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# DELIVERING MORE

### EDITORIAL

### **People Power**



At two recent major nuclear functions (both of which are reported in this issue) there was a common topic – the need for people – if we are to meet the challenge of the resurgence of the Canadian nuclear power program now underway.

This problem has been discussed for a few years. After a decade and a half of a declining or dormant nuclear program

the number of people in it had declined and those remaining had grown older. Linda Keen, President of the Canadian Nuclear Safety Commission, referred to the problem four years ago at the annual meetings of the CNS and the CNA and took action with an intern program, which brought several bright young people into her organization.

The rest of the industry did little. Admittedly, if business is slow it is difficult to expand your workforce even if you have hopes of better times. But the major organizations had, and have, the financial resources to take a longer perspective. Now it appears that they will be fighting each other for the relatively small number of qualified engineers, technicians and trades people currently available.

There are some positive notes. UNENE was established, UOIT will be graduating the first class of its nuclear engineering program next year and McMaster reports an increase in the number of students pursuing nuclear- related programs. Nevertheless, much more is needed to attract young (and not-so-young) people to pursue studies in the needed areas. A major "demographic" that has been largely overlooked was highlighted at the WiN Global 2006 conference - women. The 350 or so women attending that meeting displayed an energy and enthusiasm not seen in the nuclear field for several decades. They can attract more young women into engineering and related studies if there are clear opportunities for them. The participation at that conference of senior people (albeit "men") from three major organizations (AECL, Bruce, OPG) suggests that they have got the message. Now they need to put it into action and the many smaller companies in the nuclear program need to follow. One thing most of the women at the conference identified as important was flexible arrangements for those who wish to have a family.

In the short term there is another "demographic" that could be utilized. There are predictions of 20 to 30 percent of current employees being eligible for retirement within the next five years. It is likely that many would like to continue contributing if flexible working arrangements could be made. (An analogous challenge to that presented by women.)

This "human resources" challenge is one facing the entire industry. It would be sad and destructive if the organizations involved resort to bidding against each other. While each organization has its own particular requirements, the entire industry needs to continue and amplify a common program to attract young people into the professions, technologies and trades essential for an on-going and expanding nuclear program.

Fred Boyd

### As The Publisher

First, our apologies for the lateness of this issue. The original intention was to have it published in early June, before the CNS Annual Conference, using as a focus two major conferences held in May – the EIC Climate Change Technology conference of early May and the Women in Nuclear Global conference in late May.

Following our pattern of the past couple of years a number of technical papers to be presented at the Climate Change Conference had been identified as being suitable for reprinting and initial contacts had been made with authors. As the Engineering Institute of Canada (EIC) is a "society of societies" of which the CNS is a member and part of the organization for the conference, it was presumed that there would be no problem in reprinting the selected papers.

However, the EIC turned to its largest member society, the

Institute of Electrical and Electronic Engineers (IEEE), to handle the technical program. It ensued that IEEE has a rigid copyright system, to which most authors at the CCC had submitted. As a result the technical papers became unavailable for reprinting at this time. The result is that this issue is missing the usual technical papers.

As with many misfortunes, there was a bright side. The delay made it feasible, and logical, to include a report on the CNS Annual Conference and the embedded presentation of the Nuclear Achievement Awards. So, you have reports on three conferences and one workshop but little technical content. Perhaps that is appropriate for summer reading.

Fred Boyd

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### ~ Cover Photo ~

The photograph on the cover is an aerial view of the Darlington nuclear power station of Ontario Power Generation, rumoured as the likely site of new reactors mentioned in the Ontario government statement on the future of electricity generation of June 13, 2006.

- Photograph courtesy of



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La SNC procure aux Canadiens intéressés à l'énergie nucléaire un forum où ilf peuvent participer à des discussions de nature technique. Pour tous renseignements concerant les inscriptions, veuillez bein entrer en contact avec le bureau de la SNC, les membres du Counseil ou les responsables locaux. Les frais annuels d'adhésion pour nouveaux membres sont 75\$, 44\$ pour les retraites, et sans frais pour les étudiants.

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### LETTERS

### CNSC comments on new licensing approach

### The editor

The editorial in the March issue of the CNS Bulletin (Vol. 27, No. 1) raised some questions about the Canadian Nuclear Safety Commission's policy regarding international standards and the licensing of new nuclear power plants. I would like to offer your readers the following clarifications on some of the questions raised.

Readers of the Bulletin will be aware that no new nuclear power plants have been built in Canada in the last 25 years, and that new legislation (the *Nuclear Safety and Control Act* and the *Canadian Environmental Assessment Act*) now guide the CNSC's actions. While past approaches have served well, the CNSC is exercising due diligence in modernizing the regulatory framework to reflect new realities.

There are several principles that guide the CNSC's approach to licensing of new power reactors. The first of these principles is that safety is the CNSC's priority. Other stakeholders, including governments, operators, and vendors may have different interests – such as economics, timelines and productivity – but the CNSC's mandate remains the same. Our job is safety.

Second, the CNSC is aligning its regulatory requirements with standards published by the International Atomic Energy Agency to the greatest extent practicable because these standards represent the collective knowledge and operating experience in nuclear safety gained over the years in Canada and throughout the world.

Bulletin readers will note that any new regulatory standards will be published by the CNSC, after open and transparent consultation with all stakeholders. Such standards can best ensure that Canadians can have confidence in the CNSC's modern, internationally-benchmarked regulatory oversight.

Third, as the Canadian independent nuclear regulatory body, the CNSC does not make choices on technology. The CNSC is technology neutral in all areas of its mandate, including nuclear power plants. The choice of technology is the responsibility of the proponent. Independence and objectivity are key principles in ensuring that the CNSC operates in accordance with its mandate and maintains public trust.

I hope these comments help to clarify the CNSC's direction with respect to its regulatory framework for new nuclear power plants. For more information on this subject, your readers may consult the CNSC information document INFO 0756 "*Licensing Process For New Nuclear Power Reactors*" available on the CNSC web site at www.nuclearsafety.gc.ca or upon request.

Sincerely,

Ian M. Grant P. Eng. Director General, Power Reactor Regulation Canadian Nuclear Safety Commission

### In This Issue

The content of this issue differs somewhat from the norm of the past year or two in that it has only one technical paper but does have reports on three conferences and one workshop. (*See the note "as 'Publisher'" on page 1 for background.*)

Beginning is our report on the **27th CNS Annual Conference**, which was held in Toronto, June 11- 14, 2006, followed by a slightly edited version of the **W. B. Lewis lecture** given at the luncheon on the first day and an account of the **2006 Nuclear Achievement Awards**, which were presented at the conference dinner.

The next meeting report is on the very successful and different **Women in Nuclear Global 2006 Conference**, held in Waterloo, Ontario at the end of May 2006.

Lastly, there is an account of the **EIC Climate Change Technology Conference (CCC2006)** held in Ottawa, May 10 – 12, 2006, followed by the one technical paper, **Nuclear Fission Fuel Can be Considered as Inexhaustible**, which is a modified and updated version of one presented at the CCC2006 conference. Then, the last of the "reports" is a note on a workshop, **CWESI 2**, held by the Society in April.

A short **Profile** is provided of the unassuming Kevin Routledge, who has the challenging role of Director of the Bruce refurbishment project.

In reflection on the 20th anniversary of the **Chernobyl** disaster there is a reprint of the summary of the report from the Chernobyl Forum, which provides a partial "closure" on that tragic event.

An expanded **General News** section reflects the many development in the Canadian nuclear scene over the past few months and **CNS News** provides a view of the society's activities, including a report on the Annual General Meeting held June 13, 2006.

Lastly, but definitely not least, is the inimitable contribution from Jeremy Whitlock in **Endpoint** along with an updated **Calendar** of events.

Happy summer reading.

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Close to 400 delegates attended the **27th Annual Conference** of the Canadian Nuclear Society and the embedded 30th Student Conference sponsored by the CNS and the Canadian Nuclear Association held in Toronto, June 11 - 14, 2006.

In what might be considered a serendipitous coincidence the announcement from the Ontario government on the future of electricity generation in the province, which will include refurbishment of existing plants and construction of new ones, occurred on the second day of the Conference. This did not alter the program. In fact speakers on the first day had anticipated the announcement. The generally negative reports from the Toronto media did become a topic of discussion.

The structure of the conference was modified slightly from recent years, partially to accommodate a meeting of the Pacific Nuclear Council on the Sunday, June 11. (*See a report on that meeting in CNS News.*) Nevertheless, an opening reception was held on the Sunday, at a somewhat earlier hour than in past years. That afternoon the North America Young Generation Nuclear (NA-YGN) held a professional development seminar which attracted about 100 young professionals or students.

Following welcoming remarks from **Lloyd Jones**, Honorary conference chair and **John Luxat**, CNS president, on the Monday morning, the conference proper began with a plenary session on the theme "*Forward – Leadership and Public Trust*".

**Murray Stewart**, president of the Energy Council of Canada opened the session with a broad overview of "*The Global and Canadian Energy Outlook*". He began with a brief description of the Energy Council of Canada and the World Energy Council to which ECC and 97 other country organizations belong. The WEC has recently produced a report on the world energy outlook out to 2050, which includes a study of the future of nuclear in Europe. These show only a small contribution from nuclear. He noted the large oil resource in the Alberta tar sands and the potential of gas from methane hydrates. He also mentioned the large coal reserves in the USA. To a question, he asserted that there is no early end of oil, that higher prices and advanced technology will result in continuing production.

Next was **Dennis Galange**, vice-president Ontario Market, at Atomic Energy of Canada Limited, whose presentation was titled "*Managing Competitiveness and Risk in New Nuclear Power Plants*". He spoke of the recently formed "Team CANDU", composed of AECL, Babcock & Wilcox Canada, General electric Canada, Hitachi Canada, and SNC Lavalin Nuclear, which is prepared to offer turnkey, fixed price, contracts with ontime guarantees. He referred to the Qinshan (China), Wolsong (Korea) and Cernavoda (Romania) projects as evidence that the team could deliver. To a question, he said the ACR design would

be completed in two years and could be in service by 2016, which would meet the Ontario target. (In the technical sessions Robert Ion said AECL had an agreement for a 'pre-licensing" statement from the CNSC in 2009.)



Following a break, **Duncan Hawthorne**, president of Bruce Power, took the stage. He titled his talk, *"The Leadership Challenge"*. Referring to the anticipated announcement from the province (which came the following day) he commented it was not good news. "If the province had any other option [than nuclear] they would take it", he said. The nuclear community must show that it can be trusted, he stated and added that we can not convince [the public] by technical arguments. With today's capacity the most the industry could do

Duncan Hawthorne

is maintain market share since it could not build more than two units, he asserted. It is essential to expand our manpower, he added, and develop a plan for a brand new workforce.

*"Managing Nuclear Power Stations for Success"*, was the title of the presentation by **Gregory Smith**, senior vice-president, Darlington NGS, Ontario Power Generation. He began by stating the mandate of OPG prescribed by the Ontario government:

- Operate with a commercial focus
- Improve performance -- emphasis on nuclear
- Benchmark against the best
- Expand generating capacity hydroelectric.

He commented that it was technically feasible to refurbish Pickering units 2 and 3 but not justifiable commercially. They are in worse shape than units 1 or 4, he added. The focus is on maintaining a high safety standard, put people first, improve the material condition of the plants and build effective leadership. OPG nuclear is working towards a three-year outage cycle. Given the high capacity factors of the Wolsong CANDU units, OPG has had discussions with Korea Hydro and Nuclear Power to see if there is anything to be learned from their operating practices. He also mentioned the problem of an ageing workforce, noting that 30% of OPG Nuclear staff could retire in five years.

**Rod Eagles**, director of refurbishment at NB Power's Point Lepreau station, provided, "*An Update of Point Lepreau Operations and Refurbishment Project*". He began by noting the decision last July by the provincial government to proceed with the refurbishment of the station. He also noted that Gaetan Thomas had been appointed vice-president of NB Power Nuclear to succeed Rod White on his retirement. Point Lepreau will have a "midterm" review by the World Association of Nuclear Operators (WANO) this year and a full peer review in 2007. They have used SLARETTE to inspect 26 fuel channels. The refurbishment shutdown is scheduled for April 2008.

A different view was provided by **David McFadden**, partner in the legal firm Gowling, Lafleur, Anderson, who spoke from the perspective of the Stakeholders Alliance for Electricity Competition and Customer Choice. The title of his talk was *"Winning Public and Political Support for Nuclear"*. He began by recalling the Porter Commission of the mid 1980s which was overly long but did recommend proceeding with the Darlington station. *"We are on the eve of another historic battle"*, he suggested. The recent polling results for the CNA that showed 61% in favour of nuclear were encouraging, he commented, until that is compared to over 90% support for solar, wind and hydro. Even gas has a 79% rating.

Another factor, he noted, is that scientists are considered the most trustworthy source of information, with politicians being the lowest. The nuclear industry should target its message to: business leaders, municipal politicians, columnists and editors, and organized public groups. Seize every opportunity to get out the message, he urged.

The session ended with an "*Update on the Global Nuclear Energy Partnership Initiative*" by **Larry Brown** from the US Department of Energy. "Closing the fuel cycle", is the focus of this activity he explained at the beginning. Although initiated in the USA the objective is to build a global consensus on a number of points:

- expand nuclear power
- manage spent fuel
- demonstrate recycling technologies
- demonstrate advanced burner reactors
- establish reliable fuel services
- enhance exportable technology
- enhance nuclear safeguards technology

DoE has asked for \$250 million for initial planning. A preliminary estimate suggests that it would require over \$40 billion over 20 years to achieve the above program.

The luncheon was the setting for the **W. B. Lewis lecture**, which was given by **Dr. John Cowan**, principal of Royal Military College. A slightly edited version of his remarks is reprinted in this issue of the *CNS Bulletin*.

In the afternoon the first set of technical sessions and first round of the Student Conference were held. There were five parallel technical sessions and two parallel student sessions. This pattern was repeated on the Tuesday morning and Wednesday afternoon. The titles of the technical sessions provide some indication of the breadth of topics covered:

- safety analysis
- plant refurbishment
- control room operation
- nuclear chemistry and materials
- advance reactor design
- corrosion processes

- control systems / physics / modelling
- plant operation
- reactor physics
- chemistry / chemical engineering
- nuclear instrumentation
- general nuclear topics

That evening the Canadian Nuclear Achievement awards were presented at the conference banquet. (*See the separate article on the awards.*)

Tuesday morning saw a continuation of the technical sessions and the student conference. The CNS Annual General Meeting was held over the lunch period. (*See a separate report on the AGM in the CNS News section of this issue of the* CNS Bulletin.)

The Tuesday afternoon saw two plenary sessions; the first on *"The Infrastructure Challenge"*, the second on *"Bruce Restart"*.

**David Hay**, president of NB Power Holding Corporation, began the first session with comments on *"Financing the Next Round of Nuclear Plants"*. He stated at the beginning that he was not speaking about forms of financing but the factors necessary to obtain it. It is essential to build on-time and on-budget and to operate reliably, he stated. There are a number of organizations with large amounts of capital who are "keen" to invest IF there is the right risk / reward environment, he said. A number of factors are becoming favourable, he commented, including: increased cost of fossil fuel; concerns about climate change and greenhouse gas emissions; improving nuclear performance and growing public acceptance.

In his talk on "*Challenge to Nuclear Suppliers: Positioning for the Nuclear Renaissance*". **Richard Reimels**, president of Babcock & Wilcox Canada, repeated the dictum of "on-time / on budget". He spoke of the modest number of "second tier" suppliers who provide significant components and the multitude of "third tier" suppliers who make the many small parts or provide specialized services. Some supply to the world market. With necessarily limited capabilities many will say "no" to orders if they are fully committed. A major question for the smaller suppliers is how long will it be before real orders are issued, noting the uncertainty of environmental and regulatory processes.

**Claude Drouin**, deputy director G2 refurbishment, Hydro Quebec, provided an overview of the Hydro Quebec system and the role of the Gentilly 2 station. Nuclear provides only 3% of the electricity in Quebec but is still considered valuable for system stabilization and export. Hearings by the Canadian Nuclear Safety Commission on the G-2 refurbishment begin this December. The final (Quebec government) decision is scheduled for December 2008.

After a break **Steve Lowen**, a director at Cameco Corporation, spoke on "*Nuclear Fuel Supply Challenges and Opportunities*". He began with an overview of Cameco's operations from the mines in Saskatchewan to the refinery at Port Hope. There remains a large gap between production and consumption of uranium, which has been met by downgrading of military high enriched uranium. This source is diminishing and the price of uranium has gone from \$17 to over \$40 in two years. This has induced many small uranium firms to re-enter exploration. But, he cautioned, it takes typically 5 to 7 years to discover a large reserve, 3 to 5 years to confirm it, and 10 years to construct the mine. To a question, he stated that Cameco had decided not to process the low enriched fuel (for Bruce) at its Port Hope refinery.

The session closed with a different perspective by **Susan Brissette**, Bruce Power and president of Women in Nuclear Canada, in a talk she titled "*Playing the Gender Card* – *Winning the Hearts and Minds of the Female Demographic*". She outlined the history of WiN, which started in Europe in the early 1990s and WiN Canada, which began just four years ago. She referred to the energy displayed at the very successful WiN Global Conference held in Waterloo, Ontario at the end of May. (See separate article on the WiN Global Conference.) In closing she threw out a challenge to the mostly male audience to recognize, celebrate and encourage the achievements of women in the nuclear industry, noting that she was the only woman [plenary] speaker at the conference.

Late in the afternoon a second plenary session was held on "Bruce Restart" with presentations from three different perspectives.

**Andrew Johnson**, executive vice-president, Projects, at Bruce Power, began with that of the licensee and operator, Bruce Power. "We are not making the [Bruce A] units "new", he said but putting them into shape for a 25 year life extension. The prerequisites for committing to the huge project were:

- confidence in the electricity market (which required a commitment from the province)
- investor commitment
- community support
- industry commitment (from contractors and unions)
- a clear regulatory process

The overall budget is \$4.25 billion, of which \$2.75 billion is for the restart of units 1 and 2; \$1.2 billion for refurbishment of unit 3 (after units 1 and 2) and \$350 million for replacement of the steam generators in unit 4. There are many contractors involved, he said, and all understand that "everyone succeeds or fails as one". He offered a list of requirements for success:

- continued safe operation
- environmental compliance
- contractor oversight
- project governance
- regulatory involvement
- adequate human resources
- openness and transparency

On the last point Bruce Power has created a sub website providing much detail of the refurbishment of units 1 and 2.

He closed by commenting that the preparatory phase is coming to an end but there is still much detailed engineering to be done.

Next, **Kevin Routledge**, president of AMEC NCL, who has been appointed Project Director, provided "*The Project Manager's Perspective*". This is the most ambitious refurbishment in the world, he noted. Before committing to the project there was a two-year project definition exercise.

The project management mission is, he said, to create the conditions necessary for success by ensuring that services, resources, approvals, components, etc., are provided in a timely manner.

(See a " profile" of the unassuming Kevin Routledge in this issue of the CNS Bulletin.)

The third viewpoint was given by **Bryan Murdoch**, general manager, Retube, Atomic Energy of Canada Limited, who spoke on "*Restarting Bruce Units 1 and 2 from a Contractor's Perspective*". He illustrated the proposed retubing exercise, which will be done by AECL, with a number of slides. He noted that it had been decided not to remove entire feeder tubes but only sections where the corrosion or erosion dictated it.

To a question he refuted the common perception of the shortage of qualified people, saying that AECL has had no problem recruiting over the past year.

Unlike the past few years there was no event planned for the Tuesday evening but one of the major sponsors and exhibitors, AREVA, offered an extended reception and another sponsor, Wardrop, held a similar but smaller one for students and young members.

The last plenary session was held on the Wednesday morning, under the title *"Technology to Meet Commercial, Environmental and Public Challenges"*. This began with four what might be termed "sales pitches" from AREVA, General Electric, Westinghouse and AECL. (Interestingly, the first three speakers were all alumni of the US nuclear submarine program.)

**Roy Ganther**, vice-president, New Plants Deployment, AREVA NP Canada Ltd., began with a brief overview of AREVA, which has over \$13 billion (Cdn) annual sales and employs 58, 000 of which 1300 are in Canada (including two subsidiary companies, Canberra and Cogema). He then turned to a description of the 1600 MW EPR design, which is being built in Finland and just recently approved for the Flamanville site in France.

The design began a decade ago when Framatome (France) and Seimens (Germany) decided to collaborate on a new "European" nuclear power plant design using the best features of each company's previous ones. It is designed to provide 1600 MW net, has double containment; four safety trains; larger safety margins; reduced number of components and a predicted core damage frequency of 4 X 10<sup>-7</sup> which can be compared to the US Nuclear Regulatory Commission's requirement of 1 X 10<sup>-4</sup>. He showed a slide illustrating the much smaller "foot-print" of two EPR units compared to four CANDU 6 units. Their design target is a capacity factor of 95% and a life of 60 years.

He said that engineering modifications are underway to meet North American requirements (such as 60 Hz rather than 50 Hz) and will be proceeding to evaluate the design to Canadian regulatory requirements, commenting that they welcomed the CNSC move to "technology neutral" standards. In the USA they have teamed with the utility Constellation Energy to apply for design certification. To a question on cost he said it fall between \$1600 and \$2000 /kw. depending on the site and other factors.

Next was David Hinds, vice-president Business Development

and Technology, General Electric Nuclear, who presented the case for their ESBWR, which he described as the only advanced GEN III design reactor in operation (in Japan).

There are 92 GE type boiling water reactors around the world, he noted. The ESBWR has full passive safety features based on natural circulation and simplified design. It has a USNRC design certification and, he said, could be built in 36 months in the USA. Over the years GE Nuclear has developed an extensive list of suppliers. He claimed a core damage predicted frequency of  $3 \times 10^{-8}$ .

