeing without looking? Eye movements in sustained inattentional blindness. *Vision Research, 50*, 2010, 977-988.

[4] Simons, D. J., & Chabris, C. F. Gorillas in our midst: Sustained inattentional blindness for dynamic events. *Perception, 28,* 1999, 1059–1074.

[5] Most, S. B., Scholl, B. J., Clifford, E. R., & Simons, D. J. What you see is what you set: Sustained inattentional blindness and the capture of awareness. *Psychological Review, 112,* 2005, 217–242.

[6] Bressan, P., & Pizzighello, S. The attentional cost of inattentional blindness. *Cognition, 106,* 2008, 370–383.

[7] Hyman, I. E., Boss, S.M., Wise, B.M., McKenzie, K.E., & Caggiano, J.M. Did You See the Unicycling Clown? Inattentional Blindness while Walking and Talking on a Cell Phone. *Applied Cognitive Psychology,* 24, 2010, 597-607.

[8] Lavie, N. Perceptual load as a necessary condition for selective attention. *Journal of Experimental Psychology: Human Perception and Performance*, 21, 1995, 451–468.

[9] Wickens, C.D., & Hollands, J.G. (2000). *Engineering Psychology and Human Performance.* Upper Saddle River, NJ: Prentice Hall.

Technology Spin-offs from a CANDU Development Program

by STEPHEN YU[1]

*[**Ed. Note:** the following paper was presented at the 32nd Annual Canadian Nuclear Society Conference "Nuclear @ Niagara", 2011 June 5-8.]*

Abstract

Both Enhanced CANDU 6 (EC6) and ACR-1000 design retain many essential features of the operating CANDU 6 plant design. As well as further-enhanced safety, the design also focuses on operability and maintainability, drawing on valuable customer input and OPEX. The engineering development of the ACR-1000 design has been accompanied by a research and confirmatory testing program. The ACR technology developed during the ACR-1000 Basic Engineering Program and the supporting development testing has extended the database of knowledge on the CANDU design.

This paper provides a summary of technology arising from the ACR program that has been incorporated into new CANDU designs such as the Enhanced CANDU 6 (EC6), or can be applied for servicing operating CANDU reactors.

1. Introduction

Atomic Energy of Canada Limited (AECL) has two CANDU[a] reactor products matched to markets: the Enhanced CANDU 6™ (EC6™)a modern 700 MWe class HWR design, and the Advanced CANDU Reactor™ (ACR-1000™), a 1200 MWe class Gen III+ design. Both reactor types are designed to meet both market-, and customer-driven needs. The ACR-1000 design [1] is 90% complete and market-ready, while current domestic and off-shore market attention is focussed on the EC6 because of its attractive size and proven operational performance.

The ACR-1000 design retains many essential features of the original CANDU plant design. As well as further-enhanced safety [2], the design also focuses on operability and maintainability, drawing on valuable customer input and OPEX. The engineering development of the ACR-1000 design has been accompanied by a research and a confirmatory testing program. This program has extended the database of knowledge on the CANDU design.

The ACR-1000 design has been reviewed by the Canadian regulator, the Canadian Nuclear Safety Commission (CNSC) which concluded in the Phase 2 pre-project design review that there are no fundamental barriers to licensing the ACR-1000 design in Canada. The generic PSAR for the ACR-1000 design was completed in September 2009. The PSAR contains the ACR-1000 design details, the safety and design methodology, and the safety analysis that demonstrate the ACR-1000 safety case and compliance with Canadian and international regulatory requirements and expectations.

2. Applicability of ACR-1000 technology

The Enhanced CANDU 6 (EC6) design (see Figure 1) design change engineering program has been in progress following closely to the successful completion of the pre-project design review of the ACR-1000 design. The EC6 product definition and design planning was completed in 2010 September and the Phase 2 of the pre-project design review by CNSC is currently underway.

The EC6 design engineering has leveraged a significant amount, approximately 80%, of design changes using the results from the ACR-1000 product engineering. The ACR-1000 basic engineering program includes design concept development, licensing compliance review, confirmatory testing and design documentation. This up-front adoption has been critical in enhancing the CANDU 6 design to ensure the EC6 meets current regulations and standards, and international security requirements. Applicable philosophies and design changes have been carried over to the EC6 design.

The EC6 design features make full use of the ACR technology developed and the supporting development testing completed during the ACR-1000 Engineering Program will result in:

- Compliance with new licensing and regulatory requirements
- improved EC6 components and systems;
- enhanced engineering processes and engineering tools, which lead to better product quality, and better project efficiency; and
- improved operational performance

The following sections provide further details of where ACR technology developed through ACR-1000 Development are used in EC6:

3. EC6 Design improvements and changes

Design changes to the reference plant to achieve the safety goals stated in CNSC RD-337 are incorporated in the EC6 design based on the technology developed

1 Atomic Energy of Canada Limited, Mississauga, Ontario, Canada

in the ACR program. The changes are to enhance robustness, design margin and reliability of the design.

- Robust Steel lined containment:
  - Design for main steam line break (MSLB) as a design basis accident (DBA) event.
  - Consider the effects of severe accidents and introduce design features to provide design robustness to mitigate severe accidents.
  - Consider beyond design basis threats such as a large commercial aircraft crash.
  - Design for regulatory release limits.
  - Design for a design basis earthquake (DBE) PGA of 0.3g to improve the marketability of the product as it would meet all potential sites in Eastern North America.
  - Meet a lower leak rate and an exclusion zone of 500 meters which is the requirement of most utilities.
  - Addition of passive auto-catalytic recombiners (PARs) to deal with hydrogen behaviour in containment.
- Design Enhancement for Beyond Design Basis Events BDBA prevention and mitigation
  - Optimization of moderator inlet and outlet nozzle configuration on the calandria for increased moderator sub-cooling;
  - Stronger fuel channel position assembly when fuelling machine is attached
  - Provide flow paths (interconnection) between end shields and calandria vault
  - Increase pressure relief capacity in the calandria vault
  - Design emergency heat removal system (EHRS) as a safety system.
  - Dual train heat sinks independence for RSW and RCW systems.
  - Automatic actuation of the EPS diesel generators (DGs), ECC, and reserve water tank make-up to steam generators on a loss of all Group 1 systems
  - Seismically qualify the steam generator automatic depressurization logic .
  - Battery supply for 24 hours for components required for station blackout events .
  - Severe accident recovery and heat removal system (SARHRS).

Another key area where ACR-1000 work has been leveraged in the EC6 design is the physics assessments. Although the two reactors have different cores, the EC6's physics assessments for core optimization and LOCA improvements are based on updated Industry Standard Toolset (IST) physics codes developed for ACR-1000. Extensive Licensing progress achieved with the ACR-1000 has also been built on through the establishment along with endorsement from the CNSC of the Preliminary Safety Analysis Report (PSAR) structure and content. Feedback from the successful completion of the CNSC Phase 1, 2, and 3 reviews of the ACR-1000 product using the concept of an interim Safety Case Report allows EC6 a more efficient licensing approach from pre-project design review through to Construction License Application review by CNSC.

Other key design changes adopted by EC6 include:

- Updates to the reactor (for example, improvements to the spacer design, positioning assembly, the use of fission chambers, the seamless calandria tubes, and enhanced flow paths between the end shields and calandria vault);
- Use of ultrasonic feedwater flow measurement to reduce power measurement uncertainties and hence permit higher output without exceeding design limits.