To the repeated question of cost he said it would be about \$1350 / kw, excluding owner's costs.

The third "overseas" vendor representative was **Ed Cummins** of Westinghouse. His topic was their AP 1000 design.

He began with comments on the "renaissance" of nuclear in North America which he attributed to: cost of natural gas; desire for energy security; concern about GHG emissions; regulatory stability [in the USA]; and growing public and political support. On the last point he referred to President Bush's recent statement supporting nuclear power.

AP 1000 received USNRC design certification last December. he stated, noting their estimated core damage frequency of 5 X  $10^{-7}$ . Nevertheless, the regulatory process [in the USA] is a lengthy one. Referring to the [June 13] statement by Ontario Energy Minister Dwight Duncan, he commented "it is better than nothing".

To the repeated question of  $\$  cost, he suggested \$1500 to \$1800 /kw.

Last in this line-up of vendors was **David Torgerson**, senior vive-president Technology, AECL, who spoke about the "Enhanced CANDU 6" and the Advanced CANDU Reactor (ACR). The former, he stated, is a "living project that is available today". ACR 1000 is a GEN III (plus) design with enhanced safety, better economics, and improved operability. It has a balance of passive and active safety features, with four safety trains. His estimate for core damage is 3 X 10<sup>-7</sup>. The design is optimized for "open top" construction, he commented, adding that construction period is estimated at 42 months.

The design target is a capacity factor of 93% over 60 years, including one fuel channel replacement. AECL has sought the views of OPG and Bruce Power on operability. He mentioned the recently formed "Team CANDU" for the construction of new CANDU units in Canada. (*See note in* General News.)

To the inevitable question of cost, he just replied "same as the others – but in Canadian dollars".

The final three plenary presentations provided views from other countries.

Beginning this group of talks was **Eduardo Messi**, president of Nucleolectrica Argentina S.A. who spoke on *"Current Situation and Future of a Nuclear Power Plant in Argentina"*. He commented that, after some years of a slowdown the economy of his country is improving and there is now need for more electricity generation. They are completing the Atucha II unit (a German designed pressure vessel heavy water moderated reactor rated at 692 MW) which has been laid-up for a decade. Two operating nuclear plants, the 335 Atucha I reactor (also a pressure vessel HWR and the CANDU 6 at Embalse provide about 10% of the country's electricity. Argentina also has one small uranium mine, a fuel fabrication facility, and a small diffusion enrichment plant. It is planned to conduct a refurbishment of the Embalse plant while planning for new nuclear generation.

**Ok-Kyung Kim,** president of NETEC, a division of Korea Hydro and Nuclear Power Co. spoke on *"Nuclear Waste Management in Korea"*. Much of his presentation was about the process of choosing a site for a low and intermediate waste disposal facility. They invited local governments to bid, giving inducements of grants and the promise to move the headquarters of KHNP to the area. The site chosen is near the Wolsong nuclear station in the province of Gyeonju, which houses Korea's most famous shrine. A poll of residents of the province was held resulting in a large majority in favour. The final selection was made last November. The next hurdle, he said, is to find a location for spent fuel.

The last plenary speaker was **Subesh Mittal**, executive director (operations) of the Nuclear Power Corporation of India Ltd. He reviewed the current situation of several stations having 220 MW or 500 MW heavy water reactors based on the Douglas Point early CANDU design and one PWR. He noted that over the years India mastered all aspects of the PHWR technology, not only the reactors but also fuel fabrication, heavy water production, etc. Current plans are to increase the electricity produced by nuclear plants to 40,000 MW by 2020, primarily by new PWR reactors.



At the luncheon, **Bruno Comby**, president of Environmentalists for Nuclear Energy, spoke on *"The Role of Nuclear in Preserving Our Planet"* After describing how his upbringing had led him to becoming an *"environmentalist"*, he turned to the danger of climate change caused by man's burning of fossil fuels. Energy conservation and greater energy efficiency can help, he said but cleaner sources are needed.

Bruno Comby

He mentioned the potential of using relatively deep heat exchanger coils to tap the earth's ability to provide both cooling and heating. But the major problem is transportation, he said.





*Opening panel members wait while Lloyd Jones opens the conference. Left to right: Dennis Galange, Murray Stewart, John Luxat, Pierre Charlebois.* 

While wind power is strongly promoted in some countries he noted that those countries with the greatest amount of wind generation, Germany and Denmark, have the highest release of  $CO_2$  per unit of electricity of all countries of Europe. (*See graph.*) Nevertheless, all clean energy sources should be used, he asserted, which definitely includes nuclear, He then went on to outline the advantages of nuclear from his perspective. Uranium is a concentrated form of energy; nuclear waste is small in volume and readily managed and has few emissions.

He gave a brief description of EFN, which has over 8,000 members in 56 countries. It is largely a "virtual" organization, he said, with most of the communication being conducted by e-mail or the web. The EFN website is www.ecolo.org. He closed by commenting that the world needs "thousands of reactors" for a safe, clean future, plants that are well-designed and well-operated.

After lunch the technical and student sessions continued with, surprisingly, good attendance.

The student presentations had been judged. (The winners are given in the *CNS News* section of this issue.)

The conference was organized and run by a large committee of volunteers chaired by Dan Meneley. Major members of the committee were: Ben Rouben, assistant chair; Anne Greve, secretary; Ken Smith, treasurer; Ron Oberth, plenary program; Krish Krishnan, technical program; Denise Rouben, registration and administration; Morgan Brown, website. Others involved were: (Plenary program) Dorin Nichita, Dave Mullen, Terry Dereski, Glenn Archinoff, Ken Talbot, John Luxat, Keith Scott, Mike Lees; (Technical program) Charles Gordon, Jad Popovic, Hong Huynh, Hussam Khartabil, Eric Davey, Prabhu Kundurpi, Jasia DeGroote; (Publicity) Jeremy Whitlock, Romney Duffey, Fred Boyd; (Sponsorship) Eric Williams, Patrick Reid; (Registration) Ginette Wainstein, Veena Sharma, Janna Goldman, Melissa Boyd. David Shoesmith chaired the Student conference.

The conference was made possible at a reasonable fee through the generous sponsorships of many organizations: AECL; AMEC-NCL; ANRIC; AREVA; Babcock & Wilcox Canada; Bruce Power; Cameco; CNA; E.S.Fox Ltd.; General Electric Canada; Hydro Québec; MDS Nordion; NLI Canada; Nuclear Safety solutions; Ontario Power generation; Power Workers Union; SNC Lavalin Nuclear; Wardrop; Zircatec Precision Industries. A number of these organizations also had displays in the exhibition accompanying the conference.

The 2007 CNS Annual Conference will be held in Saint John, New Brunswick, June 3 - 6, 2007.

Scenes from 27th CNS Annual Conference



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### W. B. Lewis lecture Myths and Realities in Education and Research: the problem of knowledge and judgement in democracies

Dr. John S. Cowan, Principal, Royal Military College of Canada

*Ed. Note:* Since 1988 Atomic Energy of Canada Limited has sponsored a special lecture in memory of Dr. W. B. Lewis who headed the Chalk River Laboratories from 1946 to 1973 and was a leader in the development of the CANDU nuclear power reactor concept. Following is an edited (for length) version of the presentation given by Dr. John Cowan after the luncheon on Monday June 12, at the 27th CNS Annual Conference in Toronto.



I'm very honoured to be asked to give the W. B. Lewis Memorial Lecture, for at least three different reasons. First, we live in an odd time, when large numbers of otherwise logical folks have become inappropriately sceptical about the possibility of progress through science. Such a view would have been anathema to Wilfred Bennett Lewis, who never lost confidence in the ultimate benefit to humankind of advanced scientific knowledge. I share that opinion and delight in the fact that you honour his memory. Secondly, I am honoured to be counted amongst the ranks of the erudite crew who have carried out this annual task for you since 1988. And thirdly, ever since I first visited Chalk

River as a young undergraduate physics student some 44 years ago, I have been convinced that the Canadian approach to nuclear power made more inherent sense than the approach of other nations.

I am pleased to bring you greetings from the Royal Military College of Canada. RMC is Canada's only military university, and is Canada's only federal university. As such, we are a walking constitutional crisis, or so it might seem, until one discovers that we were created in 1876 under part 91.7 of the Constitution Act, the part which deals with defence of Canada, and not under part 93, which deals with education and is provincial. We do grant our degrees via an Ontario act passed in 1959, and so we adhere, voluntarily, to all accreditation systems used by Ontario universities. Some 43% of RMC's full-time undergraduates become engineers. But we are also very graduate studies intensive, and grant one masters or Ph.D. for every two undergraduate degrees, a ratio unmatched by any other Canadian university. About 15% of our graduate students are civilians with no connection to defence. The average faculty member at RMC attracts over \$130,000 a year of extramural research resources, or about the same as faculty at Waterloo. And RMC is one of the few Canadian universities offering degrees in nuclear engineering.

Faculty at RMC have academic freedom, and seek extramural support wherever they wish. And yet most of them choose to do at least some research which is defence relevant. So you would think that the institution would have a strong bias towards very applied research and would show less interest in basic research. Fortunately, this is not the case, and fundamental research remains strong at RMC. And this leads me to my first substantive observation, which is a caution against underestimating the extent and the alacrity of the impact of basic research on real human progress, and exaggerating the anticipated impact of certain projects of applied research.

A third of a century ago the United States Air Force, in a deeply flawed study called "Operation Hindsight", concluded that the momentum for critical advances in applied technology was the result almost exclusively of applied research and development. The authors claimed that the technological revolution owed little or nothing to fundamental, or curiosity-oriented research, which, according to them, normally had no practical use for at least 50 years.

Doubting the conclusions of that study, two great American medical scientists, Julius Comroe and Robert Dripps, conceived and executed one of the first large-scale research studies on the subject of research and discovery itself. Focussing on fields they knew, they undertook to learn what were the real antecedents of the 10 most critical practical advances in cardiovascular and pulmonary medicine of the period 1945-1975, including things we now take for granted, such as heart-lung machines. The international panels they conscripted eventually identified some 1500 seminal discoveries which led to those ten critical advances, and followed the trail of discovery as far back as Andreas Vesalius, the famous Flemish anatomist who taught at Padua in the 1540's and Hieronymus Fabricius of Padua, who discovered the valves in the veins some 60 years later. They also identified 112 critical enabling discoveries, which they called "nodal points". And that is where it got interesting.

Comroe and Dripps discovered that over 40% of the nodal points were pieces of basic, curiosity-oriented research, and another 20% were discoveries made during applied research projects which had been intended to yield completely different results for other purposes.

Furthermore, they found that the time lag from basic research discovery to the practical application was sometimes very short. In almost 10% of cases it was less than 12 months, and in 20% was less than a decade. Their findings debunked "Operation Hindsight".

Their widely disseminated, rigorous reports transformed official attitudes in the United States, and were a significant factor leading to the last 30 years of massive publicly funded support for fundamental research in that country, and by imitation, in Canada.

Since the title of my talk is "Myths and Realities in Education and Research: the problem of knowledge and judgement in democracies", I now need to link that hypothesis of breadth in research to a similar suite of issues in education, and to tie them to some concerns about democracy.

The word "Democracy" has been getting quite a workout lately, much of it resulting from the world's most powerful democracy proselytizing pretty hard for its particular variant. But while there are many forms of democracy, some more direct than others, some more secular than others, some with broader franchises than others, with widely varying constitutional frameworks and checks and balances, they all are forms of collective decision making.

Democratic forms don't always produce the right decision, and they frequently fail to take timely decisions, but at least we're masters of our own fate, and we do continue to hope that the choices made by the majority have a reasonable chance of being good decisions for the great majority. And they probably will be, if that majority has a clue.

It has become fashionable to know a great deal about a single field, but quite unfashionable to have a solid basic

grounding in many. How did this fashion come into being?

Since the end of World War II, North Americans have witnessed an explosion in higher education. Once the province of a privileged few who were either wealthy or especially talented and determined, university attendance steadily grew to the present state of affairs, in which it has become a nearnormal expectation for those who finish high school well.

In the 1950's, degrees were few enough that possession of one was usually a ticket to a better than average economic future. But during the 1960's we saw the first signs of a clear shift towards a noxious mythology that holds sway in many quarters today. It appeals particularly to folk who describe themselves as "pragmatic".

### False assumptions

This odd dysfunctional mythology rests on five false assumptions made by governments, and by many parents and students about the taxonomy and purpose of higher education:

- 1. A specialized technical, commercial or professional education which provides immediate access to a good job is the main reason for going on to higher education.
- 2. Such education is more desirable than a less marketable one, but is also inherently more difficult. Fortunately, since it is preferred, the competition to get into it is fiercer, and so the entry standard is appropriately high.
- 3. For those who feel especially driven towards one of the other less practical disciplines, intense specialization in it may be acceptable, as one can always work as a teacher and scholar in that discipline, in which case the rest of society will support you, albeit grudgingly.
- 4. A liberal education consists of a buffet style selection of the humanities and social sciences. It is good for something, in that it makes you a well-rounded person so you can enjoy the world around you more and think beautiful thoughts during your leisure time.
- 5. Since a liberal education is not good for getting a job, it is good choice only for the slightly less energetic children of the well to do whose families can afford to support those beautiful thoughts. Others, however, may pursue a liberal education while still finding themselves, provided that they then move on.

The holder of a so-called liberal education is therefore viewed as rather a dilettante, and the primacy of specialized, professional education as the real higher education is reinforced.

In the Middle Ages, the pillars of liberal education were the subjects of the *trivium* and the *quadrivium*. The trivium of three logical and linguistic disciplines, which were grammar, logic (usually called dialectic) and rhetoric, formed the basic platform, sort of the BA of medieval times. The quadrivium of four mathematical disciplines, which were arithmetic, music, geometry and astronomy was the advanced program, more or less the MA of its day. These more advanced subjects were not viewed from a theoretical perspective at all, but rather were taken as descriptive of and explaining the actual world.

These were the "liberal arts"; they were so heavily laced with mathematics that it makes one chuckle to think of the occasional modern student who flees to the liberal arts because of a fear of math. The trivium and the quadrivium were called the liberal arts because they were viewed as the minimum suite of subjects necessary for "liberi" – "free men". This is an important concept, that there is a broad educational requirement for those who would be free, and that there is a way of defining what that reasonable minimum might be.

We speak easily of living in a free society, but have given little thought to what the citizenry of a free society need to know to meet their obligations. Indeed, society is so free that individuals are free to know nothing, while still having an equal vote and an equal say in our affairs of state.

So what risks do we run by accepting the primacy of specialized, professional education? In some ways we don't know, as we haven't run the experiment all that long. The scientist was also a natural philosopher and often an artist not only in Leonardo Da Vinci's time, but right up to the dawn of the 20th century. Until that point, we placed a very high value on knowing a reasonable amount about almost everything. The idea of the Renaissance man or woman as the epitome of education did not end with the Renaissance, but it may have died on the battlefields of the First World War.

This natural desire to know things, right down to the smallest detail, is enormously valuable in a democracy, a society committed to collective forms of decision-making. For any collective decision-making process to produce good decisions, many of those participating need to have a reasonable grasp of the facts of the matter at issue, and at least some of those who are knowledgeable need to have access to the tools used to communicate with and persuade others.

Despite the communications revolution the flow of real information in Canada on questions of public policy is drying up. This is a grave threat to any functioning democracy. And it's related to some disturbing trends in dissemination of news in Canada.

There are multiple causes for the remarkable dumbingdown of the media in Canada over the past 40 years. Some of the obvious reasons are the need to compress complex issues into 10—30 second sound bites and the narcissism of portions of the media who report incessantly on themselves. But the less obvious cause is our failure to provide a liberal education designed to foster good judgement. Most journalists are neither literate nor numerate, and do us the huge discourtesy of assuming we aren't either.

# Most journalists are neither literate nor numerate.

Interestingly, one crucial flaw also relates to market size. As critical as we are of US media, one can find some thoroughly brainy specialized commentary in the US. This is because it is a huge market, so that through syndication a journalist actually can make a living understanding issues in economics, or science, or geopolitics. But not here: in Canada, you are the science reporter the week after you were the society reporter, and the week before you are the constitutional issues reporter. Generalist journalists know that they haven't the time to learn enough to deal with the full complexity of the issues, so they fall back on the stock in trade of any articulate journeyman, human interest and scandal. Hence all Canadian news is covered as human interest or scandal.

Furthermore, major studies have shown that when they do reflect the real complexities, their editors dumb it down or declare the story not interesting. The ill-informed editor is a well-documented Canadian paradox.

Contrast the CBC television news with the BBC equivalent, which is full of hard news. The CBC version is half filled with the opinions of reporters and pollsters while the other half they show scenic postcard views or stick microphones under the noses of whatever slack-jawed gumchewing vagrant they can find on the street.

If perchance they should stray to a science or medicine story, don't expect anything better. Drugs, diseases, and chemical compounds will be alluded to without actually giving their names (unless they are already widely known) and scientific papers will be cited without actually giving a précis of the published findings. You can just imagine a story on nuclear power generation, as they would assume a moderator should be chairing a panel of talking heads, and enrichment would be somehow related to "Adscam".

At RMC, we knew we could not leave liberal education to chance. H. G. Wells described the history of humankind as "a race between education and catastrophe". Nowhere is this truer than for the modern profession of arms.

On the one hand, the public in the developed world have come to view any significant failure of judgement within the profession of arms as a genuine catastrophe. We would be profoundly unwise to dismiss this as merely anti-military bias and an appetite for scandal. While those factors may amplify that perception, the perception itself is inextricably tied to the increasing importance of human rights issues in both domestic and foreign policy throughout the developed world.

On the other hand, the remarkable acceleration of technological change and the growth of knowledge have the potential to be a vast multiplier of the effectiveness of numerically small forces. It amplifies the need for complexity of thought and maturity of judgement to avert catastrophe, and drives that requirement further down the chain of command than ever before. Complexity of thought and maturity of judgement are the product of strong education, and its application to the interpretation of experience.



An aerial view of Royal Military College.

Traditionally, of course, in the Canadian Forces, some education was

viewed as a "nice to have", but training was viewed as the real antidote to catastrophe. Today, when a young officer may be called upon to be a skilled leader, a technical expert, a diplomat, a warrior, and even an interpreter and an aid expert, all at once, there is no question that good training is not enough. Skills are not enough. The job calls for judgement, that odd distillate of education, the thing which is left when the memorized facts have either fled or been smoothed into a point of view, the thing that cannot be taught directly, but which must be learned. Without the mature judgement which flows from education, we fall back on reflexes, which are damned fine things for handling known challenges, but which are manifestly unreliable when faced with new ones.

From November 1997 until June 1998 a small committee chaired by Gen Ramsey Withers studied RMC and planned for its future. At that time I was Vice-Principal at Queen's, and was one of the members of that committee. One of our recommendations was for a vastly altered core curriculum. This core is a suite of subjects deemed essential for officership in the 21st century.

Once the Minister had approved the recommendations of the Withers Report, the Board of Governors of RMC struck a committee to rewrite the undergraduate curriculum to comply with the requirement to enhance the core curriculum. While still at Queen's, I chaired that Core Curriculum Committee of RMC and drafted the revised undergraduate curriculum, which the Board approved in March of 1999. The report did not argue for one size fits all. It mandated a common suit of core minimum competences, but not everyone would use the same courses to get there. The minimum math competence, for example might be a year long course in Arts Division, but might be met halfway through the first math courses for science and engineering. A common minimum, but different slopes for different folks. Similarly, the Canadian history course was twice as full for Arts as it was for engineers. The one for engineers was the minimum, and Arts students probably needed even more for the follow on aspects of their program.

The new undergraduate core curriculum was implemented for first year in September 1999. The first class that got all four years of that curriculum graduated in May 2003. Already the Chief of the Defence Staff and other senior officers tell us it is making a difference. Under this

curriculum all officer-cadets meet minimum standards in those core subjects viewed as essential for officership, specifically: ethics, psychology, leadership, Canadian history, Canadian civics, politics, law, military history, international affairs, cross-cultural relations, mathematics, logic, information technology, physics, chemistry, English and French. On top of that, they do their specialized component, whether it is electrical engineering, French literature, economics or whatever.

Of course, it makes the academic portion of an RMC degree a bit long, but it has been always thus. An honours arts or science degree at RMC has 5-17% more course credits than at a good civilian university, and an engineering degree about 10% more course credits. But this is unavoidable if the needed breadth is going to be there, while still getting the specialization that society has come to expect. What is interesting, however, is that the students can do it, even while meeting the substantial demands of the required bilingual, sports and military components of the program.

The RMC core curriculum is the modern equivalent of the trivium and the quadrivium, so much so that, for example, the minimum physics requirement can be met with the everpopular course on the physics of music. We didn't get there from nostalgia or from someone's pipe dream. We got there by working backwards from what we needed on the ground in the Balkans or Afghanistan, on ships engaged in blockade, and in air operations around the globe. Strange as it seems, the subjects needed to be truly free are pretty much the same ones needed to defend freedom in an ethical manner.

Liberal education works. It is not just the humanities and social sciences. It is not just to think beautiful thoughts. It is not just for the idle rich. It is not second-class education. It is what helps people make good choices. And it is the collective making of those good choices that will determine our collective future, and our persistence as a free people. So in effect, it is what makes us free, and it is what keeps us free.



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Each year the Canadian Nuclear Society together with the Canadian Nuclear Association create an Honours and Awards Committee which seeks nominations for the several awards that the two organizations have created over the years. The 2006 recipients were presented their awards at the Awards Banquet held Monday, June 12, 2006 at the end of the first day of the 27th CNS Annual Conference in Toronto. This year there were no recipients of the two senior awards: the W. B. Lewis Medal, for distinguished scientific or technical contribution, and the Ian McRae award for significant contribution other than scientific.

Following are the award winners with the citations for their respective award.

### **Outstanding Contribution Award**

### Purpose of the Award

To recognize Canadian-based individuals, organizations or parts of organizations that have made significant contributions in the nuclear field, either technical or non-technical. There are two categories of the award, one for individuals and another for organizations or parts of organizations.

Four persons were named for this award.



### Dr. R. Allan Brown – Outstanding Contribution Award

Allan Brown has served in the Canadian nuclear industry for more than thirty years, and continues that service as CEO of his own consulting company. In the course of his career he has contributed in a wide variety of fields, from reactor physics to safety, to design and management.

Dr. Brown has had several notable achievements. The one selected for special commendation is his ability to under-

stand the vast array of factors that collectively determine the level of safety of nuclear plants, both technical and human. The Ontario Hydro Department that he led became the true Centre of Excellence for nuclear safety in Canada. Dr. Brown has, throughout his career, demonstrated an outstanding ability to understand the weaknesses of various safety designs, and to devise practical ways and means to correct those weaknesses. These talents have been demonstrated, amply and often, both nationally and internationally. In particular, he led a team to the former Soviet Union, which showed the real safety potential of the RBMK and recommended ways in which a high level of operational safety could be established and maintained. His skill in leading both individuals and organizations toward worthy goals with high integrity is the hallmark of Dr. Allan Brown's career.



### Dr. Ian J. Hastings – Outstanding Contribution Award

From the time he joined AECL, Ian Hastings was a key leader and major contributor to an extensive body of work on the basic properties and performance of CANDU fuel. This was accomplished through successful in-reactor testing and a sound understanding and application of scientific theory. The work led by Dr. Hastings is a large part of the foundation for understanding and modelling

CANDU fuel performance, and has contributed significantly to international understanding of UO2 fuel performance.

Dr. Hastings was instrumental in developing and testing new and novel CANDU fuels. He served as an original member of the CANFLEX fuel development team, designed and tested numerous fuel types to improve fuel performance and reactor operating margins, and made significant contributions to research reactor fuels. He extended his expertise to fusion fuel studies in the Canadian contribution to fusion research.

He has authored more than 250 conference presentations, peer-reviewed papers, and internal reports, edited 11 books and Conference / Workshop Proceedings, and was member of the Editorial Advisory Board of Nuclear Technology and guest editor for the Journal of Nuclear Materials.

Dr. Hastings is a Charter Member of the CNS and the founding Chair of the Chalk River Branch of the Society.



### Dr. Robert L. Tapping – Outstanding Contribution Award

Bob Tapping is an internationally recognized leader in water chemistry, metallurgy, and component performance. His multidisciplinary research is innovative, spanning all reactor systems and components, particularly heat exchangers, steam generators, fuel channels and feeders. He has a unique ability to apply mechanistic understanding to chemistry and materials-degradation issues. He has been particularly effective in applying knowledge to support reliable CANDU and LWR reactor operation.

Dr. Tapping has been instrumental in the development and implementation of the cutting-edge SMART reactor technology which allows reactor engineers to anticipate and deal with issues proactively, resulting in improved capacity factors.

Dr. Tapping's leadership is appreciated internationally. In 2004, he was selected by the US Nuclear Regulatory Commission to serve on an 8-member international panel to identify reactor components that could degrade in the future, and provide input for developing proactive management programs.

Bob Tapping's personal energy inspires his colleagues. He has a flair for developing young talent and supporting the interests of mature talent.

Dr. Tapping is a prolific author, with over 200 scientific and technical publications and presentations. He is one of the pioneers in the highly competitive field of R&D of materials degradation.



### **Declan J. Whelan** – *Outstanding Contribution Award*

Declan Whelan was the senior representative of Canada's nuclear regulator for the Bruce-A reactors during their original licensing. During this period Mr. Whelan's work resulted in fundamentally important improvements to the safety of these reactors.

Particularly noteworthy was Mr. Whelan's recognition of the importance of process support systems in maintaining

sufficient cooling of reactor fuel. His efforts prompted the development of Safety Design Matrices for analyzing the performance of such systems for their potential to contribute to accidents, and their reliability in mitigating the consequences. Significant changes in design and operating procedures led to improved safety.

Furthermore, Mr. Whelan appreciated the importance of testing safety-related functions to demonstrate their effectiveness. One result was a decision to conduct a full-scale test of the dousing system that resulted in modifications that were needed for the successful operation of the system.

When changes to the design requirements for the emergency cooling system were proposed, Mr. Whelan prevailed upon designers to review the implications of the change on previous design decisions. Several important issues identified by this review were successfully addressed.

Declan Whelan's work on Bruce-A also contributed, indirectly, to the development of probabilistic safety assessments and to improvements to the design and operation of subsequent CANDU reactors.

### Innovative Achievement Award

### Purpose of the Award

To recognize significant innovative achievement or the imple-

mentation of new concepts which display qualities of creativity, ingenuity and/or elegance and embody an outstanding contribution in the nuclear field in Canada.

Two recipients were named.



### J. Dennis Chen – Innovative Achievement Award

Dennis Chen was the driving force behind the development of the Cerenkov Viewing Device (CVD) at AECL.

The CVD is recognized by the IAEA as the instrument-of-choice for safeguards inspectors conducting fuel inventory verification at nuclear installations. In 1983 Mr. Chen led a team at AECI's Whiteshell Laboratories that developed the prototype CVD, adapted from mili-

tary night-vision technology. The CVD lets IAEA inspectors "see" the residual radioactivity of used nuclear fuel stored under water at reactor sites, in a fast and non-invasive manner that revolutionized the inspection process.

Mr. Chen also guided the development through four generations of the commercial CVD product, with sales of over 130 instruments. As part of this development, Dennis worked with industry to design and manufacture a high-output ultraviolet lens to further increase the CVD's sensitivity. He also led the development of a course to train inspectors on the technology. This course was recognized by the IAEA in 1992 for its "outstanding contribution to Safeguards Inspector Training".

Since 1998 Dennis Chen has continued to develop CVD technology as part of Channel Systems Incorporated. His contribution to CVD technology has brought Canada international recognition for technological excellence, dedication to nuclear safeguards, and superb customer commitment.



### Dr. Kelvin Tashiro – Innovative Achievement Award

Kelvin Tashiro received a PhD in Materials Science from McMaster University in 1985. He joined Kinectrics Inc. that year, and is currently Senior Engineer in Fuel Channel Integrity.

Dr. Tashiro developed a procedure using differential scanning calorimetry to measure the terminal solid solubility (TSS) of hydrogen in zirconium alloys. From this he conceived the idea of mea-

suring in situ the hydrogen concentration in pressure tubes.

The corrosion of CANDU pressure tubes in service increases the hydrogen concentration. The hydrogen level must be monitored to ensure it does not reach concentrations that can affect the tube properties. Existing methods were expensive in reactor downtime and radiation dose. By measuring changes in the coefficient of resistivity with temperature of a locally heated region of the pressure tube, Dr. Tashiro could determine when TSS had been reached. The successful measurement of TSS temperature enables the hydrogen concentration to be calculated without affecting the tube. Despite numerous setbacks, Kelvin Tashiro relentlessly pursued the objective of developing this truly non-destructive method, and became a key member of the team developing the appropriate tool. With his extensive support, the tool has been employed in 15 monitoring campaigns and has produced important savings for the utilities.

### Fellow of the CNS

### Purpose

CNS members who are designated "Fellow of the Canadian Nuclear society" belong to a special membership category established in 1993 to denote outstanding merit. One Fellow was named in 2006.



### William J. Garland – Fellow of the CNS

Bill Garland has served the Canadian nuclear industry for over thirty years, first at Ontario Hydro, then AECL, and finally at McMaster University, from which he earlier graduated with a PhD. His career at McMaster spans twentythree active and creative years. He is unstinting in his assistance and sound advice to students as well as to many professionals in the CANDU industry.

Dr. Garland has always shown keen

interest in the education and development of students, in addition to his own research. That research, initially in reactor physics and thermal hydraulics, has expanded to include many other aspects of engineering as well as numerical analysis. More broadly, he has contributed to several areas of work related to education. His dedication to education is exemplified by his deep commitment to the development of the CANTEACH information archive project, and to direction of the University Network of Excellence in Nuclear Engineering. He has also worked for many years on behalf of the Canadian Nuclear Society, of which he is a charter member.

Dr. Garland's work on the CANTEACH project has been instrumental in its emergence as one of the original and valuable contributions to sustaining knowledge of the CANDU nuclearelectric generating system.

### Education and Communication Award

### Purpose

This award recognizes the recipients for significant efforts in improving the understanding of nuclear science and technology among educators, students and the public.

Two awards were presented.

### **Deep River Science Academy** – Education and Communication Award

In 2006 the Deep River Science Academy (DRSA) marks its 20th anniversary, with campuses at Pinawa, Manitoba and Deep River, Ontario.

Since 1986, under the founding vision of Alistair Miller and John Hardy, the DRSA has provided high school students with a unique opportunity to participate in the active research and development programs of its several Research Partners.

Each year about 50 to 60 DRSA students are engaged in planning, conducting, and reporting real science-based research and development in the fields of environmental science, forestry, and nuclear science and technology. These students work under the supervision of professional scientists and engineers, assisted by university undergraduate tutors or graduate research assistants. For most DRSA students, this summer program provides their first introduction to nuclear science and engineering.

The contribution that the DRSA makes by encouraging Canadian youth to pursue careers in science and engineering has been widely recognized, most recently with the receipt of the Michael Smith Award in 2004. The success of DRSA is due to the dedication and enthusiasm of its volunteers, staff, Research Partners and Funding Partners.



### **Dr. John K. Sutherland** – Education and Communication Award

John Sutherland is an outstanding communicator who has distinguished himself by improving understanding of nuclear science and technology among educators, students and the public.

Dr. Sutherland, who has worked with radiation for more than 40 years, successfully educates those around him about general risks, radiation risks and nuclear energy. His inspiring talks are

much sought after by community organizations, workshop organizers, universities, and teacher groups.

His courses on Nuclear Safety and Reliability are regularly given at the University of New Brunswick and to interested groups. In teacher workshops on Radiation and Nuclear Energy, the participants consistently praise Dr. Sutherland for his ability to inspire, motivate and inform. He successfully combines the theoretical with the practical, and explodes myths around nuclear science. He is a Director of Environmentalists for Nuclear Energy Canada.

Dr. Sutherland is widely published throughout Canada and has written a series of articles on spent fuel for UNESCO. A compilation of his newspaper articles has been published and received wide circulation throughout Atlantic Canada's education institutions.

John Sutherland is a tireless advocate for scientific truth

and the promotion of nuclear energy. His reward has always been seeing myths and misinformation disappear in the minds of his audiences.

### John S. Hewitt Team Achievement Award

### Purpose

This award aims at recognizing the recipients for outstanding team achievements in the introduction or implementation of new concepts or the attainment of difficult goals in the nuclear field in Canada. Two awards were made.

### Council of the Municipality of Kincardine and Ontario Power Generation – John S. Hewitt Team Achievement Award

The Kincardine Council/OPG team, through cooperation, transparency and trust, established a path forward and an opportunity to attain one of the nuclear industry's most difficult and elusive goals: what to do with the low- and intermediate-level radioactive waste.

The Council and OPG negotiated a "win/win" hosting agreement that established the conditions under which the Council felt comfortable to submit the proposal to establish a deep geologic repository for this waste, beneath the Bruce site, to their residents for approval.

An extensive public information campaign was conducted to assist residents to make an informed choice during the subsequent poll. The campaign included a storefront office on the main street of Kincardine staffed by representatives of the municipal council and OPG, mail-outs to all residents, advertising, media stories, open houses, speaking engagements and a dedicated website.

The result was a successful independent, audited poll of Kincardine residents over the age of 18, with a 72% participation rate. The results were 60% Yes, 22% No, 13% Neutral, and 5% refusal to participate.

In addition, the team earned the support of the local MP, MPP and the four surrounding municipalities of Arran-Elders lie, Brockton, Huron-Kinless and Sautee Shores.

### McMaster Nuclear Reactor Team – John S. Hewitt Team Achievement Award

The 5 MW McMaster Nuclear Reactor (MNR) is Canada's largest and longest-serving university research reactor, beginning operations in 1959. However, by the late 1980s and early 1990s MNR faced severe funding cuts, operating issues, and possible closure.

MNR mobilized a team to improve the facility's safety culture and pursue financial self-sufficiency. A process for I-125 production, developed by Dick Tomlinson, was successfully transformed from lab experiment to licensed process by Alice Pidruczny and John Avelar. Overseeing operations at this difficult time were Peter Ernst and Mike Butler.

Based upon a well-articulated business plan, the univer-

sity supported continued operation of MNR. This required an update of the facility's Safety Analysis Report (SAR), ably developed under Bill Garland and Charles Blahnik by the analyst team of Simon Day, Rob Pasuta, Mike Butler, and Dave Tucker.

Since the late 1990s, MNR has implemented significant safety, operating and infrastructure improvements. It has also reached a sound commercial footing under the marketing leadership of Elise Herzig and isotope production management of Brad Trushinski, while operating efficiently under Frank Saunders and later Chris Heysel.

The dedication of this team has transformed MNR into a world-class research, educational and commercial facility, where safety is the first priority.

### **CNS** President's Award

### Purpose

The President's Award was created in 1997 by then CNS president Hong Huynh to recognize special contributions to the Society or to the Canadian nuclear program not covered by other awards. This year's award is just the third presentation.



### Frederick C. Boyd – CNS President's Award

Fred Boyd has been a member of the CNS since 1981 and a member of Council since 1990. To many, Mr. Boyd is best known as the long-time Editor of the CNS Bulletin, and its chief photojournalist at CNS events. Less well known is his almost singlehanded transformation of the Bulletin from a simple newsletter to the highly respected primary publication of the

Society. His dedication has maintained a consistent high quality of technical, editorial and current news content. Over the years Mr. Boyd has also ably represented the CNS in several international organizations.

Fred Boyd is a Canadian nuclear pioneer, devoting his life to the field since graduating in 1949. His career includes Eldorado Mining and Refining Ltd., the NPD project at Canadian General Electric, the Atomic Energy Control Board, a senior advisory position at Natural Resources Canada, and an assignment with the IAEA. While at the AECB, Mr. Boyd and Dr. George Laurence collaborated on the Siting Guide, which established safety design and licensing principles followed by CANDU projects for many decades.

Fred Boyd was named a Fellow of the CNS in 1994 and a Fellow of the Engineering Institute of Canada in 2004.



### WiN Global 2006 - a very successful conference - with a difference

The **Women in Nuclear Global Annual Conference** was held in Canada for the first time, at Waterloo, Ontario, May 30 to June 1, 2006, and it was impressively successful.

This was the 14th in the series of WiN Global meetings and the largest to date, with over 350 delegates from 39 countries! (There were 19 men officially registered but many were representatives of sponsoring organizations who came just for the dinner.) It was also the first major international nuclear conference held in Canada since PBNC 11 in Banff in 1998.

Considering that WiN Canada began only about four years ago with a gathering prior to the Annual Seminar of the Canadian Nuclear Association in Ottawa, this was a remarkable feat of organization – one that male-dominated associations will be hard pressed to equal.

Even the choice of venue was adventurous. Waterloo is just a modest sized city, but it is in the midst of south-western Ontario's industrial heart land and close enough to the Pickering, Darlington and Bruce stations for pre and post conference tours. Another tour went to the Babcock & Wilcox plant in nearby Cambridge followed by a visit to the historic town of St. Jacobs. There was even a pre-conference tour to Cameco's McArthur River uranium mine in northern Saskatchewan. And, for the many overseas visitors, there was a visit to Niagara Falls.

Formally, the conference began with a reception on the evening of May 30, but there were "pre-conference" workshops all that day. In the morning the workshop was on "*Safety and Performance*" with an emphasis on safety culture. At lunch **Jill Cooley**, of the International Atomic Energy Agency was slated to speak on the Non-Proliferation Treaty but confined her remarks to the IAEA's safeguards system in support of that agreement. In the afternoon there was another workshop titled "*Catch Them and Keep them* – *What Makes Nuclear Appealing*" which focussed on recruitment and succession planning. The suggestions ranged from providing challenging work to accommodations for women who wish to combine family and profession.



The conference proper began on the Wednesday morning with greetings from the president of WiN Global, **Junko Ogawa** of the Japan Atomic Power Company , and the president of WiN Canada, **Susan Brissette** of Bruce Power. Brissette noted that **Linda Keen**, president of the Canadian Nuclear Safety Commission, had been an active

"honorary chair" but was unable to attend. She then played an audio message from Keen. Cheryl



**Boggess** of Westinghouse, USA, gave a short history of WiN, noting that although there were similar groups in Switzerland and Sweden in the 1980s, WiN was formally organized in 1992. There are now WiN groups in 60 countries with a total (unofficial) membership of well over 2000.

Susan Brissette

They were followed by .a plenary session on "Positioning for Growth: Setting the Stage" with

**Irene Aegerter**, a member of the Swiss federal Nuclear Safety Commission and the founding president of WiN Global, as keynote speaker. She noted how the WiN group in Switzerland had helped to increase the acceptability of nuclear in that country.

During the mid-morning break all 350 or so delegates filed out to the hotel parking lot for the official conference photograph. To accomplish this the conference photographer, Jan Pirak of Waterloo, obtained a scissors type elevating device to lift him some three metres above the crowd. The resulting photograph was remarkable with almost everyone being clearly distinguishable.

The second half of the morning was devoted to a panel discussion on "*Nuclear Operators' Best Practices*" moderated by **Regina Scheer** of World Association of Nuclear Operators (WANO). She began by outlining the work of WANO in assisting member organizations to achieve maximum safety and reliability in their operations. WANO organizes "peer" reviews by teams of 15 to 20 experienced nuclear operations people from around the world. It recommends having such a review every six years. The three panellists, **Elizabeth Bogue**, Nuclear Management Company, USA; **Zdenka Pavkova**, NPP Temelin, Czech Republic and **Aileen Sullivan**, Ontario Power Generation each spoke on their experiences as members of peer review teams.



At lunch **Ann Bisconti**, who has her own public opinion research company in the USA, provided some statistics (mostly American) in her talk titled "Public Acceptance and Attitudes: Demographics and the Nuclear Industry". Noting the historical difference between men's and women's attitude toward nuclear energy, she asked "Have we closed the gender gap?" Her answer was,

Ann Bisconti

not yet. Support for nuclear among women with university degrees has grown to 69%, but that of university men is 82%.



That afternoon there were two more panel sessions. The first was on "Public Consultation and Waste Management", moderated by Donna Snowden of Zircatec Precision Industries with panellists: Elizabeth Dowdeswell, president of Nuclear Waste Management Organization; Se-Moon Park, Korea Hydro and Nuclear Power Company; Isabelle Pelletant, Electricite de France, and

Elizabeth Dowdeswell

**Kathe Sarparanta**, TVO, Finland. Dowdeswell outlined the work of NWMO over the past three years leading up to it recommendation for an "adaptive phased management" approach for nuclear spent fuel. She commented that citizens are capable and pragmatic and have a right to be engaged. Moon mentioned the recent decision by the Korean government to locate a repository for low and intermediate waste near the historic city of Gyeongju. Pelletant spoke of the long program of public consultation in France and Sarparanta described the proposed repository for spent fuel in Finland, which was approved in principle last year.

The second panel session was titled "Nuclear Generations to Come - What the Future Looks Like" and moderated by Sylvana Guindon of Natural Resources Canada. Panellists were: Byung-Joo Min, KAERI ; Kathy Demetri, Westinghouse; Basma Shalaby, AECL; Susan Ion, BNFL; and a lonely male, Freeman Hudson, AREVA. All referred to the international "GEN IV" program. Min reported that Korea had signed on to the SFR and VHTR programs as well as continuing work on an advanced liquid metal reactor and a nuclear hydrogen production reactor design. Demetri spoke of Westinghouse's AP 1000 design, which, she said, is ready now. The company is also working on the pebble bed and IRIS passive safety designs. Shalaby spoke about the planned evolution of the CANDU design from CANDU 6 to ACR to SCWR and eventually "CANDU X". Hudson continued the "sales pitches" by referring to the EPR reactor being built in Finland and stating that "EPR for North America" is almost ready. Reflecting the absence of a nuclear policy in the UK, Ion spoke about prospects out to 2100. She commented that by 2023 the only reactor operating in the UK would likely be Sizewell B. Nevertheless, the UK is participating in the GEN IV program.

That evening saw the conference reception and dinner. A number of overseas delegates appeared in the traditional dress of their countries, adding colour and elegance to the setting. **David Torgerson** welcomed everyone on behalf of AECL, the dinner sponsor. After dinner there were light-hearted greetings from **Pierre Charlebois**, OPG, and **Duncan Hawthorne**, Bruce Power (the two largest supporters of the conference).

Then came the presentation of the WiN Global 2006 Award for Outstanding Information on Nuclear Energy which went to **Donna Jacobs**, Vice-President, Nuclear Services, PG&E's Diablo Canyon nuclear power plant in southern California. Jacobs was the first woman to head a nuclear power plant in the USA when she was appointed manager of the Wolf Creek



WiN Global president Junko Ogawa presents the WiN Global 2006 Award for Outstanding Information on Nuclear Energy to Donna Jacobs of the USA accompanied by her two children.

station in 2001. She quickly became a public role model for women, especially in the nuclear field in the USA and around the world. Her two children joined her for the presentation and shortly afterwards her six-year old daughter stole the limelight with her dancing to the music of the a cappella group, called "The Essentials" who followed.

The elegant harmonies and compelling rhythms of "The Essentials" soon had most of the delegates up swaying and dancing to the music. Twice this erupted into very long conga lines.

Thursday morning began with reports from the WiN groups in many of the countries represented. The primary focus of all groups is communication, especially with women, to explain the advantages of nuclear energy and try to dissipate the apprehensions.