For environmental protection and fire protection, the review of current regulations including CNSC RD-337 and MISA regulations and the determination of requirements have been leveraged from ACR-1000. The following EC6 design changes address current federal and provincial regulations which outline the as low as reasonably achievable (ALARA) principles to protect the environment, and to reduce emissions of non-radiological substances:

- Liquid Waste Management System
  - Collect detergent wastes separately from active wastes to prevent mixing of detergent wastes with active liquid wastes and extend the life of the ion exchange resin.
  - Add a treatment circuit to comply with Municipal/Industrial Strategy for Abatement requirements for oils, organics and toxicity.
- Steam Generator Blowdown System
  - Add a wet lay-up loop to the steam generator blowdown system to reduce the release of hydrazine to the environment.
  - Increase steam generator blowdown flow from 0.1% to 1% of feedwater flow to extend the life of the steam generators to 60 years.
- Vapour Recovery System
  - Add a new dryer in the service building for the moderator auxiliary areas and D_2O management systems to reduce airborne tritium emissions.
  - Reroute the vent connections from the moderator auxiliary systems to the moderator enclosure vapour recovery system to reduce airborne tritium emissions.
- Solid Spent Resin Handling System
  - Segregation of spent resin storage tanks to ensure the moderator resins holding large amounts of carbon-14 from other resins.
  - Use spent resin tank water for spent resin slurry operations to reduce liquid tritium emissions.
- Moderator Cover-Gas System
  - Circulate moderator cover gas through reactivity mechanism thimbles to reduce the possibility of hydrogen (D_2) deflagration.
- Moderator Purification System

- Install filters downstream of the moderator ion exchange columns to capture resin fines and reduce carbon-14 emissions.

• Off-Gas Management System
  - Addition of two off-gas streams from the fuelling machine D_2O supply system to the off-gas management system to reduce emissions of noble gases to the environment.

4. Operational improvements

Design changes have been identified to address a number of modern plant expectations (i.e., Generation III/III+) as identified in Utility Requirements Document by Electric Power Research Institute (EPRI), World Association of Nuclear Operators (WANO) and European Union and as specified by owner requirements, such as modern instrumentation and control, maintenance based design and operational support systems.

Modern instrumentation and control (I&C)

Major plant design changes brought over to EC6 from ACR-1000 for I&C include:

- Use of a modern distributed control system (DCS) [3] to address the obsolencence of digital control computers (DCCs)
- Incorporation of a computerized safety parameter display system
- Computerized safety system testing

For Instrumentation & Control (I&C), the methodology and toolsets including software work practices have also been leveraged from ACR-1000, in particular, the technology selection, design concepts, and qualifications processes adopted.

Incorporation of the Human Factors Program into EC6 was accomplished through development in ACR-1000 program. The same methodology and approach has been carried over to the EC6 design.

Maintenance based design and O&M improvements

The EC6 plant lifetime capacity factor target is 92%, with less than 1% forced outage rate and a 30-day outage on a 3 year frequency. The EC6 performance targets are comparable to ACR-1000 which is substantially higher than for operating CANDU 6. In the case of the forced loss rate, the EC6 performance targets are even higher than for ACR-1000. Therefore the respective operations-oriented changes on ACR-1000 to meet the higher performance targets are being adapted to EC6. The processes and experience used for ACR-1000 will be used for the EC6 to the extent possible:

• Design documents are reviewed by the same Operations & Maintenance (O&M) group for design and layout improvements to improve operability and maintainability.

• OPEX (Operating Experience) used for ACR-1000 is being applied to EC6.

• The maintenance-based design process for ACR-1000 is being applied to EC6.
  - Identification of single points of vulnerability and critical components.
  - Application of O&M checklists for the designers to follow.
  - Use of modern equipment status monitoring and equipment health monitoring tools – use of remote monitoring and collection of data via computers.

• Modern engineering tools used for ACR-1000, such as the site LAN and master equipment database will be used for EC6.

• The process to minimise length of ACR-1000 planned outage will be applied to reduce EC6 outage length.

• The process followed to achieve planned outages every three years for ACR-1000 will be applied to EC6, and will be available on-site to support plant operations and maintenance.

• The computerization of the ACR-1000 controls, such as the safety systems, will be applied to EC6 improving operational testing.

• The manpower required to run the ACR-1000 is less then for other CANDU plants. Applying the changes made to the ACR-1000, such as computerized equipment monitoring for more equipment, with greater details, will be applied to EC6 to allow a reduction in EC6 manpower requirements.

• ACR-1000 design changes to reduce collective staff dose will be applied to EC6.

• The work done on the ACR-1000 Technical Specifications for operations will be utilized for EC6.

Operational Support Systems

Several new operational support systems developed for ACR and for Operating CANDU to support plant performance improvements have also been added to EC6:

a) Augmented and/or improved equipment health monitoring system for a selection of critical components:

   Increased and improved diagnostic health monitoring and associated analysis software packages are provided to detect the degradation of important systems/equipment prior to failure. The data analysis and visualization software includes AECL's SMART CANDU software suite of ChemAND (Chemistry ANalysis and Diagnostic), ThermAND (Thermal ANalysis and Diagnostic), FCMAT (Fuel Channel Monitoring and Assessment Tool), FDMAT (Feeder Monitoring and Assessment Tool), and FPMAT (Fuel Performance Monitoring and Assessment Tool).

b) Online risk monitor:

   An online risk monitor is provided to promote a risk-informed optimization of maintenance. The online risk monitor is implemented using EPRI's Equipment-Out-Of-Service (EOOS) software, and evaluates risk in terms of core damage frequency and large release frequency using AECL's EC6 probabilistic safety assessment models adapted for use with EOOS. This serves to enable increased maintenance on-power and improve the scheduling of maintenance both on-power and during shutdown to keep risk below acceptable levels.

c) Equipment status monitor:

An information system is provided to manage plant status control. This system acts as a central repository for equipment status, managing the processes used to control and track equipment state or availability (e.g., work permits, lock-outs/tag-outs, alignments, temporary changes, jumpers, position assurance checks, turnovers, operator rounds, etc.).

5. Engineering processes and tools

The QA Program as developed for ACR-1000 is being rolled-out essentially in its entirety to support the EC6 program. This is possible as both ACR-1000 and EC6 work is of the same type (new build design), utilizing the same project organization model and execution methodology. The processes and tools being adopted on EC6 were developed, tested/debugged/implemented, and firmly established in the ACR department culture. The ACR program was reviewed by CNSC and audited by OPG and found by both as satisfactory. By transferring these as well as ACR staff directly to EC6, we give EC6 the advantage of avoiding the learning curve typical for mobilization of any project making it possible for effort to be immediately and solidly focussed on carrying out the scheduled work activities for the EC6 Design Change Engineering Program and to support Phase 2 of the EC6 Pre-project design review by CNSC.

Examples of some specific program practices that were developed during ACR, found to be very successful in project execution, and that have been transferred to EC6, are:

- Management Review Meeting (for oversight on progress of Non-Conformance Reports (NCR)
- Processes facilitating Safety Culture initiatives in a design organization, like Event Free Day Reset
- Establishing of Nuclear Safety Review Board for design organization
- Methodology for execution of Self-assessments
- Action Tracking (including Licensing, Configuration Management, and QA actions)
- QA Orientation training for staff joining the project
- Processes for document production and design data management from 3D design models using integrated design tools
- Processes related to module development and integration work
- Risk Management program with methodology of mitigation of the risk during design

The use of advanced electronic tools for document control, material management, integrated wiring and 3D plant design on Qinshan is estimated to have resulted in a cost avoidance of over $100M. With the additional advances made through ACR, EC6's adoption of ACR-1000's data-centric approach sets the project up for far greater savings in plant design, construction, commissioning, and operation costs. Examples of advances in ACR data-centric toolset include:

- Integrated 3-D CADD for system, equipment, civil and instrumentation design;
- Project Control for schedule and cost controls; and
- Requirements Compliance (mandated by the regulator and customer) through electronic requirement management system.

6. Conclusion

The ACR technology developed during the ACR-1000 Basic Engineering Program and the supporting development testing has extended the database of knowledge on the CANDU design. The EC6 design has leveraged a significant amount of design changes using the results from the ACR-1000 product engineering program – resulting in:

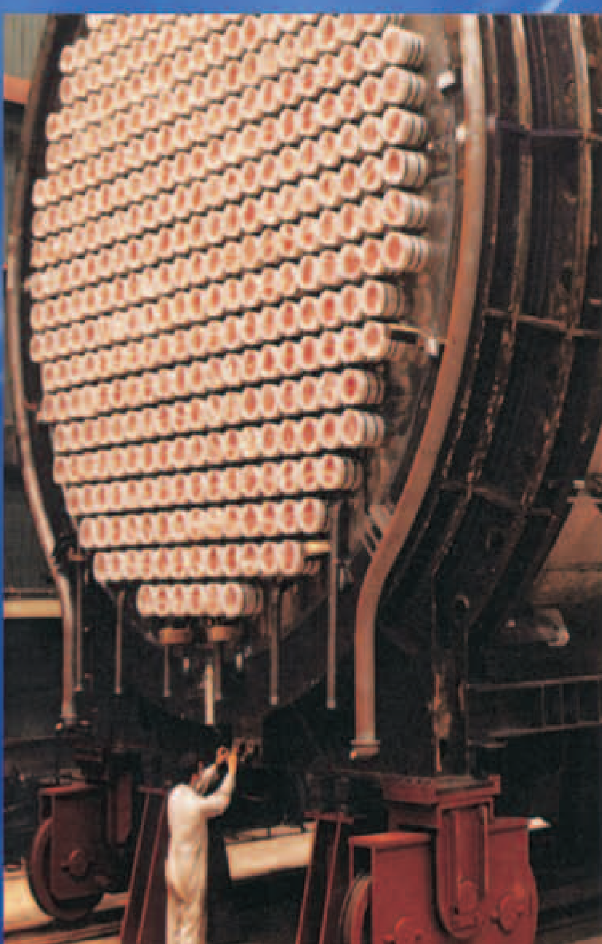
- enhancements of safety and compliance with current regulatory requirements
- better and more robust CANDU components and systems in compliance to current regulations and meeting modern plant expectations;
- better engineering processes and engineering tools which leads to better product quality and project efficiency; and
- better design features or improved operational performance.

7. References

[1] N.Popov, S.Doerffer, R.Ion & S.Yu, "ACR-1000 – Advanced CANDU Reactor Design", Proceeding of European Nuclear Conference, Barcelona, Spain, May 30 –Jun22, 2010.

[2] S.Yu, Z. Bilanovic, P.Reid, P. Santamaura & M. Soulard, "ACR-1000 Design and Safety Performance", Proceedings of the 18th International Conference of Nuclear Engineering, Xian, China, May 17-21, 2010.

[3] V.Gomez et al, "Application of DCS to New Build CANDU Designs using the G-HIACS ÐSAFE Platform", Proceedings of the 23rd Annual Conference of the Canadian Nuclear Society, Niagara Falls, Ontario, Canada, 2011 June 5-8.



GENERAL news

(Compiled by Fred Boyd from open sources)

Canadian team wins first Nuclear Olympiad

A team from Canada has won the inaugural International Nuclear Energy Olympiad, held in Seoul, South Korea.

The Canadian team which took the top prize consisted of Alex Wolf and James Harrington, students at McMaster University, which is located in Hamilton, Ontario. They called themselves "Team Steeltown" after the historic reputation of Hamilton as a steel-making centre. They were closely followed in joint second place by South Korea and Turkey.

The Canadian students said that public campaigns should cater to specific groups and focus on fighting misinformation targeting the as-yet undecided majority of the population. They had both spent some time with the Canadian Nuclear Association as interns with the CAN communication program.

The contest was organized by the World Nuclear University (WNU) and hosted by the Korean Nuclear Energy Promotion Agency (Konepa). The theme of the competition was gaining public acceptance for the use of nuclear power.

Out of 70 applicants, ten teams representing Canada, India, Japan, Korea, Malaysia, Mongolia, Romania, Russia, Turkey and the USA were selected to take part in the five-day event. Three of the teams came from countries that do not currently use nuclear power.

The ten finalist teams, each comprising two students aged between 19 and 26, were asked to conduct a public opinion survey, analyze the current promotion efforts by respective national associations, and suggest future directions. Each team was required to submit a paper, give a 15-minute presentation, and then answer questions from an international judging panel. The presentations were closely geared to the cultural and social situations in each country.

The award ceremony for the first International Nuclear Energy Olympiad (Image: Konepa)

The judging panel comprised two eminent academics from South Korea and a representative from each of the WNU and the World Nuclear Association (WNA).

The WNU is a partnership supported by the WNA, the OECD Nuclear Energy Agency, the World Association of Nuclear Operators and the International Atomic Energy Agency (IAEA). It is committed to enhancing international education and leadership in the peaceful applications of nuclear science and technology.

Bruce A units nearing restart

After five years of challenging work that required much innovation as well as much "sweat and tears", Bruce A units 1 and 2 are nearing the final goal – restart.

Laid up in 1997 and 1995 respectively, Units 1 and 2 of the Bruce A station have been undergoing an extensive refurbishment which began in mid-2006 after the project's environmental assessment was accepted by the Canadian Nuclear Safety Commission. Both 750 megawatt units are expected back in commercial service in 2012.

Unit 2 is slightly ahead of Unit 1. The calandria of Unit 2 was filled with the heavy water moderator in the early summer this year and 5780 new fuel elements manually loaded in July. The most recent critical step was a pressure test of the reactor vault which was completed in mid-September.

At the time of writing the calandria and related systems of Unit 1 have been filled with heavy water and the moderator system is undergoing commissioning tests.

Panel accepts environmental assessment for new Darlington units

In mid-August 2011 the Joint Review Panel for the Environmental Assessment of proposed new nuclear plants at the Darlington site issued its report. The report states:

> *The Panel concludes that the Project is not likely to cause significant adverse environmental effects, provided the mitigation measures proposed and commitments by OPG during the review and the Panel's recommendations are implemented.*

The Panel issued a long list of recommendations addressed mostly to the federal agencies having regulatory responsibilities. Most of the recommendations are aimed at the Canadian Nuclear Safety Commission but Transport Canada, Environment Canada, Health Canada, the Canadian Environmental Assessment Agency and the federal and provincial governments are also named. The recommendation to the federal government specifically refers to the need to update the Nuclear Liability and Compensation Act which has been under review for years.

Copies of the report can be downloaded from either CNSC or CEAA websites or printed copies can be requested.