Then the meeting broke into four concurrent sessions:

- Beyond Energy Latest Advance in Healthcare, Agriculture, Manufacturing and Elsewhere
- Communicating the Nuclear Message
- Nuclear Facility Life Extension and Rehabilitation: the Canadian Experience
- Chernobyl Twenty Years Later

After lunch **Colleen Moorehead**, former president of E\*Trade Canada, spoke on *"The Balanced Life"*, juggling the demands of a career and family.

The afternoon began with further reports from WiN groups followed by the closing plenary session, titled: *"Leading the Way: A Power Executive's Perspective on Corporate Social Responsibility"* with **Ruth Shaw**, president of Duke Nuclear, USA as the keynote speaker. She commented that the absence of national guidelines places an obligation on corporate executives to develop their own policies.

The conference closed with an invitation to attend the WiN Global 2007 event in China..

The conference organizing committee was chaired by Susan Brissette, Bruce Power and president of WiN Canada. Yvette

Amor of Babcock & Wilcox Canada proposed the Waterloo venue and ended up in charge of local arrangements. Claudia Lemieux of the CNA did such an amazing job in obtaining sponsorship that there was no registration fee and there was even some travel support for overseas delegates. Sanela Turkanovic, also CNA, ended up handling registrations. Others involved in various tasks, especially the tours, included Tonie Chaltas, Hill and Knowlton; Cheryl Cottrill, Bruce Power; Janet Donegan, OPG; Sheryl Fox, Cameco; Barbara Goetz, Bruce Power; Therese Kirkpatrick, Cameco; Heather Joynt, Bruce Power; Cheryl McCulloch, Bruce Power; Rita Mirwald, Cameco; Helen Spencer, OPG; Davinder Valeri, AECL; Rumina Velshi, OPG; Alice Wong, Cameco; Pauline Watson, Nuclear Safety Solutions; and Phil Ecclestone of Golden Planners Inc. the company that handled many of the details.

Among the many touches that made this conference special

were: detailed information provided to overseas visitors; colour coordinated registrars; a woman RCMP officer in dress uniform; a "Canadian Pavilion" with information about Canada and the Canadian nuclear program plus an "internet café" where attendees could access their e-mail and the web; meals and refreshments that were "healthy" and representative of many of the countries present; and ample time allowed for "networking".

The sponsors, in order of their level, were: Ontario Power Generation; Bruce Power; Hill and Knowlton; Babcock & Wilcox Canada; Cameco; Power Workers' Union; AECL; NEI; Accenture; AMEC NCL; UOIT; CNSC; Society of Energy Professionals; GE Energy Nuclear Products; WNA; AREVA; Vattenfall; Atlantis; CNS; SNC-Lavalin Nuclear; Hydro Quebec; NHL; Kinetrics; NSS; Ian Martin; Capgemini; OCI; Bell Canada; Harlequin. The CNA provided organizational and administrative support.







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### CCC 2006 EIC Climate Change Conference focuses on technology - Significant nuclear participation

With "climate change" in the news daily the Climate Change Technology Conference (CCC2006) organized by the Engineering Institute of Canada (EIC) and its member societies (see box) held in Ottawa, May 10 -12, 2006 was very timely.

About 400 attended this successful event held in Ottawa's Congress Centre. The distinct focus of the meeting was on how engineering could help eliminate or mitigate the release into the atmosphere of "greenhouse gases" (GHG), primarily carbon dioxide, CO2. The increasing concentration of GHG in the atmosphere is considered to be the primary cause of the climate change we have been experiencing and which is predicted to become worse over the coming decades.

Unlike many other "environment" meetings nuclear energy was well represented and the role of nuclear in meeting the "climate change" challenge appeared to be accepted by most (but not all) of the delegates.

The three-day conference began with two plenary sessions on the first day. The morning session began with a short address by **Wayne Richardson** of Environment Canada, representing the Minister of the Environment, Rona Ambrose. He spoke about the department's TEAM program for innovation and commercialization of programs to minimize GHG emissions. This is a cooperative program between the government and industry. Natural Resources Canada

and Industry Canada are also involved. Some of the projects Richardson mentioned were: hydrogen fuel storage; fuel cell vehicle demonstration in Vancouver; green roof technology; lake water cooling of buildings. More than \$1 billion has been invested since 1998, about 2/3 of which was by industry.

**Arthur Carty**, formerly president of the National Research Council and now Science Adviser to the Prime Minister, served as chairman of the morning plenary session, titled *"The Big Picture"*, and made the first presentation. He titled his talk *"Future Challenges and Opportunities for Canada in a Changing Global Environment"*. He began with slides of population and economic growth, which has resulted in the dramatic increase in the emission of GHG. We must increase energy efficiency and reduce carbon emissions, he stated. Among engineering solutions he mentioned: hydrogen and fuel cells; clean coal (CO2 sequestration); nuclear; gas hydrates. There is no unique solution, he asserted, all must be pursued and Canada is a leader in several.

He then introduced **Donna Cansfield**, then Ontario Minister of Energy. She said Ontario is committed to new, clean, renewable sources of energy and mentioned 600 MW of potential wind



Donna Cansfield



Duncan Hawthorne

generation. Conservation is important, she asserted, and, although it is difficult to get people to change habits, the aim is to reduce [electricity] demand by 5%. She rejected the claim of "clean coal" but would accept the term "cleaner coal".

An industrial perspective was presented by **Simon Laddychuk** of Alcan who spoke on "*Material and Product Solutions towards a More Sustainable World*". He outlined the many Alcan products and its efforts towards increased energy efficiency.

**Duncan Hawthorne**, CEO of Bruce Power, presented the nuclear story under the title; "*Nuclear Power: Friend or Foe*?" He began by referring to Minister Cansfield and quipped, "We are nuclear – no one likes us – we don't care." Nuclear is part of the solution, he said, noting that in Ontario 50% of the electricity is generated by nuclear power. There is growing international support for nuclear, he contended, noting Finland, France, Russia, USA. He referred to the Ontario Power Authority (OPA) report (Supply Mix Advice ) of last December, which recommended maintaining the nuclear contribution to Ontario's electricity generation at 50%. This would not replace the power from the coal plants planned to be shut down, he noted.

Wind cannot replace nuclear , he asserted, noting

that the German system was experiencing stability problems because of the amount of [intermittent] wind generation. After noting that Ontario premier Dalton McGuinty had indicted the need to consider new nuclear plants he commented that the big challenge is, will Ontario be prepared to buy Canadian technology ?

**Brian McNaughton** of the Canadian Association of Petroleum Producers spoke on *"The Oil and Gs Industry's Role in a Climate Change Strategy for Canada"*. There are three ways to address the climate change challenge, he contended, reduce, change, capture. CO2 capture and storage is essential, he stated. In the long term he foresaw the oil sands producing hydrogen and electricity rather than crude oil. A number of government policies are needed, he said, which should have the following characteristics: certainty; non-discriminatory; harmonized between federal and provincial; supportive of new technologies; economically and administratively efficient.

A buffet lunch gave delegates an opportunity to view the small poster display and visit the exhibits, most of which were from government departments.

In the afternoon plenary session, titled "Engineering for

*Mitigation*", **Martin Hoffert**, of New York University, gave one of the specifically anti-nuclear presentations in his talk "*An Energy Revolution for the 21st Century*". We must rebuild our electrical systems to accept the [intermittent] generation from wind and solar sources, he stated. Among other criticisms of nuclear he asserted that there is not enough uranium to maintain, let alone expand, current nuclear generation. (This point was raised in other papers in the technical session but refuted in a paper co-authored by CNS vice-president Dan Meneley, which is reprinted in this issue of the *CNS Bulletin*.)

**Pierre Anctil**, of SNC Lavalin, titled his presentation "*GHG Abatement in the Energy Sector*". He said little about abatement but outlined his view of the major sources of electricity. Hydro has the potential to double the 63,000 MW it now supplies globally but has high capital cost, long lead-time. For nuclear he just referred to Chernobyl. Coal is abundant but expensive to clean. Gas has a short lead time but the supply is indefinite. He commented that a major problem is the lengthy and costly regulatory process.

**Alan Johnson**, retired from ZECA Corporation, spoke on *"The Challenge for Coal"*. The target is to achieve zero GHG emission by 2025. This must be met, he said, or we will overload the environment. He claimed that the ZECA system was 70% efficient.

A pitch for hybrid cars and trucks was made by **David Deacon** of Azure Dynamics. The barrier is that low volume results in high costs leading to the need for initial subsidies. An initial subsidy, for example for 100 buses, could result in a commercially viable production, he suggested.

Although he titled his presentation "*The Role of Engineering in Addressing Climate Change*", **John Stone**, Canadian representative to the Intergovernmental Panel on Climate Change (IPCC), spoke primarily about that organization. He began by commenting that, after being involved in the many evaluations by IPCC, he was convinced that climate change is real, that the human input is significant and we must respond. He then reviewed the history of IPCC. Its first report was issued in 1990 and considered at the 2nd Conference on Climate Change. That led to the adoption of the Framework Convention on Climate change of 1992. The IPCC's second report in 1995 led to the Kyoto Protocol of 1997. The IPCC's third assessment concluded that most of the increase in GHG concentration was attributable to human activity. The Kyoto Protocol came into force in 2005. The nest IPCC report is scheduled for 2007.

The concluding speakers of the afternoon, **Don Lemmen**, of Natural Resources Canada and **Paul Kovacs**, of the Institute for Catastrophic Loss Reduction, both spoke about the impact of climate change. A small change in the mean temperature could lead to more extreme events, they said.

The following day and most of the third day were devoted to technical sessions organized in parallel "paths'. Five sessions ran concurrently.

The "paths" were:

- Policy, Strategy and Regulations
- Monitoring and Standards
- Engineering for Mitigation
- Engineering for Adaptation

- GHG Markets and Risk Management
- GHG Education Programs and Strategies
- Modelling and Analysis.

Over 140 papers were presented. Most were available on the CD provided with registration.

A conference dinner was held on the second day. Partially because of a strike at the Congress Centre the dinner was held at a hotel several blocks west of the Centre. There were two (!!) after dinner speakers.

**Preben Maegaard**, from Denmark, who was not on the printed program, was introduced as a "renewable pioneer". He began by showing a graph of global energy resources showing very limited oil, gas and uranium. Renewables are unlimited, he contended. He spoke of wind farms in Denmark that are locally owned and argued for smaller, distributed, sources of electricity such as biomass plants.

The second speaker was **Henry Hengeveld**, former senior science adviser on climate change at Environment Canada who titled his talk *"Climate Change 101: Why Worry? What to do?"*. Noting that recently 60 scientists wrote to the Prime Minister asserting that spending on climate change was irrational. That was followed by 90 scientists claiming we must take action. Whom do we believe?, he asked. He noted that 2005 was the warmest year since records were taken beginning in 1880 and reconstructed data suggest that the 20th century was the warmest in the past 2000 years.

Temperature changes are not evenly distributed, he noted, with the warmest in the polar regions. Doubling of  $CO_2$  concentrations are likely, he said, with tripling possible. This will lead to warmer climate which will result in less fresh water; melting in the Arctic; a rise of sea levels; extreme weather; and possible catastrophes. We need to reduce emissions, he stated in conclusion.

A short closing plenary session was held in the late afternoon of the third day. Former Governor General **Edward Schreyer** served as chair for most of this session but had to leave early. **Romney Duffy**, principal scientist at Atomic Energy of Canada Limited, stepped in to close the session and the conference.

Schreyer commented that there seemed to be a pendulum effect in our approach to problems. There is progress then regression. He noted that there were many cooperative federal / provincial energy projects in the 1960s and 1970s, such as the high voltage DC transmission line in his home province of Manitoba (which was engineered by AECL). That cooperation disappeared in the 1980s and 1990s, he commented, antagonisms developed and environmental assessments grew from months to years. There has been no hydro project for 20 years, he noted. Commenting that all energy sources were needed he hoped that those involved in the various sectors would stop "bad-mouthing" others. In closing he said he was not a pessimist and had confidence that the engineering professional was equal to the task.

He then introduced the members of the panel for the closing session: **Ralph Torrie**, of ICF Consulting; **Pierre Charlebois**, vice-president of Ontario Power Generation; and **Graham Campbell**, director general, Office of Energy R & D, NRCan.

Torrie suggested "house rules" for the planet:

- everything goes somewhere
- everything is connected
- nature is independent

He listed his criteria for sustainable energy systems: efficient; renewable; diverse; small; short lead time; environmentally benign; fail safe. We can have a low emission future, he contended, which should include: co-generation; biofuels; carbon sequestration; decarbonisation of electricity generation.

Charlebois noted that the use of nuclear for electricity generation instead of coal averts 2 to 3 billion tonnes of CO2 per year globally. The mandate of OPG, he said, is to: operate efficiently and effectively; improve nuclear performance; expand hydro production; operate fossil plants until told to shut down. Capacity factors for the nuclear stations are increasing with Darlington being over 90% in 2005. Pre-planning for life extension of the Pickering B station is underway. At this time "new build" is not in the OPG mandate, he stated, but if the shareholder (Ontario government) asks they will look at it.

Campbell began with a look at world energy demand and CO2 emissions. The latter is growing dramatically in developing countries. Canada is the only OECD country with a growing oil supply. On the technology front there are systems which will reduce emissions but some, such as the use of hydrogen for transportation require a new infrastructure. He mentioned a large solar storage project at Okotoks, Alberta. In closing he referred to a recent report from the Conference Board on "Sustainability and Energy Security".

The chair of the organizing committee was John Grefford of the Institute for Electrical and Electronic Engineering.

### EIC

The Engineering Institute of Canada is a society of societies.

Member societies are:

- Canadian Dam Association
- Canadian Geotechnical Society CGS
- Canadian Nuclear Society CNS
- Canadian Society of Chemical Engineers **CSChemE**
- Canadian Society of Civil Engineers CSCE
- Canadian Society for Mechancial Engineering CSME
- · Canadian Society for Engineering Management CSEM
- Canadian Society of Senior Engineers CSSE
- Institute of Electrical and Electronics Engineers IFFF
- Marine Technology Society



Hybrid car on display



Exhibit area

Guy Gosselin introduces the closing panel at CCC2006. Left to Right: Graham *Campbell; Pierre Charlebois; Ralph Torrie;* Edward Schreyer



### Nuclear Fission Fuel Can be Considered as Inexhaustible

by H. Douglas Lightfoot<sup>1</sup>

At the Engineering Institute of Canada Climate Change Technology Conference held May 10 -12, 2006 in Ottawa, two papers were presented that dealt with nuclear fission energy.

With the supply of fossil fuels diminishing daily, the paper "Nuclear Fission Fuel is Inexhaustible"[1] made the point that by using fuel efficient fast breeder reactors uranium reserves can be extended to supply the world with power for tens of thousands of years.

A second paper titled, "A Strategy for Adequate Future World Energy Supply and Carbon Emission Control", made the point that only nuclear fission energy has the capacity to replace fossil fuels on the scale required[2].

Both papers will be available on the IEEE website: http:// ieeexplore.ieee.org/Xplore/guesthome.jsp

This paper is a summary of "Nuclear Fission Fuel is Inexhaustible" by the following authors, but with some additional information:

- H. Douglas Lightfoot, Domtar Research Centre, retired Global Environmental and Climate Change Centre, McGill
- Wallace Manheimer, Naval Research Laboratory, retired
- Daniel A. Meneley, Engineer Emeritus, AECL
- Duane Pendergast, Computare, AECL, retired
- George S. Stanford, Argonne National Laboratory, retired

### 1. Introduction

Reserves of uranium to provide nuclear fission energy would power the world at the current energy consumption rate for ten to thirty years[3]. However, by using fast breeder reactors, which are about one hundred times more fuel efficient, uranium reserves would be extended to 1,000 to 3,000 years. These estimates are based on a uranium price of US\$80/kg.

By examining how little the price of uranium affects the price of electricity, and applying a much higher allowable price for uranium it was concluded that for all practical purposes uranium reserves are inexhaustible. Thus, uranium is in the same category as the usual renewable energies—hydro, wind, solar, and biomass.

Although there are no perfect substitutes for fossil fuels, nuclear fission fuel has the capacity to replace fossil fuels, whereas, because of technical limitations, the other renewables can make only a small contribution to world energy supply.

The advantages of using fast reactors with their much better fuel efficiency in place of thermal reactors has been known for some. It was suggested by W. B. Lewis[4] in 1968 and Bernard Cohen in 1983[5].

# 2. How much nuclear energy is needed?

World primary energy consumption in 2005 was 457 EJ, $^2$  of which 388 J was fossil fuels, or 85% $^3$ .

If all world primary energy were supplied by nuclear fission energy, then 946 EJ of nuclear fission energy would be required to replace the 457 EJ of primary energy consumed in 2005. This estimate was constructed on the basis that nuclear replaced the primary energy for generating electricity on a 1:1 basis, space heating in residential, industrial and commercial on a 2:1 basis, and transportation fuel on a 4:1 basis. Virtually all of the electricity produced goes for residential, industrial and commercial uses and very little for transportation. More is likely to go into transportation in the future. Transportation fuel for road and air transport in the future is unknown at this point, but will eventually come from nuclear fission energy.

The Intergovernmental Panel on Climate Change (IPCC) scenario IS92a suggests the world might use about three times current energy consumption in 2100, or 1,453 EJ/yr. If this is projected to 2200 at the same slope and then converted to nuclear fission energy, the world would require 5,000 EJ/yr of nuclear fission energy. Uranium already mined and now existing in spent fuel from thermal reactors and in stores of depleted uranium would provide energy for another 150 to 200 years.

# 3. Sources and quantities of nuclear fuel

Table 1 shows various sources and quantities of uranium available. Reserves of uranium are always based on the amount that is economically recoverable at a given selling price.

The number of years of reserves in Table 1 is based on the use of fast breeder reactors, which are one hundred times more fuel efficient than thermal reactors, and world energy consumption of 5,000 EJ/yr.

The figures for the amount of uranium in the earth's crust of  $6.5 \ge 10^{13}$  tonnes, i.e., 65 trillion tonnes, i.e., about 15,000 times as much as in the ocean, comes from Bernard Cohen[5]. He also estimated that about 32,000 tonnes of uranium come down rivers into the ocean every year, or about one-half of uranium consumption estimated for 2200.

<sup>1</sup> Global Environmental and Climate Change Centre, McGill University, Montreal, QC

<sup>2 1</sup> EJ = one exajoule =  $10^{18}$  Joules

<sup>3</sup> All energy figures are from Energy Information Administration publications.

Uranium Price US\$/kg	Uranium reserves tonnes	Energy available years
801	3,192,000	-
1302	15,400,000	-
1604	32,000,000	500
320	320,000,000?	5,000?
640	3,200,000,000?	50,000?
14,000	?	?
Phosphate deposits	20,000,000	-
U in seawater	4,400,000,000	-
U in earth's crust	6.5 x 10 <sup>13</sup> 65,000,00,000,000	_
U in annual river flow	32,000	-

Table 1 Uranium reserves vs. price and how long reserves might power the world.

In Table 1, a United States Geological Survey (USGS) report provides an estimate that 3,192,000 tonnes of uranium are economically recoverable at a price of US\$80/kg. <u>In Climate Change 2001: Mitigation</u>[6], IPCC indicates 15,400,000 tonnes are economically recoverable at a price of US\$130/kg. The USGS report indicates that if the price of uranium doubled to US\$160/kg, ten times the amount would become available, i.e., 32,000,000 tonnes. This is enough uranium to power the world for about 500 years.

If the same USGS factor holds, and the price doubled again to US\$320/kg, there would be enough uranium for 5,000 years. Similarly, doubling the price again to US\$640/kg, there would be enough for 50,000 years. However, at US\$14,000/kg, the price is more than on hundred times the US\$80/kg used to estimate 3,192,000 tonnes of reserves, rather than eight times.

The amount of uranium shown by the "?" is unknown, but very large and enough to supply the world with energy for tens of thousands of years.

Recovery from seawater might become economically viable with uranium selling at the same price as gold.

# 4. Uranium price is a small part of the price of electricity

At a price of US\$70/kg<sup>6</sup>, uranium is a small part of the cost of electricity, i.e., US\$0.015/kWh as in Table 2.. If the price of uranium were to increase one hundred fold, then its contribution to electricity cost would be US\$0.15/kWh. Based on the current range of electricity prices in North America of US\$0.05 to US\$0.15/kWh, the range would increase to US\$0.20 to

4 USGS

US\$0.30/kWh. This price of electricity would be manageable.

With fast reactors and uranium at US\$14,000/kg, the contribution of uranium to the cost of electricity would be US\$0.003/kWh.

Table 2 Uranium price vs. contribution to electricity price

Price of uranium US\$/kg	Contribution to electricity price \$/kWh
70	0.0015
7,000	0.15
Price of electricity in North America	0.05 – 0.15
Price of electricity in North America with U = \$14,000/kg	0.20 – 0.30
Fast reactor $U = $14,000/kg$	0.003

Nuclear fission is the only source for generating electricity that can provide long-term stability of electricity prices—more capacity can be added as needed. As natural gas and oil become scarce, people will convert to electricity for heating their homes and for cooking.

### 5. Thermal reactors vs Fast reactors

Safety features in design and operation of fast reactors are similar to those of thermal reactors. Differences are relatively small and tend to favor fast reactors.

The functional difference between thermal and fast reactors is the speed of the neutrons. In a thermal reactor, the neutrons are slowed by moderators such as water or carbon. This reduces neutron speed and increases the probability that a  $^{235}$ U or  $^{239}$ Pu atom will fission when a neutron collides with it.

In a fast reactor, there is no moderator to slow the neutrons. Fission at this higher neutron energy yields a larger number of new neutrons, which can in turn produce more fissile atoms than are lost in the fission reaction. As a result, virtually all of the original fuel atoms can undergo fission. The result is a much more fuel-efficient reactor and waste that is of concern for less than 500 years.

Startup fuel for a fast reactor is 80%–85% "fertile" (mainly <sup>238</sup>U), and the rest is "fissile" (<sup>235</sup>U or <sup>239</sup>Pu). In a thermal reactor, about 30% of the energy comes from fissioning some of the plutonium that is formed from the <sup>238</sup>U that is present, and the rest is from <sup>235</sup>U. In a fast reactor there will not be very much <sup>235</sup>U, so most of the energy will come from creating and "burning" plutonium. Acquiring the fissile material needed to start up fast reactors may become a factor limiting the rate at which the use of nuclear power can be expanded.

During the pyrometallurgical process for reprocessing of spent metallic fast reactor fuel, plutonium is always mixed with other elements, thereby reducing the risk of proliferation of bomb-making materials."

<sup>5</sup> IPCC Climate Change 2001: Mitigation Table 3.28a

<sup>6</sup> The current spot price of  $U_3O_8$  is about US\$95/kg

The UN safeguard procedures for thermal reactors can readily be adapted to fast reactors.

Because of the much better fuel efficiency of fast reactors, thermal reactors will eventually be phased out. Japan and India have advanced fast reactor programs because they have little, if any, indigenous uranium and are looking for security of energy supply.

# 6. Uranium is concentrated energy

Even with thermal reactors, there is a great incentive for using nuclear energy, especially, for countries with little or no coal resources. As shown in Table 3, very much less material has to be handled with uranium fuel, carbon emissions are eliminated and there is no air pollution. Fast reactors may be better than the 1.6 tonnes shown, and may be closer to the theoretical limit of 1.0 tonnes.

For reference, in Table 3, one kg of uranium has the same energy content as 2,300,000 litres of gasoline.

Table	3	Fuel	for	а	1	000	MW	nower	nlant
labic	J	I UCI	101	u	۰,	000		power	piunt

1,000 MW power plant	Fuel/year
Coal	3,800,000 tonnes
Thermal reactor uranium	160 tonnes
Fast reactor uranium	$1.6 \rightarrow 1.0$ tonnes
1 kg uranium	2,300,000 litres gasoline

### 7. Nuclear fusion

Nuclear fusion has been pursued for about half a century and is still about that far away. However, nuclear fission energy is here now when we need it. We have experience to use it safely and to manage the waste.

It may be that the first use of nuclear fusion would be to use the neutrons from nuclear fusion to make fissile material for nuclear fission reactors. This appears to be significantly less technologically difficult than extracting heat. There is a further advantage in that a fusion reactor can provide ten times more energy by manufacturing nuclear fission fuel than by delivering heat directly. The reason is that a fission event releases ten times more energy than a fusion event.

### 8. Developing timely fast reactor capacity

Because nuclear fission energy with fast reactors is the only source of energy available to replace fossil fuels on the scale required to power the world, we have to be successful in developing and implementing fast reactors to take over the role of thermal reactors in a timely manner.

The two main problems encountered in converting the

world to fast reactor nuclear fission energy are: (1) how to build fast reactors quickly enough, and (2). how to provide timely quantities of the fuel mixture required for starting fast reactors.

Figure 1 shows some strategies considered by Yoon Chang[7]. Estimated world electricity consumption is shown for 2005 and 2020.

The slope of world electricity consumption between 2005 and 2020 is close to the same as the slope of increasing nuclear fission power availability. In other words, under the scenario shown be Chang, we are not gaining in converting the world to nuclear fission electricity.

Total world energy consumption in 2005 is about five and a half times electricity production, which gives an indication of how far we have to go to power the whole world by nuclear fission energy.

### 9. Conclusions

- Even at the price of gold of \$US14,000/kg, with fast reactors the contribution of the cost of uranium to the price of electricity is only US\$0.003/kWh.
- At the price of gold, very low-grade uranium ores become economically viable, and the supply for all practical purposes becomes virtually inexhaustible. It may be that even "mining the sea" for uranium becomes feasible.
- Advanced fast reactors will be developed and replace thermal reactors simply based on greater fuel efficiency and the resulting security of energy supply.
- Only nuclear fission energy produced by fast reactors has the capacity to replace fossil fuels.
- Management of waste from fast reactors is simpler because the waste is of concern for less than 500 years, rather than several thousands of years.

Figure 1 Fast breeder reactors must be developed and implemented in a more timely manner than shown.



• Proliferation prevention is simpler because there is no pure plutonium at any stage during reprocessing of spent metal reactor fuel. Nevertheless, international over-sight of the nuclear fuel cycle will still be necessary.

There is a lead time of several decades for conversion from fossil fuels to nuclear. Regardless of when you believe fossil fuels will peak, we must start the process for converting to fast reactors now.

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Artist's concept of two-unit ACR station.

Over 50 specialists from various organizations associated with the Canadian nuclear program, plus one delegate from Pakistan, gathered at the Holiday Inn, Toronto airport, April 3 and 4, 2006, for the Second **Canadian Workshop on Engineering Structural Integrity** organized by the Canadian Nuclear Society.

The 22 technical papers presented over the two days were scheduled to allow considerable discussion, in keeping with the "workshop" concept. In addition, there were two luncheon presentations on topics closely related to the theme of the workshop.

The Workshop was opened by **Prabhu Kundurpi** who headed the organization committee followed by greetings from CNS president **John Luxat**. Then the program moved directly to the first morning session beginning with the first of three "keynote" speakers.

**Rod Eagles**, director of the Point Lepreau refurbishment project for New Brunswick Power, offered some introductory remarks as Honorary Chair and then gave the first "keynote" address, on "*The Role of Structural Integrity in the Point Lepreau Refurbishment*". After a brief review of events leading to the approval to refurbish Point Lepreau, Eagles spoke about the condition assessment process, which produced 162 condition assessment reports. The conclusion was that the physical condition of the plant is well understood. All 380 fuel channels, calandria tubes and feeders will be replaced. When questioned about availability of trades persons he commented they expected to be able to attract New Brunswickers back from the tar sands.

The lunch speaker the first day was **Keith Dinnie**, of Nuclear Safety Solutions, who spoke on *"The Role of Risk in Plant Life Management"*. He began by talking about living with risks, using examples from Japan where Mount Fuji has erupted 16 times in the last 1200 years, and severe earthquakes are frequent. Then turning to the focus of the workshop he pointed out that plant ageing and equipment degradation increases the risk [of failures], which needs to be managed. A risk-informed approach is much better than being too conservative , he stated, and recommended using risk-informed asset management. He commented that "reducing the predicted rupture frequency of pressure tubes, feeders or steam generator tubing would not reduce, meaningfully, the public safety risk" Risk assessment can support plant life management, he said, by prioritizing; optimizing, and determining "acceptability.

The afternoon keynote speaker was **Winston Revie**, of the CANMET laboratory of Natural Resources Canada in Ottawa. His title was, *"Trends in Corrosion R & D for Materials Reliability: Prediction, Detection, Prevention"*. Most of his references were to pipelines. The overall objective is failure prevention. "How much research is enough?", he asked, and followed by, "How much corrosion is too much?". For pipelines, he noted, it is necessary to consider both inside and outside surfaces and gave

an illustrated overview of the various systems that have been developed for monitoring oil and gas pipelines. He closed by commenting that growth areas for the future were in monitoring, modelling and mitigation.

Full-Scale Test for SCC at CANMET.



Richard Sauvé, of Atomic Energy of Canada Limited, Sheridan Park, gave the third "keynote" paper the morning of the second day on, "Structural Integrity Analyses: Can We Manage the Advances?" Using over 70 slides he gave a "tour d force" of the evolution of computer modelling pertaining to structural integrity. "The development of computing power has transformed engineering and design philosophy", he commented, noting advances in: numerical methods; finite element methods; and computer-aided design and engineering. Structural analysis began in the 1700s, he said, with Euler's work on differential equations of beams and plates. Although there were advances in mathematical techniques their application was limited until the 1960s by lack of computing power. He reviewed in some detail the finite element method of stress analysis. He closed by commenting that, "the engineering community must maintain a balanced approach to adopting new technologies while retaining fundamentals".

**David Burns**, professor emeritus at the University of Waterloo, who spoke after lunch on the second day, titled his talk, *"Enhancing the Interface among Schools, Colleges, Universities and Industry"*. He encouraged more communication by industry with the schools, both as a source of knowledge but also to make students more aware of the nuclear industry.

The technical papers were grouped under the following subject headings:

- Fitness for Service
- Experimental Measurements & Online Monitoring
- Manufacturing & Material Procurement
- Probabilistic Risk Assessment and Reliability
- Stress Analysis & Residual Stresses
- Structural Integrity



**Fred Dermarker**, Director, Engineering Services Division, Ontario Power Generation, chose a broader, but relevant, subject for his talk at the dinner the first evening, "*OPG Nuclear: Looking Back and Looking Ahead*". After what he described as a "tumultuous" decade, things are going reasonably well at OPG Nuclear, he said. He pointed out that OPG had to respond to the expectations of its shareholder (Ontario government) which include:

- be commercially focussed;
- have high standards of governance; and,
- operate the nuclear fleet effectively while investing to improve reliability, predictability and performance.

He noted that OPG's computed liability for waste management and decommissioning is \$8.5 billion against which there is already \$7.3 billion deposited in a segregated fund.

Although the average cost of electricity generation in Ontario in 2005 was 7.3 cents/kwhr OPG Nuclear is paid only 4.95 cents/kwhr, he commented.

Initial planning is underway for the possible refurbishment of the Pickering B reactors but the decision on whether or not to proceed is with the [Ontario] government. "New build" is not part of OPG's mandate, he stated.

The event was organized by a committee headed by Prabhu Kundurpi while the program committee was headed by David Burns. AECL, Babcock & Wilcox Canada, Kinetrics and Nuclear Safety Solutions provided sponsorship.

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

### CNS Membership Renewal Reminder

If you have not yet renewed your CNS membership for 2006, but would like to retain your membership in good standing, please take a moment to do it now. Please return the individual membership renewal form which you received in November, or fill out and return the renewal form available on the CNS website at www.cns-snc.ca. **Non-renewed memberships will be definitely cancelled in mid March**.

Thank you. Ben Rouben Chair, Membership Committee

### Rappel de renouvellement d'adhésion à la SNC

Si vous n'avez pas encore renouvelé votre adhésion à la SNC pour 2006, mais aimeriez garder les bénéfices de votre adhésion, veuillez prendre un petit moment pour le faire tout de suite. Veuillez renvoyer le formulaire individuel que vous avez reçu en novembre, ou bien remplir le formulaire disponible sur le site internet de la SNC, à www.cns-snc.ca. Les adhésions non renouvelées seront définitivement annulées à la mi-mars.

Merci bien. Ben Rouben président du comité d'adhésion

# Profile: Kevin Routledge "Point" person for Bruce refurbishment



Kevin Routledge is very much in the nuclear "hot seat". As Project Director for the huge (\$2.75 billion) refurbishment of Units 1 and 2 at the Bruce A station he carries the weight of not only that immense task but also, as Bruce CEO Duncan Hawthorne said at the recent CNA Seminar, possibly of the future of nuclear in Ontario (and that means Canada).

Not only is he in that challenging role, he is also president of three companies: the

recently formed AMEC NCL, Nuclear Safety Solutions, and Monserco, the leading Canadian radioactive waste management company. However, as he commented in a recent conversation, he is concentrating on the Bruce project because that is the most important (and because Duncan Hawthorne requested him to do so). There are competent people to run the three companies, he said.

Although Kevin is a relatively newcomer to the Canadian nuclear scene he brings impressive credentials. Born in St. Catherines, Ontario, he emigrated (with his parents) to Ireland at the age of 15. There he attended Trinity College in Dublin, obtaining double degrees in Physics and Mathematics. Over the years he has worked on almost every type of reactor, including AGR, BWR, CANDUJ, HTR, PWR, RBMK, VVER.

He began his nuclear career in 1973 with National Nuclear Company (NNC), the major private nuclear services company in the UK, as a thermal-hydraulic analyst, working on a number of reactor types - AGR, HTR, SGHWR, and the Sizewell B PWR. Over 1981 -82 he was seconded to Westinghouse in Pittsburgh to lead a team in further development and application of their codes. From 1982 to 1989 he managed the analytical group working on Sizewell B. In 1990 he was appointed Senior Project Manager for PWR, and then, in 1991 he switched to gas reactors and managed that division until 1996. That year he became Consultancy Director to develop and head the new NNC Consultancy business.

In 2001 he was appointed Deputy CEO of NNC Holdings Ltd. and became president of NNC Canada when that subsidiary was established. The following year he negotiated with Ontario Power Generation to transfer their Nuclear Safety Analysis division to NNC. In September 2002 the new company Nuclear Safety Solutions Ltd. was created and Kevin "returned" to Canada to be its president.

In mid 2005, as the leading shareholder director of NNC Holdings Ltd., he was very involved, along with Duncan Hawthorne, in the sale of the company to AMEC plc. That led to the creation of AMEC NNC Canada Limited (AMEC NCL) which currently has about 350 professionals working on nuclear projects in Canada, USA and overseas.

Kevin has a residence in Toronto but spends much of his time at the Bruce project (or on the road between Toronto and Kincardine). His "permanent" home is in Leicester, England which he gets to see from time to time through his frequent commutes to the UK.

When he is not working he turns his interest to sports. He has retained his interest in hockey from his young years in St. Catherines (and even supports the Maple Leafs!!) and is, reportedly, involved in professional basketball in the UK.

The parent company of AMEC NCL, AMEC plc, is an international project management and services company with headquarters in London, England. It has over 44,000 employees in more than 40 countries. Although the name AMEC was introduced in 1982 the origins of the companies from which it evolved go back to the 1840s, in particular, Societé de Construction des Batignottes in France and the Matthew Hall Group in the UK.

As well as its nuclear projects AMEC is involved in a number of other energy projects in Canada, such as wind farms fossil stations, and cogeneration plants. Its environmental division is involved in projects in Alberta and with the proposed De Beers diamond mine in northern Ontario

AMEC claims almost 100 years experience in Canada since it acquired AGRA in 2000, which, in turn, had acquired Monenco (formerly Montreal Engineering) in 1992, and Monenco was formed in 1907.



Ed. Note: April26, 2006 marked the anniversary of the worst nuclear accident - the eruption and burning of Unit 4 of the Chernobyl nuclear power station in the Ukraine. To mark the occasion we are reprinting the Summary of the report "Chernobyl's Legacy: Health, Environmental and Socio-economic Impacts" prepared by the Chernobyl Forum. The first version of the report was issued in the fall of 2005. It was revised twice with the second revision being released in late April 2006, about the time of the twentieth anniversary of the accident.

The "Chernobyl Forum" was established in February 2003, by representatives from the International Atomic Energy Agency, other United Nations organizations (Food and Agriculture Organization; UN-Office for the Coordination of Humanitarian Affairs; UN Development Program; UN Environment Program; UN Scientific Committee on the Effects of Atomic Radiation; World Health Organization and The World Bank) and Belarus, Russia, and Ukraine.

# Chernobyl's Legacy: Health, Environmental and Socio-economic Impacts

### Summary

The accident at the Chernobyl nuclear power plant in 1986 was the most severe in the history of the nuclear power industry, causing a huge release of radionuclides over large areas of Belarus, Ukraine and the Russian Federation. Now, 20 years later, UN Agencies and representatives of the three countries have reviewed the health, environmental and socio-economic consequences.

The highest radiation doses were received by emergency workers and on-site personnel, in total about 1000 people, during the first days of the accident, and doses were fatal for some of the workers. In time more than 600 000 people were registered as emergency and recovery workers ('liquidators'). Although some received high doses of radiation during their work, many of them and the majority of the residents of areas designated as 'contaminated' in Belarus, Russia and Ukraine (over 5 million people) received rela-tively low whole-body doses of radiation, not much higher than doses due to natural background radiation. The mitigation measures taken by the authorities, including evacuation of people from the most contaminated areas, substantially reduced radia-tion exposures and die radiation-related health impacts of the accident.



An aerial view of Chernobyl reactor 4 a few days after the accident of April 26, 1986.

Nevertheless, the accident was a human tragedy and had significant environmental, public health and socio-economic impacts.

Childhood thyroid cancer caused by radioactive iodine fallout is one of the main health impacts of the accident Doses to the thyroid received in the first few months after the accident were particularly high in those who were children at the time and drank milk with high levels of radioactive iodine. By 2002, more than 4000 thyroid cancer cases had been diagnosed in this group, and it is most likely that a large fraction of these thyroid cancers is attributable to radioiodine intake.

Apart from the dramatic increase in thyroid cancer incidence among those, exposed at a young age, there is no clearly demonstrated increase in the incidence of solid cancers or leukaemia due to radiation in the most affected populations. There was, however, an increase in psychological problems among the affected population, compounded by insufficient communication about radiation effects and by the social disruption and economic depression that followed the break-up of the Soviet Union.

It is impossible to assess reliably, with any precision, numbers of fatal cancers caused by radiation exposure due to the Chernobyl accident — or indeed the impact of the stress and anxiety induced by the accident and the response to it. Small differences in the assumptions concerning radiation risks can lead to large differences in the predicted health consequences, which are therefore highly uncertain. An international expert group has made projections to provide a rough estimate of the possible health impacts of the accident and to help plan the future allocation of public health resources. The projec-tions indicate that, among the most exposed populations (liquidators, evacuees and residents of the so-called 'strict control zones'), total cancer mortality might increase by up to a few per cent owing to Chernobyl related radiation exposure. Such an increase could mean eventually up to several thousand fatal cancers in addition to perhaps one hundred thousand cancer deaths expected in these populations from all other causes. An increase of this magnitude would be very difficult to detect, even with very careful long-term epidemiological studies.

Since 1986, radiation levels in the affected environments have declined several hundred fold because of natural processes and countermeasures. Therefore, the majority of the 'contaminated' territories are now safe for settlement and economic activity. However, in the Chernobyl Exclusion Zone and in certain limited areas some restrictions on land-use will need to be retained for decades to come. The Governments took many successful countermeasures to address the accident's con-sequences. However, recent research shows that the direction of current efforts should be changed. Social and economic restoration of the affected Belarusian, Russian and Ukrainian regions, as well as the elimination of the psychological burden on the general public and emergency workers, must be a priority. Additional priorities for Ukraine are to decommission the destroyed Chernobyl Unit 4 and gradually remediate the Cherno-byl Exclusion Zone, including safely managing radioactive waste.

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### *"MANAGEMENT OF REAL-LIFE EQUIPMENT CONDITIONS & SOLUTIONS FOR THE FUTURE"*

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For information on the conference, including Call for Papers, visit: WWW.CNS-SNC.Ca

# **GENERAL news**

### **Ontario's Electricity Future**

**Ed. Note:** Following is the official release from the Ontario Ministry of Energy on the future of electrical generation in Ontario which was issued on June 13, 2006. The reference is to the report issued by the Ontario Power Authority in December 2005 titled "Supply Mix Advice Report"

QUEEN'S PARK — Energy Minister Dwight Duncan directed the Ontario Power Authority (OPA) today to proceed with its recommended 20-year electricity supply mix plan, with some revisions.

The plan achieves a healthy balance by moving away from coal in favour of new nuclear power and renewableenergy. The government has set targets that will double energy efficiency through conservation and double theamount of energy from renewables by 2025.

The government has directed Ontario Power Generation (OPG) to undertake feasibility studies for refurbishing units at the Picketing and Darlington sites. OPG has also been directed to begin the work needed for an environmental assessment for the construction of new units at an existing nuclear facility. Nuclear is expected to continue to be the single-largest source for Ontario's electricity in 2025.

The government has accepted the advice of the Independent Electricity System Operator in their June 9 report that indicates a need for 2,500 - 3,000 megawatts of additional capacity to maintain system reliability. Therefore, further delays will be necessary in the government's plan to replace coal-fired generation completely with cleaner sources of energy.

The government is referring the question of how to best replace coal in the earliest practical time frame to the OPA. The OPA is also being asked to recommend options for cost-effective measures to reduce air emissions from coal-fired generation.

The government will continue with the plan announced in its 2006 Budget to establish a bio-energy research facility associated with the Atikokan station.

The government has also accepted the advice of the OPA that natural gas should only be used to meet peak demand in highefficiency applications and to meet local reliability need when no alternative is available.

Since the government received the OPA recommendations in December 2005, it has consulted extensively with the public, stake-holders, the electricity industry, the IESO and the OPA itself.

The government is acting on the advice of the OPA, the agency that studies Ontario's long-term energy needs and is responsible for carrying out the government's electricity plan.

"We are taking action to secure the electricity supply Ontarians

need today and have set a balanced plan for meeting growing demand in the years ahead," Duncan said. Other features of the government's plan include:

- Planning to ensure adequate baseload electricity supply while limiting the future use of nuclear power to today's installed capacity level of 14,000 megawatts.
- Directing OPG to begin a federal approvals process, including an environmental assessment, for new units at an existing facility. Although the government prefers to use Canadian companies and technology, its first obligation is to the people of Ontario. Decisions will be made based on the best technology offered at the best price that limits the risk for Ontario ratepayers.
- Directing OPG to begin a feasibility study on refurbishing its existing nuclear facilities that will include a review of the economic, technological and environmental aspects of refurbishment. As part of this initiative, OPG will begin an environmental assessment on the refurbishment of the four existing units at Pickering B.
- Doubling the amount of electricity drawn from renewable sources, bringing the total to 15,700 megawatts by 2025.
- Doubling the conservation efforts suggested in the OPA's report, to reduce electricity demand by 6,300 megawatts by 2025.
- Expanding the transmission capacity from the Bruce Peninsula to facilitate the transmission of electricity from several new wind farms and the Bruce facility to Ontario homes and businesses.

"We remain committed to replacing coal-fired generation in Ontario," Duncan said. "We have made significant progress in reducing greenhouse gas emissions and ensuring cleaner air to improve the standard of living and quality of life for all Ontarians."