Wolsong unit 1 back in service after refurbishment

At the end of July, Korea Hydro and Nuclear Power Company announced that Wolsong Unit 1 had been restarted and connected to the grid after completing an extensive refurbishment that included replacement of all of the 380 calandria and pressure tubes.

Wolsong 1 is one of the early CANDU 6 units and is essentially a copy of the Point Lepreau unit. It was built, essentially as a turn-key project, by Atomic Energy of Canada Limited beginning in the late 1970s and entered service in 1983. AECL was contracted by KHNP in 2006 to do the retubing with work beginning in 2009. That work was completed by late 2010. Since then KHNP has been completing other tasks associated with the refurbishment. The entire outage took 839 days.

A view of the Wolsong site. Unit 1 is at the far right.

A team from Korea came to Point Lepreau station in 2009 to participate in the planning of that station's refurbishment. Reportedly they observed similar problems with the calandria tubes as occurred at Pont Lepreau and quickly changed the procedure.

With the restart, Wolsong 1 marks the first time a CANDU 6 reactor has been successfully dismantled, retubed and restarted.

SNC Lavalin submits financial proposal to Jordan

In May 2010 Atomic Energy of Canada Limited was one of three bidders to be short-listed by Jordan as a potential supplier of that country's first nuclear power plant. The other bidders short-listed were an Areva-Mistubishi consortium and Russia's AtomStroyExport. That was on the basis of their technical proposals. AECL had submitted the Enhanced CANDU 6 design. The deadline for financial proposals was August 14, 2011. SNC-Lavalin International submitted the Canadian proposal on the basis of its take-over of the engineering part of AECL.

A special committee formed by the Jordan cabinet will study both the technical and financial bids. The winner is scheduled to be announced in December.

No radioactive material released at French waste site explosion

On September 12, 2011 an explosion occurred at the Centraco facility near Marcoule in France. Because it was associated with a nuclear complex the explosion received wide coverage in the general media. One worker was killed and four injured.

The French regulator authority ASN (Autorité de Sûreté Nucléaire) subsequently announced that no chemical or radioactive release occurred and none of the injured was contaminated.

The explosion was of a furnace used to melt scrap metal, such as structural components, pumps, tools and similar material that are or suspected of being lightly contaminated with short-lived, low-level radioactivity.

An aerial view of the Centraco plant.

Saskatchewan partners with Hitachi for nuclear research

In late August 2011, Saskatchewan Innovation Minister, Rob Norris and representatives of GE Hitachi Ltd. Signed two memoranda of understanding, one for research associated with nuclear medicine, materials science nuclear safety, and a small reactor design. The other MOU is for the study of proton beam therapy technologies. Each partner will invest $5 million over five years.

GE Hitachi is joined by Hitachi-GE; GE Hitachi Nuclear Energy Americas LLC and Global Fuel Americas.

Earlier in 2011 Saskatchewan announced a $30 million investment in a centre for research in nuclear medicine and materials science. Earlier this year a group based in Saskatchewan was granted for research into non-reactor methods of producing Mo 99.

CANDU Energy Inc. to refurbish Embalse

Three months after agreeing to buy the CANDU division of Atomic Energy of Canada limited for $15 million the new SNC Lavalin subsidiary, CANDU Energy Inc., in late August 2011 signed agreements with the Argentine government state-run utility Nucleoelectra Argentina, worth a report $444 million for a major participation in the refurbishment of the Embalse reactor.

The contracts cover the provision of tools, equipment and services, including technical assistance through out the project. CANDU Energy will also assist Nucleoelectra in making design changes to increase the generating power of the unit.

Nucleoelectra will do the actual refurbishment. The Argentine government estimated the total cost would be in the order of $1,366 million with about $800 million going to Argentine companies. AECL will begin the execution of the contract until the transaction between AECL and SNC Lavalin closes. When that occurs CANDU Energy will take over full responsibility for the contract.

Site work on first new UK nuclear plant begins

EDF Energy, a subsidiary of Electricité de France, has received permission to begin site preparations for the first of the new nuclear plants to be built in the UK. The company has received permission from local authorities as well as the national regulator to conduct preliminary work at the Hinkley Point C site where it proposes to build two EPR units.

An official application for a Site Licence has been submitted to the UK Office of Nuclear Regulation which has said it will take about 18 months to consider.

Hinkley Point A site has two early designed gas-cooled reactors which are shutdown. Hinkley Point B site has two AGRs which are expected to continue operating until 2016. EDF Energy hopes to have the first of its units operating in 2018.

McMaster opens new nuclear research facility

In August 2011, McMaster University in Hamilton, Ontario unveiled its new expanded Nuclear Research Building, which includes a new cyclotron and improvements to the McMaster Nuclear Reactor building.

The university received a total of $22 million from the federal and provincial governments in 2009as part of the Knowledge Infrastructure Program. That objective was to upgrade physical infrastructure, expand isotope research and production capacity as well as enhance research and education facilities for the nuclear industry and healthcare sectors.

The new facility houses a $2 million cyclotron which will produce PET medical isotopes. McMaster intends the facility to be used primarily for the development of new drugs which will enable early diagnosis of cardiovascular, cancer and Alzheimer's diseases.

In addition, the funding enabled renovations and upgrades to the Nuclear Research Building to accommodate new laboratories and research space. The new building will play host to the Centre for Probe Development and Commercialization, a private sector, government-funded, non-profit enterprise whose goal is research, development and commercialization of new molecular imaging tools for treatment and diagnosis.

CNSC signs MOU's during the 55th General Conference of the IAEA

The Canadian Nuclear Safety Commission (CNSC) strengthened its partnerships with foreign nuclear regulators during the 55th Regular Session of the International Atomic Energy Agency's General Conference, an annual meeting in Vienna, Austria, held from September 19 to 23.

During the conference, the CNSC took the opportunity to sign arrangements, including memoranda of understanding (MoUs), and to hold discussions with many regulatory bodies in order to enhance the safety of nuclear energy in peaceful uses worldwide. These partnerships are part of the CNSC's ongoing efforts to both learn from international best practices and also share its own extensive expertise with regulatory bodies of other countries, and are in line with the CNSC's commitment to ongoing improvement.

During the IAEA General Conference, the CNSC signed MoUs to exchange nuclear regulatory information and training with the Nuclear Regulatory Commission of Jordan (JNRC) and the Atomic Energy Commission of Israel (IAEC). The CNSC also held talks to develop similar MoUs with the Nuclear Regulatory Authority (ARN) of Argentina and the State Nuclear Regulatory Inspectorate of Ukraine (SNRIU).

In addition, the CNSC finalized an arrangement with the United States Nuclear Regulatory Commission (U.S. NRC) and its Department of Transportation (U.S. DOT). This arrangement governs the sharing of information and best practices on the implementation of the Joint Canada–United States Guide for Approval of Type B(U) and Fissile Material Transportation Packages (RD-364).

The CNSC also held discussions during the conference with the National Commission for Nuclear Activities Control of Romania (CNCAN) and the Nuclear Energy Control Board of Indonesia (BAPETEN) about planned exchanges.

Obituary

George Pon

George Pon, a nuclear pioneer and former senior vice-president of Atomic Energy of Canada Limited, died in Toronto, August 9, 2011, at the age of 84.