In setting out a balanced plan for ensuring Ontario's energy needs now and into the future, the government considered the advice of the OPA, and was guided by a number of core principles:

- Ensuring reliability of energy in Ontario over the long term
- Ensuring stable energy prices for Ontarians
- Supporting Ontario businesses and creating a climate for future investment
- Increasing the use of green, renewable energy
- Integrating greater energy efficiency through conservation into Ontario's long-term energy planning

• A commitment to replacing coal-fired generation

The government is confident the directive to the OPA meets both the core principles and the long-term energy requirements of the province to enhance the standard of living and the quality of life for all Ontarians. The directive is the basis of the Integrated Power System Plan. This 20-year plan, revised every three years, will be submitted to the independent Ontario Energy Board for review and approval.

"We are building a new energy future for Ontario," Duncan said. "Our vision is of an Ontario with a safe, clean, reliable and affordable supply of electricity that will power our communities, our businesses and our homes. It is a balanced approach to power the continued growth and prosperity of our province."

# CNSC issues draft rules for refurbishment

In mid May 2006, the Canadian Nuclear Safety Commission issued Draft Regulatory guide G-360 on "*Life Extension of Nuclear Power Plants*". The draft is available in English or French on the CNSC website: www.nuclearsafety.gc.ca. Comments are requested by July 21, 2006.

When issued in final form the guide will define the steps and phases that must be considered when undertaking a project to extend the life of a nuclear power plant.

Following is the "backgrounder" for the draft guide as issued by the CNSC.

### Backgrounder

### Draft Regulatory Document G-360 "Life Extension of Nuclear Power Plants"

Most of the existing nuclear fleet in Canada has reached the point where individual licensees need to make a decision whether to extend the operating life of their facility. If they elect to proceed with life extension, they will need to develop and implement a life extension project.

Towards this end, the Canadian Nuclear Safety Commission (CNSC) oversees the activities undertaken by the licensee in the life extension project for the facility.

As such, the CNSC is currently updating its approach to regulatory oversight of life extension of nuclear power plants. A new draft regulatory guide, *"Life Extension of Nuclear Power Plants"* forms the basis for our regulatory approach. It is based on the requirements of the Nuclear Safety and Control Act (NSCA) and their associated regulations. The CNSC welcomes public comment on this regulatory guide.

Refurbishment is nothing new and closely relates to ongoing maintenance. The difference is one of scale. General maintenance of a nuclear power plant becomes life extension when the licensee decides to replace or refurbish major components or make substantial modifications to the plant with the aim of extending the safe operating life of the plant. The licensee may decide to implement a life extension project based on what is needed to keep the plant in safe operation beyond the originally planned life of the plant. In keeping with the objectives of the NSCA, the CNSC is mandated to ensure that facility operation continues to pose no unreasonable risk to health, safety, security or the environment, and will conform to Canada's international obligations.

The CNSC expects the licensee to demonstrate that the following objectives are met for any life extension project:

- 1. The technical scope of the project is adequately determined through a Safety Improvement Plan that takes into account the results of an Environmental Assessment (EA) and an Integrated Safety Review (ISR);
- 2. The programs and processes that take into account the special consideration of the project are established; and
- 3. The project is appropriately planned and executed.

The length of time it takes for a life extension project is dependent on a number of factors including the duration of an environmental assessment (EA) that may be required, completeness and quality of the information submitted with respect to each phase of the life extension project, and the complexity of the outstanding safety issues.

In accordance with the CEAA, the life extension project may be subject to an EA. Where an EA is required, a decision must be made that the project will not have significant adverse environmental effects is needed prior to any licensing action being taken under the NSCA.

As the responsible authority for the conduct of the EA process, the CNSC is responsible for determining whether an EA is required, and ensuring that the process is carried out appropriately.

An EA is required if:

- 1. The proposed life extension work is a project as defined in the CEAA; and
- 2. The life extension project requires a decision under the NSCA; and
- 3. The project does not meet the requirements of the CEAA Exclusion List Regulations.

In a nutshell, there are nine steps in the CNSC life extension regulatory process:

- a. The licensee submits a letter of intent and project description to the CNSC;
- b. The CNSC determines if an EA is required:
  - i. If yes, conduct the EA to proceed, the EA must have a positive outcome;
  - ii. If no, proceed to step c;

(The EA Guidelines and EA Screening Report must be approved by the Commission of the CNSC in the context of closed or public hearings);

- c. The licensee performs the Integrated Safety Review (ISR);
- d. Based on the ISR and the EA, the licensee develops a Safety Improvement Plan;
- e. The CNSC amends the operating licence (the process to be followed will depend on the nature of the amendment);
- f. The licensee develops a Project Execution Plan, Programs

and Processes;

- g. The licensee completes Design and Construction and submits completion assurances to the CNSC;
- h. The licensee completes Commissioning Phases and submits completion assurances to the CNSC; and
- i. The licensee conducts the Return to Service process and conducts the follow-up activities under oversight and approval from the CNSC.

### Public Involvement

There may be opportunities for public involvement as part of the EA process, should an EA be conducted as part of the specific project. The CNSC will make case-by-case decisions on the hearing process for life extension projects depending on the nature of the licence amendment. However, it is highly likely that life extension applications will be considered in the context of public hearings of the Commission, in which case the public will be invited to intervene.

The CNSC invites interested persons to assist in the further development of this draft regulatory document by commenting in writing on the documents content and potential usefulness. Please respond by July 21, 2006 (hotlink to Info Bulletin 1-8-8-360).

For more information on the CNSC and the regulatory guide "Life Extension of Nuclear Power Plants", please visit the CNSC Web site at www.nuclearsafety.gc.ca.

### Government funds Chalk River "legacy" cleanup

On June 2, 2006, at the Chalk River Laboratories of Atomic Energy of Canada Limited, the Minister of Natural Resources Canada, Gary Lunn, announced funding of \$520 million over the next five years to enable AECL to begin cleanup of "nuclear legacy liabilities" at CRL resulting from research and development activities that date back to the beginning of the Canadian nuclear program.

Decommissioning and waste management obligations on AECL managed sites have arisen from a wide variety of sources. These include: federal government facilities used during the "Cold War", before AECL was incorporated in 1952; wastes received for safe storage from universities, medical facilities, government and industry from across Canada; wastes from production of medical isotopes, and wastes from research and development (R&D) programs in support of Canada's nuclear industry.

As a nuclear operator, AECL must also decommission facilities at the end of their operating life in accordance with the plans filed with the Canadian Nuclear Safety Commission (CNSC). Decommissioning these facilities will involve safely dismantling the facility and processing any radioactive material for appropriate disposal. AECL managed facilities include the Nuclear Laboratories in Chalk River, Ontario and the Whiteshell Laboratories in Pinawa, Manitoba, as well as three prototype reactors located in Quebec and Ontario.

The major projects identified in the plan include:

· Acceleration of the decommissioning of obsolete buildings at

Chalk River and Whiteshell laboratories

- the design and construction of a new ground water treatment facility
- environmental restoration of contaminated lands on AECL managed sites
- construction of new facilities to permit waste processing, storage and long-term management.

The Government of Canada's obligations for decommissioning and waste costs are recorded as a long-term liability on AECI's balance sheet. The amount of this liability is based on the discounted value of the estimated future decommissioning and waste management costs (using present value techniques).

Due to the accelerated timing of the program and the need to build and operate facilities for decommissioning and waste management, and the adoption of best practices, the estimated liability has increased to \$2,750 million in discounted dollars compared to the previous amount of \$431 million. In 2005, AECL restated its liability to reflect the use of new Canadian Institute of Chartered Accountant recommendations on asset retirement obligations.

Natural Resources Canada will oversee management of the decommissioning funds and project execution, which will be conducted by AECI's newly formed Liability Management Unit, an independent business unit distinct from its nuclear laboratories and commercial operations.

### **AECL to retube Wolsong 1**

On June 7, 2006 Atomic Energy of Canada Limited announced that it has been awarded a major contract by Korea Hydro & Nuclear Power Co., Ltd. (KHNP) for the retubing of the Wolsong 1 CANDU 6 nuclear reactor. Terms of the contract include a fixed price and 55-month schedule.

This marks AECI's first international retubing project and the third major contract awarded to the company in the past 10 months. Previously announced contracts include the refurbishment project at the Point Lepreau CANDU plant in New Brunswick and the retubing of the Bruce A Unit 1 & 2 reactors for Bruce Power in Kincardine, Ontario. The combined value of the three contracts amount to more than \$1.5 billion.

AECL President and CEO Robert Van Adel commented that retubing essentially delivers a new power plant for half the price of building a new station and enables it to continue generating electricity for many more years.

The Wolsong 1 CANDU unit went into operation in 1982 and has achieved a lifetime capacity factor of 85.6 per cent. There are three other CANDU 6 plants owned and operated by KHNP at the Wolsong site in southern Korea all built in the mid 1990s.

AECL officials stated that this contract would lead to the hiring of additional personnel while acknowledging that the Canadian nuclear industry is facing shortages in qualified personnel. In the last 10 months, AECL has hired more than 900 new employees.

### New "Support Centre" at Bruce



On May 11, 2006 Bruce Power celebrated its fifth anniversary by officially opening its new **Support Centre** building. With room for more than 1,100 people, the 400,000 square-foot state-of-the-art office building will house nearly a third of all Bruce Power employees. *Photo courtesy of Bruce Power* 

### **Bill Garland appointed Executive Director of UNENE**



Dr. Bill Garland, of McMaster University has been appointed Executive Director of the University Network for Excellence in Nuclear Engineering (UNENE). In this full-time role, Bill has responsibility for advancing UNENE's programs of research and education. Bill had been the part-time Secretary-Treasurer and Program Director for UNENE, on top of

his role as professor of nuclear engineering at McMaster.

He did his undergraduate and graduate studies at McMaster, obtaining his Ph.D. in chemical engineering in 1975. From 1975 to 1983, he worked at Atomic Energy of Canada Limited specializing in CANDU heat transport system analysis and design. Since then he has been at McMaster in the Department of Engineering Physics. He served as Department Chair from 1988 to 1994 and was Director of the McMaster Nuclear Reactor from 1994 to 1995 leading up to the decision to revitalize reactor operations. Subsequent to that he took a lead role in MNR safety analysis and operational support analysis.

He will continue to hold the position of professor at

McMaster and will, at least initially, continue to work from his office there.

The University Network of Excellence in Nuclear Engineering (UNENE) is an alliance of universities, nuclear power utilities, research and regulatory agencies for the support and development of nuclear education, research and development capability in Canadian universities. UNENE was established as a not-for-profit corporation in July 2002.

The founding president of UNENE, Mohan Mathur, retired in April 2006. The UNENE Board of Directors decided to create the postion of Executive Director which combines the previous one of president and Garland's previous roles as Secretary / Treasurer and Program Director.

On his appointment Garland noted that five of the six NSERC-UNENE Senior Industrial Research Chairs IRC- professorships) are now in place. As the new professors are getting settled in, they have already recruited 10 Post Doctoral Fellows/Research Associates, 10 Ph.D. students and 16 Masters students (M. Sc./ M.E. Sc./M.A.Sc) who are pursuing nuclear studies and research. The IRC Program has already attracted slightly in excess of \$5M from NSERC, matching an equivalent investment made by UNENE on behalf of the nuclear industry. With each new senior faculty appointment, except one, there is a provision to add an Associate Chair, two of these have already joined and the search for the remaining one is underway.

The Master of Engineering (M. Eng.) Program in nuclear engineering, being initially jointly offered by McMaster, Waterloo and Western and plans for Queen's, Toronto and UOIT joining in shortly, has been approved and accredited by Ontario Council of Graduate Studies (OCGS). Currently 30 students are active in this course-based M.Eng. Program and 14 have graduated. This program is ideally suited for current and newly recruited employees. At present most of the registered students are from OPG. Applicants from other nuclear industries are needed to sustain the program.

### CNSC holds hearings on CRL, Lepreau, Bruce

### **Chalk River Laboratories**

On April 26, 2006, the Canadian Nuclear Safety Commission (CNSC) held the first of its normal two-day hearing on the application from Atomic Energy of Canada Limited (AECL) for "the renewal of the operating licence for the nuclear research and test establishment located at the Chalk River Laboratories". The second day is scheduled for June 28, 2006.

Brain Magee, the relatively new Vice-President, Nuclear Laboratories at AECL, led the AECL presentation. He pointed out the uniqueness of the site in that AECL is operating [licensed] facilities, building new ones and decommissioning others, all at the same time. He outlined the progress that had been made in most operational activities.

CNSC staff reported that in four of their six categories for evaluation CRL met requirements. The two that did not are: performance assurance and environmental performance. Nevertheless, noting the trend for improvement, CNSC staff recommended renewing the licence until October 2011.

Following the commission's normal practice, the first day was devoted entirely to presentations by the applicant and CNSC staff. The second day will hear from interveners.

### **Point Lepreau NGS**

On May 18, 2006, the CNSC held the second day of its twoday hearing on the application from New Brunswick Power for a five-year extension of its Operating Licence for the Point Lepreau generating station, including the proposed retubing. The Commission had heard detailed reports from NB Power and CNSC staff at the first day of the hearing, February 16, 2006. This second day was primarily for intervenors. To that end a video hook-up was made to the Delta Hotel in Saint John where a number of intervenors had gathered.

Prior to opening the hearing to intervenors the Commission heard updates from both NB Power representatives and CNSC staff. NB Power provided further information on its public information program and details on the amount of overtime its staff had been working (which Commissioners had questioned). In addition further [classified] security information was submitted (but not made public).

CNSC staff reiterated the recommendation for a five-year extension of the Operating Licence, included the proposed retubing, with a few additional conditions. They also recommended NB Power's request to delay the scheduled leak-rate of the reactor building test, currently scheduled for 2007, until 2009 after the refurbishment is completed.

The intervenors were both supportive and critical of the proposed licence renewal. Greenpeace (as may be expected) complained about CNSC's lack of regulations for life-extension and claimed that CNSC staff were helping NB Power to "minimize its regulatory risk". The Greenpeace submission also argued that there would be health impacts due to the larger radiation dose that would be received during refurbishment.

At the time of writing the CNSC had not issued its decision.

### Bruce refurbishment EA

The day after the Point Lepreau hearing the CNSC held a oneday hearing to consider the Environmental Assessment "Screening Report" for the refurbishment of Bruce units 1 and 2.

CNSC staff had submitted a 109 page "Screening Report on an Environmental assessment of the Bruce A Refurbishment for Life Extension and Continued Operation Project, Bruce A Nuclear Generating Station , Kincardine, Ontario. This was bundled together with: the 19 page "Environmental Assessment Guidelines" (issued in July 2005; a 108 page "Dispositioning of Technical Review comments on Draft EA Study Report"; a 42 page "Compendium of Federal Authorities' Technical Review comments"; a 56 compendium of "Public and federal Authorities' comments Received on Draft Screening Report"; and a 43 page Dispositioning [of those comments].

CSC staff recommended the approval of the EA Screening Report.

# AECL signs MOU with Argentine organizations

In late May 2006 Atomic Energy of Canada Limited (AECL) signed a Memorandum of Understanding (MOU) with two Argentine organizations, Nucleoeléctrica Argentina S.A. (NASA) and Comisión Nacional de Energía Atómica (CNEA), for an expanded scope of nuclear co-operation.

It is anticipated that the MOU will lead to increased trade and commercial business for the Canadian nuclear industry in South America. Argentina's nuclear power program is centred on heavy water reactors, including Embalse, which is an AECL CANDU 6 reactor that began operating in 1984, and has a lifetime capacity factor of 85 per cent.

In addition, Argentina has significant heavy water reactor infrastructure including R&D facilities, heavy water production, fuel manufacture, and supply of certain plant components.

The MOU specifies a number of nuclear-related projects on which AECL, NASA and CNEA will collaborate. These include

developing a program of refurbishment of the very successful Embalse CANDU 6 power reactor and collaboration to advance the development in Argentina of nuclear energy generation and supporting facilities, including dry spent fuel storage, CANDU fuel cycle design and heavy water supply.

Furthermore, AECL, NASA and CNEA will jointly develop a feasibility study to build a new CANDU reactor in Argentina with the intent of recommending to the Argentinean government the construction of the fourth nuclear power plant.

### **Problems at Cigar Lake**

A water inflow problem in the second shaft at Cameco Corporation's Cigar Lake mine in northern Saskatchewan could delay commencement of production by six months until late 2007.

The second shaft will be primarily used for underground ventilation during production.

A water inflow began April 5, 2006 at the bottom of the 6metre wide shaft, 392 metres below the surface. All the workers safely left the area and removed equipment. There was no impact on the environment. There is no access between this shaft and the underground development and this event will not impact existing underground development in any way.

After evaluating the situation, Cameco decided today to allow water to fill to natural levels in the second shaft. This was determined to be the most prudent choice since it allowed more remediation options.

The incident began when a worker noticed a leak in a valve that was preventing water from coming up a drill hole. These drill holes are routinely used to test for the presence of ground water and to grout off any water inflows. In the process of tightening, the valve broke, allowing water to enter the bottom of the shaft.

Cameco is reviewing potential methods to deal with the current situation. The company had already been considering the possibility of freezing the area around the bottom of the shaft to deal with the difficult ground conditions. Cameco will be able to provide a timetable for the remediation process after the plans have been finalized. The water will not damage the concrete-lined shaft.

Prior to the announcement today, Cameco was in the process of reviewing the capital costs of the Cigar Lake project. The results of the capital cost review and the costs for dealing with the delays caused by the water inflow incident are expected to increase the current estimate of \$520 million by 10% to 20%.

### Hawthorne visits B & W

Duncan Hawthorne, CEO of Bruce Power, made a special visit to Babcock & Wilcox Canada in Cambridge, Ontario on the morning of April 4, 2006, to see the progress on the construction of replacement steam generators for Bruce units 1 and 2 already underway and to give "pep talks" to the B & W staff.

The morning began with a short presentation by B & W officials, to Hawthorne and the local dignitaries invited, on the history of the company and its experience in building steam generators for nuclear plants. To date B & W Canada has built



Duncan Hawthorne talks with a tube welder in the "clean room" of the Babcock & Wilcox Canada shop during a tour April 4, 2006.

289 nuclear steam generators, 247 for CANDU units and 42 as replacement units for PWR plants in the USA.

Then followed a tour of the plant, which has two main sections, the "drum shop" where the outer shells are shaped and welded, and the "clean room" where the tubing is installed. Both are large, the "drum shop" is 90,000 square feet and the "clean room" almost as large.

During the tour Hawthorne stopped several times to speak to small groups of workers because the background noise prevented more than about a dozen clustered near him to hear his words of encouragement. His basic message was that they were all important parts of the huge task of refurbishing the Bruce units, which will put almost 2,000 MW back into Ontario's electricity system.

The group then assembled under a large tent, where many of the office staff joined, for a presentation of a plaque to Hawthorne. He responded with a short talk, beginning by noting that "nuclear" still has an "identity crisis". He emphasized the importance of the Bruce refurbishment and stated that "we all stand or fall together". It is possibly the most complicated engineering task in North America, he suggested. He said he had confidence that the capability of the Canadian nuclear industry would be rebuilt.

### "Team CANDU" formed

In March 2006 five nuclear technology and engineering companies announced the signing of a four-year agreement to work together as Team CANDU to present a turn-key service and competitive solution for building new nuclear power plants in Ontario.

Members of Team CANDU are:

- Atomic Energy of Canada Limited (AECL)
- Babcock & Wilcox Canada (B&W)

- General Electric Canada (GEC)
- Hitachi Canada Ltd. (HCL), and,
- SNC Lavalin Nuclear Inc. (SLN).

The five organizations stated that they would deliver a business model for Ontario that they have successfully deployed in other markets around the world over the past decade. Each of the partners will take on its share of project risk to deliver new CANDU power plants on a turnkey, fixed price basis. In this case, the traditional project risk is transferred from the owner/ utility to the project team members. The members point to their experience with the Qinshan project in China to illustrate their ability to ensure delivery on time, on budget.

### Two AECL alumni win US physics prize

Two physicists, **John Hardy** and **Ian Tower**, who had each spent 27 years at the Chalk River Laboratories of Atomic Energy of Canada Limited were jointly awarded the Tom W.Donner Prize in Nuclear Physics for 2006 at a recent meeting of the American Physical Society.

The Citation read:

"In recognition of their ultra-high precision measurements and extraordinarily detailed analyses of  $0+ \rightarrow 0+$  nuclear beta decay rates to explore the unitarity



John Hardy

of the Cabibbo-Kobayashi-Maskawa quark mixing matrix as a test of the electroweak Standard Model."

John Hardy joined CRL in 1970 after spending post-doctoral periods at Oxford and Lawrence Radiation Laboratory of the



lan Towner

in 1981. Ian Tower also joined CRL in 1970 after working at the Nuclear Physics Laboratory of the University of Oxford. At CRL he was a member of the former Theoretical Physics Branch which was also dismantled in 1997. He is now an adjunct professor at Queen's University.

### CNA elects 2006-2007 Executive Committee



The Canadian Nuclear Association held its Annual General Meeting, June 12, 2006, in conjunction with the CNS Annual Conference. Shown is the Executive Committee elected for 2006 – 2007.

University of California. He rose to

be director of the Tandem Acclerator

Superconducting Cyclotron (TASCC)

facility, which was shutdown in

1997. He moved to Texas A & M

University where he is now a profes-

sor and Group Leader at the Cyclotron

Institue. He is a Fellow of the Royal Society of Canada and the American Physical Society. He was awarded the

Herzberg medal from the Canadian

Association of Physicists in 1976 and

the Rutherford medal from the RSC

L to R. Pierre Charlebois, 2nd Vice Chair; Allan Kupcis, Past Chair; Rich Reimels, Chair, Finance Committee; Duncan Hawthorne, Chairman of the Board; Murray Elston, President & CEO, CNA; Lloyd Jones, Regulatory Advisory Committee; Ken Petrunik (for Robert Van Adel). Absent: Robert Van Adel, Gerald Grandey, Grant Malkoske.