George is especially remembered as the leader in the design and construction of the Boiling Light Water Cooled reactor which became known as Gentilly 1 during the 1960s. He had been seconded from A.V. Roe (makers of the Avro Arrow) to AECL Chalk River Laboratories from 1956 to 1959 and formally joined AECL in January 1960. He became part of the small team examining alternatives to the basic CANDU design as used in NPD and Douglas Point because Dr. W. B. Lewis, then scientific head of CRL, was concerned that design might develop problems. Two concepts were pursued; one a vertical Boiling Light Water (BLW) concept, the other using organic (hydrogen terphenyl) as the coolant.

George became a leader of the BLW concept group and in 1965 was moved to the Power Projects group in suburban Toronto to head the design team for a BLW reactor to be located at Gentilly, Quebec. The team produced, on time and budget, the design of a 250 MWe, vertical-oriented, heavy water moderated, boiling light water cooled, reactor. The decision to build it was made and George became the project manager. Known as Gentilly 1, the project was completed on schedule and within budget and started up in 1971. However, the design had unresolvable control problems and was shutdown in 1979. (The G-1 buildings still stand next to the operating Gentilly 2 plant.)

George grew up in Toronto and attended University of Toronto where he obtained a B.A.Sc. in 1950 and an M.A.Sc. in 1953. He followed that with a year at M.I.T. where he received a Science Masters degree. While working at Orenda Engines (part of the A.V. Roe team) he obtained a Ph.D. from U of T.

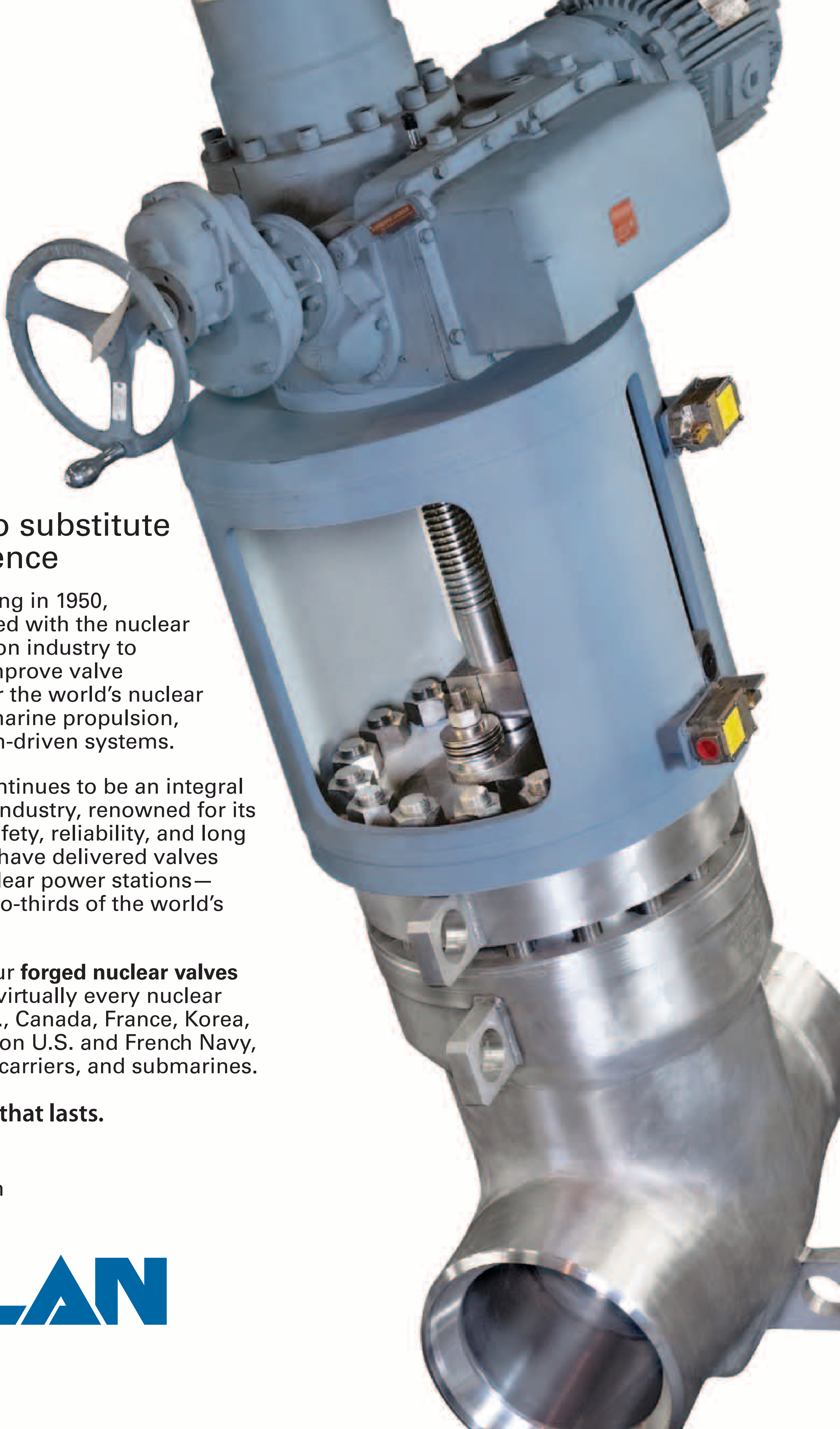
Subsequent to the Gentilly 1 project he was appointed General Manager of Power Projects (which had located at Sheridan Park) in 1974. The following year he was named Vice President, Power Projects. In 1981 he moved to Ottawa as Corporate Vice President, Engineering, retiring in 1987.

After retirement George helped organize international energy conferences and served on the Board of Directors of several companies. George was on committees of the Professional Engineers of Ontario and also on an Advisory Committee to the University of New Brunswick. He was awarded the Government of Canada Centennial Medal in 1967 and was the first recipient of the Meritorious Service Award of the Engineering Alumni Association of the University of Toronto. He received the Canadian Nuclear Association's Ian McRae Award in 1982 for contributions to the general advancement of nuclear energy in Canada through such fields of activity as management, administration, and public service. He was named a Fellow of the Royal Society for the Encouragement of Arts, Manufacture, and Commerce and was an Emeritus member of Sigma Xi, the Scientific Research Society.

Both while working but especially after retirement George was an active learner. His interests were wide, from cabinet making to classical music.

George had suffered with Parkinson's disease and his wife, Wynne, died earlier this year. He leaves a son Craig, a daughter Kerri and grandchildren Brendan, Andrew and Jason.

George Pon and then AECL president Stan Hatcher in 1982 pose with some of the documents for a CANDU bid for Mexico in 1983 (2 X 950 MWe or 4 X 600 MWe units).. George was leader of the Mexico bid. The project did not proceed.



CNS news

Meet the President

As president of the Canadian Nuclear Society for 2011-2012, Frank Doyle brings extensive nuclear technical experience and managerial competence to the task. He is committed to helping the Society achieve excellence in its programs and ensuring it is well positioned to meet members' needs well into the future.

Born in Colliers, Newfoundland, Frank spent his early childhood in that picturesque, small town surrounded by mountains overlooking the Atlantic Ocean, sixty kilometers from St. John's. After being awarded a scholarship, he completed his high school education at Brother Rice High School, in St. John's, NL. Always an 'honours' student, he strove for excellence in academics and learned to refine his skill in hockey and other school sports. He states that he continues to play hockey twice a week, winter and summer, to this day, and very proudly maintains that he is still the highest scoring member of his team. Recently, his son, Sheldon (also a nuclear engineer) joined the team and there are reports of some friendly and competitive jostling for position.