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# **CNS news**

### CNS Annual General Meeting - Dan Meneley installed as president for 2006 -2007

The ninth Annual General Meeting since the incorporation of the Canadian Nuclear Society Inc. was held June 12, 2006 in Toronto, during the 27th CNS Annual Conference with about 80 members in attendance.

Formally this meeting covered the calendar year 2005 which is the fiscal period for the Society although the term of office for the executive and members of council runs from AGM to AGM, typically June to June.

After welcoming those present, outgoing president John Luxat gave a brief review of his year in office.

Then followed succinct reports on the activities of the various divisions and committees that make up the structure of the Council. Some of these, or excerpts, are reprinted in this issue.

Jim Harvie presented his Treasurer's report for calendar year 2005. He reported a surplus of over \$196 K in 2005 but warned that the Society's income is very variable from year to year because of the different number of conference and courses, which are the primary source of income. (A copy of the Treasurer's Report, together with the Auditor's Report and Financial Statements, is enclosed with this issue of the CNS Bulletin for members.)

Following the various reports Past President Bill Schneider presented the proposed slate of officers and members of Council for the 2006 – 2007 year. There being no nominations from the floor this slate was declared elected by acclamation. (*See below*)

John Luxat then handed the symbolic gavel (which is hardly ever used in actual meetings) to incoming president Dan Meneley who spoke briefly of his goals for the coming year. He then, in turn, presented John Luxat with a plaque to commemorate his service as president for the 2005 – 2006 period.

(Both John Luxat's review and Dan Meneley's outlook remarks are reprinted below.)

### Remarks of incoming president Dan Meneley:

*Ed. Note:* The following is a slightly edited version of the notes used by Dan Meneley for his remarks as incoming president at the 9th AGM of the Canadian nuclear society Inc. held in Toronto, June 13, 2006

I offer my heartfelt thanks to the outgoing President and Council, and to the many volunteers who have helped make this year a great success. Most notable are Ben Rouben and Ken Smith, who really keep the wheels rolling. Also my thanks to CNS staff, especially Denise Rouben.

My central message is: The CNS is your society. It is governed by its members. If you tell us what you want, we will try to do it. It is also governed by its Branches. Local branch organizations represent the real philosophical centre of this community.

Please note that your Council is made up of volunteers. We ask

you to inform us when we need to be told; to assist us whenever you can; to disagree vocally with us when necessary; and to request assistance when it is needed.

Above all, this is a professional society. Our members carry a moral and ethical obligation to communicate the truth to the public. Professional Engineers have a legal obligation as well. The essence of my message to you is that when we communicate with the Canadian public we must tell "the truth, the whole truth, and nothing but the truth". Positive is good – but truth is better.

Now, I wish to recognize the new Executive of the Society, especially Eric Williams (1st vice-president) and Bob Hemmings (2nd vice-president) and our new secretary, Prabhu Kundurpi.

We have heard much recently about the ongoing "Nuclear Renaissance". I understand that in order to be reborn, a creature must first become dead. However, nuclear energy never died, and so cannot experience a renaissance. Let us call it a "resurgence" instead. In any case, it feels very good. There is plenty of work to do, and we have the skills to get it done.

In order of importance, I see our future work as including Operations, Refurbishment, New Builds, Fuel Cycle, and Energy Security. Engineering and Science will, of course, continue to underlie everything that we do.

To ensure that the communication lines are open, I invite each of you present, indeed all members of the society, to send your ideas and comments directly to me, via e-mail, at meneleyd@aecl.ca. I promise to answer each message and to take action within the scope and abilities of your Council.

Thank you for coming to this Annual General Meeting.



John Luxat(R) CNS president for 2005 – 2006 passes the traditional gavel to Dan Meneley, elected president for 2006 - 2007 at the 9th Annual General Meeting of CNS Inc. held in Toronto, June 13, 2006

### **CNS** Council for 2006 - 2007

### Officers

President	D.A. (Da	an) Meneley	Retired (formerly AECL)		
1st Vice-President	E.L. (Eri	c) Williams	Bruce Po	ower	
2nd Vice-President	R.L. (Bo	b) Hemmings	Retired (	formerly Canatom)	
Treasurer	Harvie	Retired (	formerly CNSC)		
Secretary	P.(Prab	hu) Kundurpi	Consulta	nt (formerly OPG)	
Past President	J.C. (Jo	hn) Luxat	McMast	er University	
Members at Large:		E.M. (Do	rin) Nichita	UOIT	
N. (Neil) Alexander	Consultant	J.(Jad)	Popovic	AECL	

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Consultant N. (Neil) Alexander G. (Glenn) Archinoff Candesco C. (Charles) Gordon Nuclear Safety Solutions E.M. (Ed) Hinchley Retired D.P. (Dave) Jackson V.S. (Krish) Krishnan AECL S.Y. (Andrew) Lee Retired

K. (Kris) Mohan

Murray Elston

(formerly AECL) McMaster University

(formerly OPG) Consultant

B. (Ben) Rouben Wm. (Bill) Schneider R. (Roman) Sejnoha K.L. (Ken) Smith M.J. (Murray) Stewart J.J. (Jeremy) Whitlock S.M.H. (Syed) Zaidi

AECL AECL Retired (formerly B&W) Retired (formerly AECL) UNECAN Energy Council of Canada AECL Retired (formerly NB Power)

### **Ex-officio Voting Member:**

President, Canadian Nuclear Association

### **Ex-officio Non-voting Members:**

Division, Committee, and Branch Chairs who are not elected members of Council



This jazz group entertained before and during the Awards Dinner at the 27th CNS Annual Conference.

Immediately before the CNS 2006 Annual Conference in Toronto the Society hosted a meeting of the Pacific Nuclear Council (PNC) all day, Sunday, June 11, 2006.

PNC is one of two international groupings of nuclear organizations to which the CNS belongs. Its members are national nuclear professional societies or trade associations in countries around the Pacific Rim. The other is the International Nuclear Societies Council focussed primarily on Europe.

The objectives of the PNC are:

- Promote the sharing of the peaceful uses of nuclear technologies among members
- Identify nuclear-related topics of interest warranting consideration by the PNC members. Topics to be pursued will reflect the particular interests and concerns of the PNC members.
- Provide a strong voice as an internationally recognized, regional, non-government organization (NGO) at important regional and international forums
- Conduct studies on topics and issues of importance to the members, by specific workshops and working groups; take action within the authority of the Council to publicize, promote and implement results of the studies.
- Promote safe and environmentally sound nuclear technologies to serve the energy and other needs of the region.
- Cooperate actively with other regional and international organizations in the sharing of the peaceful applications of nuclear technologies.
- Sanction periodic Pacific Basin Nuclear Conferences that are sponsored by Professional Association members and that are normally held in a Council member country every two years.

**Paul Fehrenbach**, a vice-president at Atomic Energy of Canada Limited, who has been the president of the PNC since the spring of 2004, chaired the meeting. His tenure will end at the Pacific Basin Nuclear Conference (PBNC) to be held in Sydney, Australia this October. At that time current vice-president, **Clarence Hardy** of Australia, will be installed as president for the following two years.

Hardy is also the chairman of the 2006 PBNC conference.

The large international PBNC meetings are authorized by the PNC but run by national organizations who bid for the right. They are held every two years, with the next one to be held in Aomori City, northern Japan in October 2008, sponsored by the Japan Atomic Industrial Forum and the Japan Nuclear Society. The last time the PBNC was held in Canada was in 1998 at Banff, Alberta.

The Toronto meeting followed the usual pattern of progress reports of working groups, reports on relations with organizations such as the International Atomic Energy Agency (with whom PNC has NGO status) and discussion of interesting and related programs. Paul Fehrenbach reported on meetings with the IAEA and his intention to attend its General Conference in September.

**David McInnes**, vice-president corporate relations at MDS Nordion, gave a presentation on an initiative of the IAEA , Program of Action for Cancer Therapy, with the objective of improving the facilities for treatment of cancer by radiation in developing countries. As the major producer of Cobalt 60 therapy machines in the world McInnes said that MDS Nordion has given a unit for the program. However, to make the program effective significant contributions will be needed from IAEA member countries.

**Shami Dua**, chairman of the Working Group on Codes and Standards, provided a progress report on the extensive work his group has been doing towards harmonization of nuclear codes and standards in the member countries.

One of the business items was the formal acceptance of the vote for the incoming vice-president / president elect, **Chang-Sun Kang** of the Korea Atomic Industrial Forum.

That evening the overseas delegates to the PNC meeting joined with members of the CNS Council and the Board of directors of the Canadian Nuclear Association at the CNS / CNA dinner which has traditionally been held during the Annual Conference.

For further information on the PNC go to its website: www.pnc.org.



PNC president Paul Fehrenbach (centre) is seen chairing the PNC meeting held in Toronto, June 11, 2006, flanked by Mike Diekman (L), executive director, and Clarence Hardy, vice-president (R).

### **Education and Communication Committee**

One of the very active committees of the Society is the one on Education and Communication, co-chaired by Bryan White and Jeremy Whitlock. The following is extracted from their report to the CNS Annual General Meeting, held June 13, 2006, during the CNS Annual Conference.

Through their efforts the CNS provided financial support to three organizations:

- the Deep River Science Academy (which won an award for its work over the years)
- the group Scientists in School, and,
- Visions of Science Network for Learning which promotes interest in science, engineering and technology among black youth in the Greater Toronto Area

The Committee is going to host a booth at the Annual Conference of the Science Teachers Association of Ontario to be held in Toronto November 16 –1 8, 2006 and are looking for volunteers to help. (Contact Bryan White, e-mail: bwhite\_cns@sympatico.ca.

The Committee conducted the selection of the CNS bursary award for a young professional who has been accepted to attend the World Nuclear University summer session. This year's winner is Dominic Rivard of Hydro Quebec.

Following a request for expressions of interest the Committee has garnered almost 50 names of members who are willing to speak to groups about nuclear energy. The specific means of administering this program is being studied.

Through the efforts of the Committee an Historical Plaque will be erected at the Bruce Visitors Centre to commemorate the start-up of the Douglas Point station in the fall of 1966. The ceremony is now scheduled for September 25.

### "Badge-Draw" Winners at CNS 2006 Annual Conference

At the end of the 27th Annual CNS Conference and the 30th CNS-CNA Student Conference, on June 14, 2006, 7 prizes were awarded from among badges returned by Conference attendees. The lucky badges were drawn at random by Denise Rouben, CNS Office Manager.

The winners:

- Michael Gabbani (of GE Canada) and Keith Scott (of Atlantic Nuclear Services) each won a CNS silk tie.
- Professor Chang-Sun Kang (of Seoul National University) and Nicholas McKinley (of UOIT) each won a CNS sweatshirt.
- Arnold Yuan (of University of Waterloo) won a CNS golf shirt.
- K Khumsa-Ang (of the University of New Brunswick) and Liqun Sun (of New Brunswick Power Nuclear) each won a free CNS membership, good to the end of 2007.

Congratulations to all the winners!

# Gagnants de prix au tirage des porte-insigne à la Conférence annuelle 2006 de la SNC

À la fin de la 27ième Conférence annuelle de la SNC et de la 30ième Conférence étudiante SNC-ANC, le 14 juin 2006, 7 prix ont été tirés au sort parmi les porte-insigne retournés par les participants à la conférence. Le tirage au sort a été effectué par Denise Rouben, Directrice du bureau de la SNC.

Voici les gagnants des prix:

- Michael Gabbani (de GE Canada) et Keith Scott (d'Atlantic Nuclear Services) ont chacun gagné une cravate en soie de la SNC.
- Le Professeur Chang-Sun Kang (de l'Université de Séoul) et Nicholas McKinley (de UOIT) ont chacun gagné un chandail de sport de la SNC.
- Arnold Yuan (de l'Université de Waterloo) a gagné une chemise de golf de la SNC.
- K Khumsa-Ang (de l'Université du Nouveau Brunswick) et Liqun Sun (de New Brunswick Power Nuclear) ont chacun gagné une adhésion gratuite à la SNC jusqu'en décembre 2007.

Félicitations à tous les gagnants!

### "Badge-Draw" Winners at the 2006 CNS Reactor Safety Course

At the end of the spring CNS CANDU Reactor Safety Course, on May 19, 2006, 4 prizes were awarded by random draw from among badges returned by Course attendees.

The winners:

- Lixuan Lu, of UOIT, won a copy of the book "Bluebells and Nuclear Energy" a CNS sweatshirt
- Phil Foster, of AECL, won a CNS tie
- Craig Gracie, of Bruce Power, won a CNS sweatshirt
- Susan Yatabe, of AECL, won a complimentary CNS membership for one year

Congratulations to all the winners!

### Gagnants de prix au tirage des porte-insigne au cours 2006 de la SNC sur la sûreté des réacteurs

À la fin du cours du printemps sur la sûreté des réacteurs, le 19 mai 2006, 4 prix ont été tirés au sort parmi les porte-insigne retournés par les participants au cours.

Voici les gagnants des prix:

- Lixuan Lu, de l'UOIT, a gagné une copie du livre "Bluebells and Nuclear Energy"
- Phil Foster, de l'EACL, a gagné une cravate de la SNC
- Craig Gracie, de Bruce Power, a gagné un chandail de sport de la SNC
- Susan Yatabe, de l'EACL, a gagné une adhésion gratuite d'un an à la SNC

Félicitations à tous les gagnants!

### "Badge-Draw" Winners at CWESI-2 2006

At the end of the 2nd Canadian Workshop on Engineering Structural Integrity, on Aril 4, 2006, 3 prizes were awarded by random draw from among badges returned by Conference attendees.

The winners:

- Ming Li, of OPG, won a CNS sweatshirt
- Michael Kozluk, of AECL, won a CNS tie
- David McNabb, of NSS, won a copy of the book "Bluebells and Nuclear Energy"

Congratulations to all the winners!

# Gagnants de prix au tirage des porte-insigne à la Conférence sur l'intégrité structurale

À la fin de la 2ième Conférence canadienne sur l'intégrité structurale, le 4 avril 2006, 3 prix ont été tirés au sort parmi les porte-insigne retournés par les participants à la conférence.

Voici les gagnants des prix:

- Ming Li, d'OPG, a gagné un chandail de sport de la SNC
- Michael Kozluk, de l'EACL, a gagné une cravate de la SNC
- David McNabb, de NSS, a gagné une copie du livre "Bluebells and Nuclear Energy"

Félicitations à tous les gagnants!

### Student conference winners

Following are the winners of the presentations given at the 30th CNS / CNA Student Conference, which was embedded in the 27th CNS Annual Conference held in Toronto, June 11 to 14, 2006, as reported by the Student Conference chairman David Shoesmith.

It was decided to offer prizes in two broad subject categories.

### PHYSICS / MECHANICAL AND ELECTRICAL ENGINEERING / MODELLING

A total of 15 student presentations were made in this category.

Ph.D.	Daryoosh Vashaee
M.Sc.	Michael Welland
Undergraduate	William Scott

(McMaster University) (Royal Military College) (University of Ontario, Institute of Technology)

### **CHEMISTRY / CHEMICAL ENGINEERING / CORROSION**

A total of 17 student presentations were made in this category Ph D Michael Broczkowski M.Sc. Erik Balodis Undergraduate Sarah Stewart

(University of Western Ontario) (University of Guelph) (University of Western Ontario)





Michael Welland

William Scott



Michael Broczkowski



Sarah Stewart

The following Institutions were represented

Ecole Polytechnique de Montreal Imperial College (London/UK) McMaster University Royal Military College (Kingston) University of Guelph

University of New Brunswick University of Ontario Institute of Technology University of Toronto University of Waterloo University of Western Ontario

### **Branch** activities

For many members the activities of their local CNS Branch is their primary contact with the Society. The following note on Branch activities for the 2005 – 2006 period is extracted from the report by Branch Committee Chairman, Eric Williams (who was 2nd V.P. now 1st V.P.) tabled at the CNS Annual General Meeting, held in Toronto, June 13, 2006.

### BRUCE - John Krane

Bruce Branch was pleased to host Dr. Ben Rouben, FCNS, Senior Reactor Physics Consultant, Atomic Energy Canada Limited on Wednesday April 5th 2006.

Dr. Rouben presented the Origins of Atomic and Nuclear Science and CANDU in support of the International Year of Physics. The event was well attended and Dr. Rouben answered questions and led a discussion with the audience following the presentation.

With the opening of the new Bruce Power Support Centre in May 2006, and the availability of a new 350-seat auditorium, additional presentations are planned in the 2nd half of 2006.

Chair –	John Krane
Web Master –	Michelle LaPointe
Signing Authorities –	Kevin Larson, John Roberts
Treasurer –	Eric Williams

### **CHALK RIVER** - Blair Bromley

The following sections and bullets summarize the public seminars, executive meetings, public outreach, and education activities held by the Chalk River Branch of the Canadian Nuclear Society in the period of May 2005 to May 2006.

### **Public Seminars**

Ten seminars were held in the past year. Four were in July of 2005 in conjunction with the Deep River Science Academy (DRSA). CNS members Uditha Senaratne and Marcel Heming have been instrumental in helping to set up and coordinate the seminars. The seminars were advertised in the local newspaper, on the CNS website, on AECI's company website, and on flyers posted throughout AECI's buildings, and at the public library in Deep River. Two seminars were joint ones in conjunction with the Algonquin Chapter of the Professional Engineers of Ontario. There was also a special dinner meeting held in February of 2006 with CNS President John Luxat as the guest speaker. There were plans for an eleventh seminar in May of 2006 with Peter Mason of General Electric - Canada, but unfortunately this meeting was cancelled by the guest speaker due to unplanned work demands. In addition, as a part of some of the meetings, before the guest speaker started their presentation, a 5-minute news report of various stories on what had been happening in the nuclear industry in Canada and other parts of the world were reported by CNS member Blair Bromley.

The following bullets summarize the seminars, including the date, guest speaker, and talk, in reverse chronological order.

May 5, 2006, Mr. Peter Mason, Vice President and General Manager, GE Energy, Nuclear Products, The Role of General Electric Canada in the Power Generation Industry. (CANCELLED).

April 4, 2006, Mr. Gregory Smith, Senior Vice President, Darlington Nuclear, Ontario Power Generation The Darlington Story: The Focus Areas on our Journey to Excellence

March 22, 2006, (Joint Meeting with PEO, Algonquin Chapter), Dr. Bob Andrews, Manager, Research and Development Bubble Technology Industries (BTI), An Overview of Threat Detection R&D at BTI

February 20, 2006 (Special Dinner Meeting), Dr. John Luxat, CNS President, Energy Challenges and Nuclear Opportunity.

January 26, 2006, Dr. Igor Pioro, Senior Scientist (Thermalhydraulics), AECL, Russian Nuclear Power Program (past, present, and future).

November 24, 2005 (Following Branch AGM), Thierry Joulin and Penny Neal, AECL, The World Nuclear University Summer Institute Sharing Experience.

October 24, 2005 (Joint meeting with PEO, Algonquin Chapter), Deny See Hoye, Program Manager, NRU Licensability Extension Program, AECL, In Praise of an Older Lady - Keeping NRU Young and Alive.

July 28, 2005 (Joint seminar with DRSA), Hilary McCormack, LLB, Crown Attorney for Ottawa-Carleton Science and Law - Not so Strange Bedfellows. A Look at DNA Evidence and Crime Solving

July 28, 2005 (Joint seminar with DRSA), Dr. Davis Earle, Sudbury Neutrino Observatory, Sudbury Neutrino Observatory - Observing the Sun from 2 km Underground

July 14, 2005 (Joint seminar with DRSA), Dr. Elizabeth 'Betsy' McGregor, former Fellow, Centre for Public Leadership, Kennedy School of Government, Harvard University, Science, Ethics & Governance: Who Risks? Who Benefits? Who Decides?

July 5, 2005 (Joint seminar with DRSA), Jeremy Whitlock, Reactor Physicist, AECL and Past President, Canadian Nuclear Society Splitting Atoms, Canadian Style The Annual General Meeting was held on November 24, 2005, 30 minutes before the public seminar. The following slate for the executive was acclaimed:

Chair:	Blair Bromley
Vice-Chair:	Open
Treasurer:	Marcel Heming
Program Coordinator:	Uditha Senaratne
Member-at-Large:	Bill Bournes
Member-at-Large:	Ragnar Dworschak
Member-at-Large:	Bryan White
Past-Chair:	Morgan Brown

### **Public Outreach and Education Activities**

The Chalk River Branch sponsored its 3rd Annual Essay Contest on the Applications of Nuclear Science and Technology. High school students in Renfrew County were invited to submit a 1400-2000 word essay describing one or more applications of nuclear science and technology. There were prizes for both students and mentoring teachers. The essay contest was advertised on a couple of websites, in local newspapers, and information was mailed to science teachers and principals at all the high schools in Renfrew County. Unfortunately, there were no participants this year. It would appear that competing priorities and demands for both students and teachers take a higher priority. Thus, the Chalk River Branch will need to re-evaluate the contest requirements and approaches to advertising in order to attract more participants next year.

The Chalk River Branch provided a general sponsorship of \$200 to the Renfrew County Regional Science Fair to help support their activities, plus the Chalk River Branch set up an information booth at the science fair that was held on April 1, 2006 at the Petawawa Civic Centre. There were many visitors to the booth, and our presence was well received. It would appear that information booths at public events are an effective means for communicating information to the public about nuclear energy.

CNS Members Morgan Brown and Bryan White maintain the public information bulletin boards in a high-visibility area in AECI's cafeteria at CRL, and also in AECI's J.L. Gray Engineering Centre in Deep River. The bulletin board has CNS and nuclear news, and is updated on a weekly basis by Morgan Brown.