Frank graduated from Memorial University of Newfoundland with an Engineering diploma and then attended Nova Scotia Technical College (now part of Dalhousie University) to obtain his degree in Mechanical Engineering in 1968. Before leaving for Halifax he married Mary Trahey, whom he had met in high school (she being his academic competition) and had dated during the early university years. Mary, a teacher at the time, encountered a challenge with the education accreditation process in Nova Scotia and took a job in banking to augment the family income while Frank continued his studies. Over the years, there was a role reversal. While Mary worked on post graduate degrees in her pursuit to become a school principal, Frank was ever supportive of her goal and took on added responsibility with children, chores, coaching and mentoring.

After considering a number of diverse job opportunities, the offer from Atomic Energy of Canada Limited at its Chalk River Laboratories was most intriguing to Frank, and in April 1968, he became a design and project engineer of nuclear and conventional systems and installations. Thus began his exciting and rewarding 43 year career in the nuclear industry, and he has never looked back.

While settling into life in the town of Deep River, Ontario, and spending quality time with his young son, Sheldon, Frank joined the ski club, learned to ski, took up curling, competed in bonspiels, and developed an avid interest in golf. Winter weekends now, you will still find Frank and Mary hitting the slopes with their family – two children and their spouses and five grandchildren - who are all avid skiers or snowboarders. Summer weekends are never long enough for that elusive perfect golf game. Along with extensive business and personal travels, Frank also manages to schedule a golf holiday each year with his other golfing enthusiast friends.

Frank and Mary in a formal pose at an earlier family wedding.

In 1971, Frank joined Ontario Hydro, and, after a 5 month training period at the Nuclear Training Centre and Nuclear Power Demonstration plant at Rolphton, he transferred to Ontario Hydro's head office in downtown Toronto. In September of that year, daughter Karyn was born, and life could not have been better. His new role was as a technical engineer in the Fuel Section in Central Nuclear Services and for seven years he progressed up the ranks to assume the role of Supervising Engineer, with responsibility, among other roles, for development and testing of new concepts for future nuclear plants, coordinating and supervising safety and licensing programs for the Bruce Nuclear Stations and the retubing of Pickering 3 and 4.

Frank pursued postgraduate studies while working and obtained an MBA degree from the University of Toronto in 1980. Most of his studying was accomplished on the bus and subway, on the way to and from work, with weekends reserved for very early morning completion of assignments, before Sheldon and Karyn awakened for the day to redirect his attention.

In 1988, Frank was promoted to Section Manager, In Service Nuclear Projects, in the Pickering Engineering Department. His role included managing major modifications to the nuclear safety systems, fuel channels and reactor vault.

From 1992-93, Frank was Engineering Manager for Bruce Nuclear Generating Station, where he was head of a large engineering department, as well as holding overall responsibility for developing and implementing a program to resolve derating problems at the Bruce and Darlington stations.

Frank retired from Ontario Hydro when Ontario Power Generation (OPG) was formed, on October 29, 1993. He took the weekend off to enjoy a surprise retirement party and time to bask in his retirement glow. By Monday morning, he was assuming a Principal Consultant role under his company banner, TME Associates, and providing services to Hydro Quebec, NB Power, AECB (now CNSC) and AECL.

Frank in Prague, 2010.

Frank returned to AECL in 1995 as Engineering Manager for CANDU 6 Services and moved to Pickering in 1998, on contract to OPG, as the Design Engineering Manager for Pickering A. This was to be his third engineering role for Pickering, including the second major refurbishment for Pickering 4. During these three assignments at Pickering, he considers it a personal privilege to have been involved in the testing, inspection and refurbishment of the Pickering Vacuum Building (VB), which occurs every 10 years. In 2010, he took a trip down memory lane, and did a walk down of the building internals, to be the only engineer to have been there for all four VB outages since it started up in 1970.

Frank and Mary with granddaughter Jessica in a pumpkin patch.

Since 2002, Frank has been Director of Research and Development at CANDU Owners Group (COG) Inc., providing overall direction and management of broad based research and development programs funded through COG Inc. on behalf of its members. He and Mary now live in Unionville, a small community north-east of Toronto. Frank is one of those individuals who can exist on five hours sleep and claims to be on the road by six a.m., each working day.

In addition to his continuing interest in the advancement of nuclear power, Frank has served as a member of the board of directors for several non-profit organizations. He has been a member of CNS Council for five years and a member of the Executive Council for two years. He was chair of the organizing committee for the very successful CNS Annual Conference in Niagara Falls in June 2011.

As the CNS President for 2011-12, Frank brings extensive experience, combined with a motivation and passion to ensure that the Society continues to be strong and vibrant and serve the interest of its members and the broader nuclear community. He is very much looking forward to working with Council in implementing task force recommendations to ensure long term viability of the Society.

See the June 2011 issue (Vol. 32, No. 2) of the CNS Bulletin for the report on Frank assuming the role of President at the Annual General Meeting.

The Future of the Heavy Water Reactor, and The Future of the Canadian Nuclear Society

Following are excerpts from the talk prepared by Frank Doyle, President of the Canadian Nuclear Society, for presentation at the banquet of the conference on the Future of Heavy Water Reactors, in Ottawa, October 4, 2011.

It is an honour for me to speak to you this evening on the intertwined topics of the *Future of the Heavy Water Reactor (HWR)* and the *Future of the Canadian Nuclear Society*.

The Society has evolved, and will continue to do so, as the CANDU industry has grown in Canada and is getting positioned for the future. Our Society is vibrant and strong, having grown 50% to 1200 members since the turn of the century... and by an order of magnitude since our founding in 1979.

The CNS Council continues to evolve a strategic direction which will help achieve our member's objectives in a sustainable manner going forward. I am committed to help foster that goal and we are holding a CNS Officers' seminar to discuss key recommendations of the strategic plan.

Our long term strategic plan identifies the need to engage an Executive Director to provide sustainable focus and direction for the CNS. This will be a key agenda item at the Officer's seminar.

This HWR Future conference is the fifth of six major conferences scheduled for 2011. The sixth will be the *CANDU Maintenance Conference* scheduled for early December in Toronto.

The *Waste Management, Decommissioning & Environmental Restoration International Conference* was hosted by the CNS in Toronto September 11-14.. It was attended by 400 participants, including nearly 50 representatives from potential host communities for siting a high level waste depository.

The *NURETH 14 International Conference,* held in Toronto September 25-30. was co-hosted by the CNS and the Thermal Hydraulics Division of the American Nuclear Society. It was attended by 500 participants, including 400 international participants from 30 counties. Minister Joe Oliver gave the September 26 luncheon address with an upbeat message on the Canadian energy scene which included nuclear.

In addition to the six conferences in 2011, the *Reactor Safety and the Reactor Physics Courses* were delivered earlier in the year to 43 and 47 participants respectively.

Special recognition will need to be made in 2012 of the 50th Year Milestone of First Electricity from NPD in conjunction with the *2012 Annual CNS Conference* to be held in Saskatoon. (It should be noted that 2012 is also the 60th Anniversary of AECL)

Looking further into the future, it is anticipated that the CNS will host the *Pacific Basin Nuclear Conference (PBNC 19)* in Vancouver in late August, 2014.

I would like to add my thoughts on the future of the HWR and I will begin with the restructuring of AECL. The commercial business is now in place as a new entity *`CANDU Energy'*, a wholly owned subsidy of SNC Lavalin, Inc. It has the mandate to complete existing, and undertake new, refurbishment projects for the existing fleet of CANDU reactors. In addition it has the mandate and financial support to complete the development and design of CANDU units targeted for near term markets including Darlington and off shore bids.