CNS Members Blair Bromley and Ragnar Dworschak set up and manned an information table in the AECL CRL cafeteria to help advertise and promote upcoming CNS seminars, especially the special dinner meeting that was held in February, 2006.

CNS Members Jintong Li, Jeremy Whitlock, and Blair Bromley volunteered to run science demonstrations at the spring school fair ("Spring Fling") held at Morison Public School in Deep River on May 29. Jeremy Whitlock ran a demonstration of a chain reaction involving mousetraps and ping-pong balls.

### Acknowledgements

Many thanks are expressed to members Uditha Senaratne, Ragnar Dworschak, Morgan Brown, Marcel Heming, Jintong Li, Bryan White, Jeremy Whitlock, and Bill Bournes for their efforts and contributions.

### DARLINGTON - Jacques Plourde

There is not much to report, other than our continued support of initiatives that will bring 'new blood' into our industry:

- further interfacing with the students at UOIT
- support of the new NA-YGN (North American Young Generation in Nuclear) Durham branch.

### GOLDEN HORSESHOE - Dave Novog

In 2005/2006 the Golden Horseshoe branch was involved in a number of events and undergone some changes. One of the highlights for the year was the joint sponsorship of a lecture by Patrick Moore. This event was highly successful in terms of attendance as well as interest generated. The CNS Golden Horseshoe also participated in another successful Nuclear Careers night (Nov. 14, 2005), which in past years was organized by the CNS Branch but is now organized by the students themselves. Also the Branch helped organize the very well attended talk Dec 12, 2005 at McMaster given by Ken Petrunik on management of nuclear projects; it was part of a series sponsored by the Institution of Mechanical Engineers.

### MANITOBA – Jason Martino

The Manitoba Branch donated \$500 to the Deep River Science Academy, Whiteshell Campus, and wishes to do the same again this year. We are hoping that the CNS council may be able to work with smaller branches such as Manitoba to provide a list of nuclear related speakers that can be sent out to generate some interest in branch activities. We have tried some e-mail appeals to branch members for more participation on various items this year, but the response is limited.

### NEW BRUNSWICK - Mark McIntyre

### Objectives

- To provide a forum for the exchange of information between on the peaceful applications of nuclear energy, and
- To provide learning opportunities for CNS members in New Brunswick and beyond.

### Activities since the last AGM

- Lecture by Bryan Patterson, consultant with Biron Engineering on the lessons learned from the Columbia disaster. The session delivered to the Point Lepreau Technical Unit highlighted several similarities between the aerospace and nuclear industry. Included among those lessons are the need for clear communication links within an organization and the need to control production pressures and to build and maintain a strong safety culture.
- Lecture by Mark McIntyre, World Nuclear University Fellow (Fall 2005) related to his 6-week experience in Idaho Falls along with 75 other WNU Fellows from around the globe. The Point Lepreau lecture was a noontime event attended by ~50 PLGS employees. The Fredericton lecture was of particular interest to (and well attended by) UNB engineer-

ing students. (This lecture was repeated and delivered to the Sheridan Park Branch in January 2006)

- CNS NB Branch members contributed to the media blitz, which took place in NB prior to the July 29, 2005 positive Point Lepreau Refurbishment decision. Particular thanks goes to Dr. John Sutherland for his dedication to correcting wrongs in local and not-so-local media.
- NB Branch participation in the Nuclear Waste Management Organization's 2 meetings in New Brunswick in 2005.
- NB Branch member Neil Craik delivered a talk to the local Kiwanis Club of Fredericton (Spring 2006) on the topic: "The Benefits of Refurbishing the Point Lepreau Generating Station".

### **Upcoming Activities**

- George Legate, President of Nu-Tech Precision Metals will present in New Brunswick on June 27, 2006. The title of the talk is: "Pressure Tube Manufacture in the 21st Century".
- Terry Thompson, Consultant and former Asia Regional VP for AECL, will deliver a talk to the NB Branch sometime in summer 2006. Mr. Thompson will be basing his talk on his article in the March 2006 CNS Bulletin: "CANDU is not an EDSEL but it could be an Avro Arrow".

### Branch Executive Committee 2005-2006

Larisa Duffy	Ray Quan
Mark McIntyre	Rick Sancton
Bryan Patterson	

### **Overall Assessment**

There is a renewed interest in CNS activities since the PLGS Refurbishment decision. The current CNS executive will be looking to seek out new talent in assisting with branch operations.

### OTTAWA - Jim Harvie

The Ottawa Branch had four meetings during the 2005/2006 period.

At the first meeting on November 30, 2005, Don Amundrud spoke on his experiences as an inspector for the International Atomic Energy Agency in Iraq.

On February 22, 2006, CNS President John Luxat made a presentation on "Energy Challenges and Nuclear Opportunity", in which he addressed the energy situation in North America with a particular focus on security of supply.

On March 29, Bob Pollock, Vice President of Environment, Health and Safety for AREVA/COGEMA Resources Inc., discussed "Saskatchewan's Uranium Mining Industry", highlighting major projects, technical and social challenges, and principles of sustainable development.

Finally, on April 25, a presentation on "The Future of Candu" was given by David Torgerson, Senior Vice President and Chief Technology Officer of Atomic Energy of Canada Limited. This talk focused on the status of the Advanced Candu Reactor, new features of the Candu-6, and the future of the Chalk River Laboratories.

All talks were reasonably well attended and resulted in lengthy

and spirited periods of questions and discussion from the small but knowledgeable group of members of the Branch.

Since the Branch membership is currently dominated by retirees, a drive to recruit younger members is planned.

The Branch again contributed to the Ottawa Regional Science Fair, and awarded our prize to a junior girl, Basia Walczak, for her project called "Radiation Soup" which described different types of radiation.

The Executive of the Ottawa Branch currently consists of: Chair, Jim Harvie

Vice-Chair, Ted Thexton

Treasurer, Fred Boyd

Secretary, Ralph Green

Members-at-large, Dumitru Serghiuta, Mike Taylor

### **QUEBEC** – Michel Rheaume

Members of the Québec Branch have been active in 2005/2006 particularly on the media scene. Indeed, Dr. É. Varin and Mr. Michel R. Rhéaume have participated in many interviews on different networks (CBC, CTV, TVA, TQS...) related with the 20th anniversary of Chernobyl. Moreover, Mr. Michel R. Rhéaume has debated on the consequences of Chernobyl accident and the use of nuclear energy with many representatives of anti-nuclear groups at the Université du Québec à Trois-Rivières. This debate was organized by the physic and biology departments.

On September 29th, 2005, the Canadian Nuclear Society – Québec Branch produced a press release to deny the right to participate in the climate change debate. The Canadian Nuclear Society had applied to participate in the salon for Sustainable Development 2005 / Climate Change, which took place in Montreal's Complexe Desjardins, on October 25th-28th, 2005. The organizer of this salon, which describes itself as "an information clearing house as well as a platform for the exchange of ideas, development and climate change research findings", denied the Canadian Nuclear Society the right to take part in this important public information venue. Mr. Michel St-Denis was our spoke person for this important press release.

The Montréal group's participation in the COP was facilitated by the CNA and by the group headed by Lisa Stiles-Shell, President of the North American Young Generation in Nuclear (NA-YGN) and the US Nuclear Energy Institute's Manager of State Initiatives.

The US NEI, NA-YGN and CNA organised teleconferences prior to the Montreal meeting and created a collaborative spirit of all the nuclear participants.

Despite a relatively poor location in the Palais de Congres conference centre, the nuclear booth seemed to be a clear success. It was often busy with visiting delegates from various countries around the world. Some, from countries without any nuclear industry, asked questions one would expect from people shopping around for lowemissions energy sources, including nuclear, without prejudice.

The younger age profile of NA-YGN representatives who staffed the booths over the two weeks created a good "future-focussed" image of an industry all too often represented by (much) older figureheads. The standard of the engagement of the booth staffers with delegates was very high. They were often able to refer to their own experiences working on a nuclear plant.

Participants from AECIs Montréal Office included Gilles Sabourin, Michel Saint-Denis, Luke McSweeney, Pascal Hernu and Jaro Franta. The group was satisfied that the event was successful, especially regarding people amongst the general public who visited the second booth at the Complexe Guy Favreau (which was open to the public, while the Palais des Congrès was strictly for delegations and authorized organisations). We received very interesting questions both from people for and against nuclear energy or "not convinced" as some described their position regarding the nuclear option.

Many people from the public who did not know anything about nuclear energy were amazed by the fact that a very small pellet of uranium can replace around 800 kg of coal or around 650 L of oil. Moreover, many people were also wondering why people like us from the nuclear industry usually don't do anything to inform the public on a large scale. This sent a strong message, if we want the public to be in favour of the refurbishment of the only nuclear power plant in Québec (Gentilly-2).

The joint participation of NEI/ NA-YGN from the US and CNA/ CNS from Canada was very positive for the whole nuclear industry, as we could reach delegates from many countries around the world and also people from the local public. We look forward to participating in other opportunities in the future in order to inform people on nuclear energy and its benefits.

Members of the branch continue to inform on nuclear technology through school presentations. For instance, on April 12th, 2006, Mr. P. Hernu did a lecture at College SteMarcelline, as part of our student information program.

Our webmaster, Mr. J. Franta, executive member of the Québec Branch, has provided an extensive and very good job updating the Québec Branch website and consequently the French part of the CNS website. Particularly, you can see a video showing the presentation of our brief supporting the use of nuclear energy in the Québec energy portfolio, by Dr. É. Varin and Mr. G. Sabourin before the Parliamentary Commission of the Assemblée nationale in Québec City.

### SHERIDAN PARK – Adriaan Buijs

Sheridan Park held 6 seminars over the year:

- Bruno Comby, EFN: Environmentalists for Nuclear Energy;
- Mike Lafontaine, IST Canada: In-core Flux Detectors, Introduction and Developments;
- Martyn Wash, OCI: The Organisation of CANDU Industries
- Mark McIntyre, New Brunswick Power: The World Nuclear University;
- David Scott, AECL: Retubing of a CANDU 6;
- Prof. John Luxat, McMaster: Energy Challenges and Nuclear Opportunity;

We participated as judges in two science fairs:

• the Bay Area Science and Engineering Fair in Hamilton, and,

• the Peel Region Science Fair in Mississauga.

We held an annual branch meeting in conjunction with the seminar by Mike Lafontaine, in which the executive was reappointed with the same members as before.

### TORONTO BRANCH – Nima Safaian

The Toronto Branch organized the following programs for 2005/2006:

September 20,2005 – Toronto Chapter of CNS supported the Nuclear Issues Group Meeting (U of T Student Organization). Representative from CNS attended the group's meeting and provided U of T students with information regarding the CNS and the Nuclear Energy.

November 3, 2005 – Student Career night at University of Toronto in partnership with Nuclear Issues Group. The following employers attended this Session:

- Atomic Energy of Canada Limited (AECL)
- Candesco
- Nuclear Safety Solutions Limited
- Framatome ANP Canada

Approximately ~80 students attended this event which included brief introductions by the company representatives which followed with a "mix and mingle" session between students and company representatives.

March 1, 2006 - Elizabeth Holliday, Nuclear Safety Solutions Limited.

Topic: Modelling of a Pressure Gradient Across a CANDU Reactor Inlet Header, Venue: 700 University. Attendance ~50 people. (This was a joint CNS/NSS event)

May 4, 2006 - Amir Shalaby, Vice President, Power System Planning, Ontario Power Authority, Topic: The Role of Nuclear Power in Future Generation Planning in Ontario, Venue: U of T. ~30 people attended this meeting.

Next Event - The Branch AGM will be organized for some time in July and will include presentation by the incoming CNS President. The tentative plan for the upcoming 2006/2007 will be presented at this meeting.

### **Officers' Seminar**

Branch Affairs chairman stated that the annual Officers' Seminar, to which Branch representatives are especially invited, would be held in late August or early September, probably in the Oshawa area. The proposed arrangement is for a dinner and social event on a Thursday evening and the seminar on the Friday.

The focus of the Officers' Seminar this year will be on the role of Divisions and Committees:

- how they do what they do
- lessons they have to share on their operations
- opportunities for improvement.

The object is to understand what we all do, and look for opportunities for improvement in al areas. Is the CNS working as effectively as it can?



An aerial view of the Qinshan 3 station.

### New members / Nouveaux membres

We would like to welcome the following new members, who have joined the CNS in the last few months.

Mehrdad Afroozpanah, UOIT Manohar Lar Aggarwal, OPG Naveed Akhtar, UOIT Ala Alizadeh, AECL Imelda Ariani, AECL Ibrahim Samir Aziz, Wardrop Engineering Inc. Constantin Banica, Ontario Power Generation Rupak Bhattacharyya, Sr. Technical Engineer Kevin A. Bliss, Bruce Power Jim Bowman, Babcock & Wilcox Canada Sujit Brahma, Wardrop Engineering Inc. François Caron, Laurentian University Luisa Celis, OPG Ranjeet Singh Chandla, Ryerson University Arthur W. Cockerill Angela Coulas, AECL Gilda Cruzat, Bruce Power Mohammad Amin Eshraghi, University of Waterloo Aaron Gabourie, Wardrop Engineering Inc. Lisa Gardner, Atlantis Systems International Eric Juris Grava, Bruce Power Elizabeth Lillian Holliday, Nuclear Safety Solutions Ltd. Constantin Horeica, Ecole Polytechnique de Montreal Evan Houldin, Candesco Corporation Christa D. Ingalls, Cameco Corp. Andrew Johnson, Bruce Power George Karam, Wardrop Engineering Inc. Yong T. Kim, Babcock & Wilcox Canada Kyla L. Kirk, Bruce Power Sanjay Krishnan, RCM Technologies Canada Corp. Hae Min Lee, GE Canada Nuclear Products Eun-Seok Lee, KEPRI Karam Malik, Wardrop Engineering lan G. McIntyre, Atlantis Systems International Inc. Shoshana C. Mensher, Areva NP Canada Ltd. Jeffrey Miller, University of Ontario Institute of Technology

Nous aimerions accueillir chaudement les nouveaux membres suivants, qui ont fait adhésion à la SNC ces derniers mois.

Alex Negoita, AECL Amir Hossein Noroozi, University of Waterloo David R. Novog, McMaster University Selma Nussbaumer-Roth Derrick Ofori, The University of Western Ontario **Rina Parker, Candesco Corporation** Bill Patterson, Comstock Canada Ltd. Anneliese Poetz, McMaster University Marcel Poirier, Wardrop Engineering Inc. Alexi Popov, École Polytechnique de Montréal Keith Puddick, AECL Darren D. Radford, AECL Glen A. Rae, Duratek, Inc. Margaret M. Remisz, SLN (SNC Lavalin Nuclear) Erika Ritchie, Cameco Corporation Zeeshan Rizvi, AECL Christopher J. Saayman, University of Waterloo Bikramjit Singh Sandhu, ANRIC Enterprises Inc. Paul Spagnolo, Human Factors Engineer Alireza Ghahramani Tabrizi Jun Tang, Babcock & Wilcox Canada Bernard Teper, ANRIC Enterprises Inc. Terrence Thompson, Terrence Thompson Consulting Dave M. Tucker, McMaster University Carl Turner, AECL Amir Vexler, General Electric Canada Sivaraman (Shiv) Vijayan, AECL James R. Walker, AECL Mark E. Ward, GE Canada Larry Watt, Candesco Corporation Daniel R. Wilson, GE Canada Joanna Zhihuan Wu, OPG Megan Wylie, UOIT Feng Xu, Queen's University Dezi Yang, Wardrop Engineering Inc. William Zhang, University of Toronto

Abdelhamid Zkiek, École Polytechnique de Montréal

### ENDPOINT

### Trump and Triumph

by Jeremy Whitlock

### Dearest Supporter:

As you know this has been a monumental year for Sceptical Citizens Against Radiation Exposure (SCARE). Our well-organized campaign against Aggro Corp.'s plan to blend slightlyenriched potassium fertilizer at its Port Hope facility resulted in a decision to cancel the project and import the blended fertilizer from SEB (Someone Else's Backyard).

It was SCARE's research that showed that fertilizer is a significant source of radiation exposure: one 25 kg bag of all-purpose (7-7-7) fertilizer contains over 50,000 Becquerels of radioactive potassium! Each Becquerel is a mini nuclear explosion of a single atom.

This is over five times the legal possession of radioactive Potassium without a licence from the Canadian Nuclear Safety Commission (CNSC), and that's in each 25 kg bag.

A couple of years ago Aggro Corp. announced plans to import enriched potassium fertilizer (30-40%) from the U.S., to be blended down to slightly-enriched fertilizer (typically 15-20%) in Port Hope. This meant importing tonnes of potassium into our community, next door to our homes and schools: Each tonne of potassium contains over 30 million Becquerels of radioactivity, representing over 3000 times the legal limit without a CNSC licence!

It was SCARE's research that showed how this amount of radioactive potassium, spread as an aerosol, would cause increased cancer rates and birth defects in our region. This is the true cost of living next to the fertilizer industry.

Aggro Corp. tried to argue that such calculations are a misuse of the Linear No-Threshold Theory (LNT), but SCARE's research showed these sorts of calculations to be widely accepted, even in government documents.

Aggro Corp. tried to argue that the formation of potassium aerosols is unlikely, but SCARE uncovered documents revealing not only the pyrophoric nature of powdered potassium metal (related to the form of potassium Aggro would use), but also the fact that the steel containers used to store the fertilizer will, when exposed to oxygen, burn!

It was SCARE's research that raised the spectre of an Oklahoma City-style explosion, caused by the combination of fertilizer and fuel oil. There are many fuel oil depots in the Port Hope area, and Aggro Corp. could not categorically rule out the possible mixing of these two materials under certain conditions.

In fact, SCARE asked so many questions that their very weight brought Aggro's development process to a standstill, and ultimately forced its cancellation.

SCARE has demonstrated that average citizens can have an impact! No amount of scientific argument can stand up to Time, and Time, dear friends, is what we have plenty of.

It also helps to have a very nice website and to get Dr. David Suzuki on board.

Where will SCARE go from here? Certainly not content to rest on our laurels, we will train our sights on other forms of Radioactive Aggression in our community.

Wherever there is a dairy, a beer store, or a grocery store under development, we'll be there. Wherever a house is being constructed or a granite monument being built, we'll be there. These cesspools of Nuclear Negligence will no longer be allowed to fester with impunity in our midst.

A frightening 4000 Becquerels of radioactive potassium are imported within every visitor to our region, and each day billions of Becquerels pass dangerously close by on the 401, the rails, or by ship. A single VIA passenger train alone can transport a million Bequerels past our homes and playgrounds, recklessly stowed in single-hulled steel containers perched on narrow steel tracks - all, we have found, prone to burning when exposed to oxygen.

Nor do we anticipate much solace in the "safety oversight" afforded by government officials, for we've found this cohort to be especially wily in the use of numbers and statistics to counter real public concerns.

It is this faction, for instance, that insists on doubling and tripling the amount of spent nuclear fuel stored in each of our households, claiming that smoke detectors are now "required" on each occupied floor.

A key weapon in our righteous fight is you, our membership. Your abundance is our credibility. Your support is our lifeblood. Please give generously and get your neighbours to sign up. Tell them their life depends on it.



### CALENDAR

2006		Nov. 26 - 29	5th CNS International Steam Generator Conference
July 17 - 20	ICONE 14 14th International Conference on Nuclear Engineering Miami, Florida website: www.asmeconferences.org/icone14	2007	Toronto, Ontario website: www.cns-snc.ca
Sept. 10 - 14	Physor - 2006 Physics of Reactors 2006 Advances in Nuclear Analysis and Simulation Vancouver, British Columbia website: www.cns-snc.ca/physor2006 email: physor2006@aecl.ca	Mar. 14 - 16	PHYTRA-1 Ist International Conference on Physics and Technology of Reactors and Applications Marrakech, Morocco email: erradi@hotmail.com
Sept. 17 - 20	<b>Top Seal 2006</b> <b>Conference on Waste Management</b> Oikiluoto, Finland website: www.topseal2006.org	June 3 - 6	28th Annual CNS Conference & 31st CNS/CNA Student Conference Saint John, New Brunswick website: www.cns-snc.ca
Oct. 15 - 20	<b>15th Pacific Basin Nuclear Conference</b> Sydney, Australia website: www.pbnc2006.com email:pbnc2006@tourbasts.com.au	June 24 - 28	ANS Annual Meeting Boston, Mass website: www.ans.org
Oct. 22 - 25	NEI International Uranium Fuel         Seminar 2006         Quebec City, Quebec         Contact: Linda Wells         Tel:       202-739-8091         email:       Ijw@nei.ogr	Aug. 12 - 17	I9th Conference on Structural Mechanics in Reactor Technology Toronto, Ontario website: www.engr.ncsu.edu/smirt-19
Nov. 12 17	ANC Winter Meeting		

### Nov. 12 - 16 ANS Winter Meeting Albuquerque, New Mexico website: www.ans.org

# PHYSOR-2006

Vancouver, BC, 2006 Sept. 10-14

The Canadian Nuclear Society will be hosting, for the first time, the ANS Reactor Physics Topical meeting, PHYSOR-2006, to be held in Vancouver, BC, 2006 Sept. 10-14. The conference theme is *Advances in Nuclear Analysis and Simulation*.

Ben Rouben, of AECL and a former CNS president, is the General Chair of the Conference and Ken Kozier, of AECL-CRL, is the Technical Program Co-Chair.

This Topical is a major international Conference on reactor physics and related nuclear topics that is held every two years. It brings together several hundred of the world's leading physicists and nuclear engineers involved in the design and simulation of current and future nuclear reactors to discuss the latest developments in these fields.

On the Sunday preceding the Conference, there will be workshops on the reactor-physics computer programs: TRITON, PARCS, and DRAGON.

For full details go to the Canadian Nuclear Society website <www.cns-snc.ca>

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For information on CNS activities and other links - Pour toutes informations sur les activités de la SNC

http://www.cns-snc.ca