While the type of new build at Darlington remains undecided, there is no doubt that the CANDU HWR design is a safe and reliable option.

The CNS has enjoyed a close and mutually beneficial relationship with the predecessor AECL Company at Sheridan Park and it is our wish that this same relationship carry through to the new CANDU Energy.

While AECL is poised to move into the future as the *AECL National Laboratory*, industry stakeholders, led by the CNA, are helping to shape that future to ensure there is ongoing support for the nuclear industry. The key industry stakeholders, through COG, have provided funding for a CNA study undertaken by SECOR. All impacted companies, including COG and the utilities, have provided input to the study. It defines both the significant role of CRL and the major role played by industry in supporting CRL. The study is now complete and the CNA/SECOR team will meet with NRCan officials to review the findings and key recommendations in advance of a requested meeting with Minister Joe Oliver.The industry remains convinced there is continuing need and value in having a viable national laboratory with capability to deliver products and services consistent with past practice.

Beyond the near term, Canada must remain committed to the future of the HWR program, including the Gen-IV HWR Development Program. I am proud to say that the CNS eagerly looks forward to working with NRCan, CRL and the nuclear industry in Canada to help build a bright future for HWR.

ALBERTA Branch – Duane Pendergast

1) Glen Pridham, a student of Jason Donev's course, Science 421, Introduction to Nuclear Power, is headed to the University of Saskatchewan graduate school. He is the first student of the course to go on to graduate school. He will be working with Professor Robert Pywell in the Department of Physics and Engineering Physics. Congratulations, Glen and Jason on this milestone.
2) Jason Donev was invited by Inside Education to give a presentation to a group of interested high school teachers on August 17th in Canmore. He prepared slides on nuclear power, gave a short presentation and then spent the bulk of the time answering questions. The presentation was well received, with Jason's willingness to answer any questions asked particularly appreciated. He provided 30 CDs of various teaching resources, including a simulation on how a reactor works and electronic copies of 'Half-Lives' and 'Sustainable Energy Without the Hot Air'. Mary McPhalen (also in the CNS) attended and helped out.
3) Shaun Ward, Laurence Hoye and Duane Pendergast met briefly with Lethbridge West MLA Greg Weadick on August 23. Greg is also Minister of Advanced Education and Technology. He is responsible for Alberta's newly realigned research and innovation system *(Alberta Innovates)* designed to strengthen the province's role as a world leader in using science to seek solutions. We explored the potential role of the CNS in activities of his Ministry. Mr. Weadick offered to review the level of nuclear expertise included on the Boards of Directors of Alberta Innovates.
4) Duane Pendergast accepted an invitation from David Layzell of the U of C's Institute for Sustainable Energy, Environment and Economy to participate in an Institute sponsored Conference on the Assessment of Future Energy Systems (CAFES) on November 3, 4, 2011. This is a great networking opportunity with educators and energy planners. Alberta Branch thus intends to have more CNS members registered to participate in the presentations and discussions. Shaun Ward, Laurence Hoye and Jason Donev have so far expressed interest. It also provides a rare opportunity for CNS members to meet in person to plan Branch activities.
5) Paul Hinman and Rob Varty have started to prepare for the annual ATA Science Conference which will be held in Lake Louise this year on October 20-22. At this point Pascal Mertins, Derek Belle and Peter Lang are planning to help.

CHALK RIVER Branch – Ruxandra Dranga

Speakers:

- In the two month period we have had four talks:
  - On Thursday, July 14th, David Guzonas, Research Scientist at AECL, spoke about supercritical water to a crowd of about 40 people (20 high school students and 20 community members) in the second of the four lectures co-sponsored by the CNS and Deep River Science Academy (DRSA).
  - On Thursday, July 21st, Bill Diamond, retired Senior Researcher from AECL, spoke about "Critical Thinking in Science" in the third lecture co-sponsored by the CNS and DRSA
  - On Thursday, July 28th, John Karsaras, Principal Research Officer at NRC Canada – "From the Discovery of the Neutron to the Spallation Neutron Source" – 4th lecture cosponsored by the CNS and DRSA
  - On August 25th, Dr. John C. Luxat, Professor at McMaster University, spoke on the Fukushima Dai-ichi event to a crowd of over 100 people (see pictures below). This event has been co-sponsored with the local Chapter of the PEO.
  - Sept 14th – Dr. John Campbell, spoke about the making of a documentary about Ernest Rutherford who won a Nobel Prize for his research while at McGill University 1901 – 1907.

John Luxat talking about the Fukushima-Dai-ichi events.

Education and Outreach:

- Deep River Science Academy Awards, on August 6th, 2011
  - Blair Bromley attended the Deep River Science Academy (DRSA) Graduation Ceremony in Deep River, and presented the CNS Awards for Excellence in Nuclear Research to DRSA Students Connor Dobson (St. Charles-Garnier High School, Whitby, Ontario) and Naciza Masikini (Pickering High School, Ajax, Ontario)

Blair Bromley presenting the CNS Award to DRSA Students Connor Dobson and Naciza Masikini.

Membership:

- **Current CNS-CRB Membership Statistics:**
  - Based on data provided by the CNS National Membership Chair (Ben Rouben) in September 2011:
    - 172 members in good standing
    - Up from 169 members in July, 2011.
    - ~70% Regular, ~25% Retirees, ~5% Student
    - Down from 177 members for 2010.

- **Recent Membership Activities:**
  - Email sent to a number of Deep River Science Academy (DRSA) students to encourage membership.
  - Announcements made at recent CNS and DRSA meetings in July and August to encourage membership.

- **Action Items:**
  - Prepare a small, folding information brochure for display at information racks at local public libraries, municipal offices, science fairs, etc. (Ongoing)
  - Follow-up in contacting past CNS members to encourage renewal.

GOLDEN HORSESHOE Branch (GHB) – Kurt Stoll

The summer has been slow for the GHB, with many people on holidays through the reporting period. There was a change in organization as Kurt Stoll (McMaster graduate student) succeeded Dr. Dave Novog as the GHB Chair.

Work is ongoing to book a technical seminar at McMaster in the near future. A number of high profile nuclear engineers will be in southern Ontario for the NURETH conference in late September and invites have been given to some of these attendees to also give a presentation at McMaster; so far no acceptances. A general CNS notification with a full seminar description will be circulated once a presentation is booked; all are welcome.

Some discussion has been made regarding estimating our next yearly budget. Final discussions will occur when the financial reports are due.

NEW BRUNSWICK Branch - Mark McIntyre

Unfortunately we are focused on Return to Service right now. We have not had any events since the last report.

OTTAWA Branch – Mike Taylor

The branch has agreed to appoint a Director of Education to improve our performance in this area, and Christine McNally has offered to take up this position.

We have no meetings in the immediate future but plans are in hand for some interesting talks between now and Christmas.

UOIT Branch – Kale Stallaert

The UOIT Branch has been in hibernation during the summer months. With the beginning of the new school year, the CNS - UOIT Branch has resumed regular operations. Seminar, field trip and recruitment events are currently being planned by the branch's executive committee.

9TH International Conference on CANDU® Maintenance

CMC 2011 is Coming Up Fast - Plan Now to Participate

[Register; Book Accommodation; Sponsor Students]

9th International Conference on CANDU® Maintenance

Metro Toronto Convention Centre • 4 - 6 December, 2011

"Industry Performance – Getting a Grip"

- was the promised focus – it's happening -

CMC 2011 Adopts a Dual Focus for Its Plenary and Technical Programs;
1. Industry Performance and 2. Technical Excellence

Focus 1 - 'Special Sessions on Industry Performance'

CMC 2011 is configured in four Half-day Sessions [A thru D], each opening with a breakfast or luncheon Plenary Session. These four opening Plenary Sessions [and the four subsequent 'Special Sessions on Industry Performance'], focus on essential 'Ways-of-Working Improvements' - come prepared for some interesting dialogue.

These Sessions [A, C, D respectively] address the three distinct Businesses Types of; i) 'Tightly-Managed Outage Services'; ii) 'Refurbs Small and Large'; iii) 'New Build 2011-Style'.

Session B addresses 'Ways of Working Improvements'– focusing specifically on the essential 'tools' and 'competencies' needed to improve performance going forward [we of this conference feel that such ways-of-working issues are at the root of recent performance deficits].

Focus 2 — Technical Excellence Sessions

Technical Excellence Sessions run separately/parallel to the Special Sessions. These capture research, expertise, and practice-technologies – the foundation of all Service/Operational Support.

Important Schedule Dates

Advance Program Available:	September 26, 2011
Early Registration Deadline:	October 21, 2011
Submission of PPT Slides [Industry Performance Special Sessions]:	November 14, 2011
Submission of Full Papers [Technical Excellence Sessions]:	November 14, 2011
Hotel Reservation Deadline:	November 3, 2011
Conference Dates:	December 4-6, 2011

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Plenary Session C
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www.cns-snc.ca

2011

Oct. 30-Nov.3 — **ANS Winter Meeting and Technology Expo**
Washington, D.C.
website: www.ans.org

Dec. 4-6 — **9th International Conference on CANDU Maintenance**
Toronto, Ontario
website: www.cns-snc.ca

2012

Feb. 22-24 — **CNA Nuclear Industry Conference and Tradeshow**
Ottawa, Ontario
website: www.cna.ca

Mar. 18-23 — **18th Pacific Basin Nuclear Conference**
Busan, Korea
website: www.nuclear.or.kr or www.kaif.or.kr/eng

Mar. 19-22 — **2nd International Nuclear and Renewable Energy Conference**
Amman, Jordon
Paper submission
email: rizwan@illinois.edu
copy to: secretariat@inrec-conf.org

Apr. 15-20 — **International Topical Meeting on Advances in Reactor Physics (PHYSOR 2012)**
Knoxville, Tennessee
website: www.physor2012.org

June 10-13 — **33rd CNS Conference and 36th CNS/CNA Student Conference**
Saskatoon, Saskatchewan
website: cns-snc.ca
email: cns-snc@on.aibn.com

June 24-28 — **ANS Annual Meeting**
Chicago, Illinois
website: www.ans.org

July 30-Aug. 3 — **ICONE 20 and ASME Power**
Anaheim, California
website: www.asmeconferences.org/ICONE20Power2012

"Autumn" — **7th International Steam Generator Conference**
Toronto, Ontario
Contact CNS office
email: cns-snc@on.aibn.com

The Half Life

by Jeremy Whitlock

Hello Dr. Whitlock. Some time ago you wrote that nuclear folks are a "glass half full" sort. You claimed that the nature of the business tends to weed out anyone with an aversion to bad news.

Yes, I'm glad someone read that article!

Actually I didn't. I only read the first half.

Oh that's good. Very funny.

I'm not kidding, but it wasn't half bad. Anyway, we're wondering how you feel now, since things are going so swimmingly in the industry?

Yes, well, Fukushima has indeed put a damper on the nuclear renaissance for a bit, but things will pick up.

If only those BWRs were half full eh? They were a lot less than half full of coolant it seems...

And imagine: three meltdowns that the world didn't know about for six weeks because of the lack of contamination signature outside the plant. And nobody harmed by radiation. One of the only pieces of energy infrastructure that didn't kill anyone after the tsunami.

That's odd. That certainly isn't what the media is saying about Fukushima.

Your point...?

Okay look, what about AECL and its sell-off. How's that going?

Well first of all it's not being sold off – the government is privatizing the commercial CANDU half.

So AECL is something of a "glass half full" itself now?

Something like that. It's actually a bit of a turning back of the clock: The first CANDU reactor was designed and built by a private company, Canadian General Electric, with help from AECL on the nuclear end of things. CGE then went on to sell a CANDU to Pakistan.

That's funny, I hadn't heard of that.

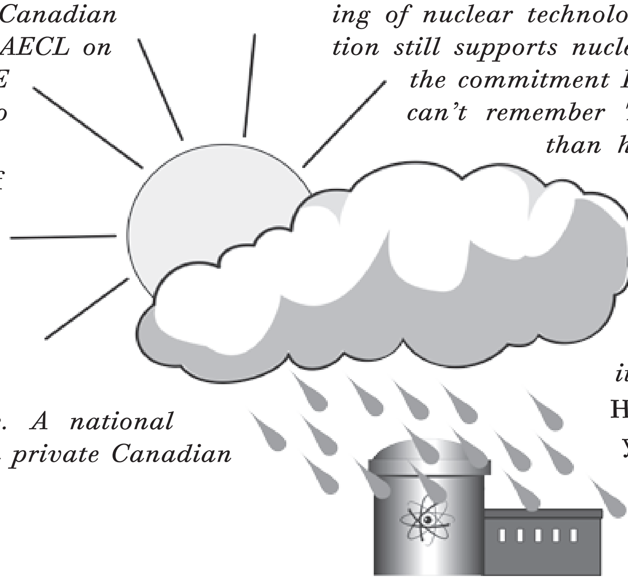
Well that's because they got out of the reactor vendor business shortly after that. But you get my point.

Which is?

That we've been there before. A national nuclear lab in cooperation with a private Canadian firm building reactors.

So it's all good?

It is what it is. Time will tell.



Ooohh, I see. Glass not so full on that one...?

They'll still need strong government support. They'll need a strong public relations department, and nuclear public relations is a strange puppy - unlike any other line of business. And they'll need to keep abreast of ongoing developments in fuel cycles and safety. There may not be short-term returns to some of this. It's not your typical private enterprise situation.

So...?

Time will tell.

New build at Darlington? How's that glass?

Inevitably half full. Ontario's nuclear edge is eroding. We're patching and patching but we need new machines.

But what about shale gas? Some might say we don't need nuclear...

Shale gas isn't all it's fracked up to be.

Cute.

Thanks. Look, the need for nuclear doesn't go away. There's been constant average electricity growth since the 1950s. All that changes is the timing. And that's as fickle as the latest election. It's why you need strong government support, to maintain the base capability. It's no country for weak hearts.

Or private enterprise?

Time will tell.

Say, it's been ten years since 9/11. Has this half-emptied or half-filled the cup for nuclear power?

Well we spend half our money on security now it seems. There's about half as much public understanding of nuclear technology. Granted, half the population still supports nuclear power, but with only half the commitment I'll wager. Half the population can't remember Three Mile Island, but more than half thinks that Fukushima is killing Japanese civilians like flies. Next year it'll be half a century since the start of nuclear power in Canada and we're still doing a half-arsed job of explaining any of it to the people who paid for it.

Hm, you're not getting crusty as you get older are you?

That's what my better half tells me.

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