CANADIAN NUCLEAR SOCIETY

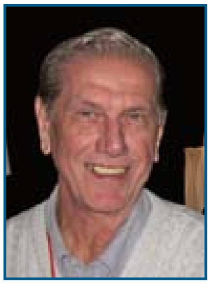
Bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

JUNE 2007 JUIN VOL. 28, NO. 2

• 28th CNS Annual Conference • Nuclear Achievement Awards
• Update on Bruce A Rebuild • CANDU and Reactivity Events

Realistic Optimism or Euphoria?



The mood at the CNS Annual Conference in Saint John at the beginning of June was so positive, so enthusiastic, that it bordered on euphoria. Our dictionary defines "euphoria" as an "intense feeling of well-being and excitement, especially one based on overconfidence or over-optimism".

It was marvellous to see and feel the spirit of those at the conference. After almost two decades of problems and decline our Canadian nuclear power program now appears to be in a resurgence, with the tremendous rebuild project at Bruce A, the imminent refurbishment of Point Lepreau, and the official expressions of intent by both Bruce Power and Ontario Power Generation for "new build".

To add a finishing touch to the conference, the New Brunswick premier announced a study on a second nuclear unit at Lepreau.

With the danger of being a male Cassandra, we suggest that some of the optimism needs to be tempered with a dose of realism, especially for the advocates of CANDU (which, presumably, includes most readers of the Bulletin). While spokespersons from Atomic Energy of Canada Limited have stated that the design of ACR 1000 is now "frozen" it is still not scheduled to be submitted to the regulator until 2009 and the leader of that organization has stated that they will only review official submissions from a proponent.

The other potential designs (as listed in Bruce and OPG's project description for environmental assessment) face the same challenge but they have been approved by the regulators in their home countries.

In contrast to the stand of the Canadian Nuclear Safety Commission, the US Nuclear Regulatory Commission is offering pre-licensing reviews and the Department of Energy is even financially supporting that action. As a speaker from the USA noted at the conference, the USNRC has also moved positively towards real "risk-informed" regulation, a concept to which the CNSC pays "lip-service" while rejecting the risk based objectives of its predecessor.

The regulatory organizations of all other countries with a nuclear power industry shape their programs to implicitly support their native designs. Only the United Kingdom, which no longer has nuclear power plant design capability, is openly inviting proposals from international vendors.

It would be a tragedy if Canada's remarkable achievement of being one of the very few countries that has developed a successful nuclear power plant design were terminated by the action of its own regulator.

Fred Boyd

In This Issue

First, our apologies for the lateness of this issue. It had been planned to be slightly late to allow for coverage of the Annual Conference but then a number of unexpected problems arose.

The major story is our report on the **28th CNS Annual Conference,** the largest and (editorial opinion) best in the decade since the CNS has been doing these annual events on its own.

That is accompanied by a note on the winners of this year's **Canadian Nuclear Achievement Awards.**

Next is the only paper from the Conference reprinted in this issue. Titled, **Reactivity Initiated Accidents and Loss of Shutdown – 20 Years Later,** it presents solid arguments why so-called "international" standards, derived for LWRs, should not be applied to CANDU reactors. (Hopefully someone at CNSC will read and understand it.)

Bruce A Refurbishment – An Update, is, as the title says, a brief overview of the remarkable project to essentially rebuild units 1 and 2 at the Bruce A station, by Rob Liddle of Bruce Power.

The title, **UOIT Graduates First Nuclear Engineers**, explains the subject of this notable event..

A short paper with a long title, **The International Reactor Physics Experiment Evaluation Project,** comes from the PHYSOR conference last fall. It was originally planned for the December 2006 issue but got caught up in copyright issues.

There is another of our "history" lessons, **The Montreal Lectures,** somewhat longer than others in this series but desirable reading to remind all of us in the Canadian nuclear program that its beginning, many decades ago, was remarkable.

Our typically eclectic selection of items for **General News** hopefully will include some that are new to you.

There are two **Obituaries** and one **Memorial** as a remembrance, not only of those individuals, but also of the ageing of many in our nuclear program.

CNS News includes a report on the Annual General Meeting of the Society at which Dan Meneley handed over the president's role to Eric Williams.

And, of course, there is Jeremy Whitlock's view of our world in **Endpoint.**

Although it did not go together smoothly we hope you find some things of interest in this, our final issue as editor. Your comments are still invited.

Load-following capability essential

While our industry representatives have kept promoting CANDU as reliable baseload supply to all who would listen, the (Ontario) Independent Electricity System Operator (IESO) has just come out with a draft load-following standard. *IESO Stakeholder Engagement SE-38, Load Following Standard* was issued by the IESO in early April 2007 with a request for comments. According to the IESO website the final version is due to be posted in late May 2007. Due to the complexity of the issue and questions raised it is unlikely that this date will be met.

This standard is a result of recent periods of negative pricing by the IESO. As the IESO puts it,

> "The presence of negative prices is a clear indication that dispatchable resources in operation during these periods prefer to remain on line; and are essentially restricted, or completely unable, to provide ramp-down services".

Such periods are expected to be more frequent as more self-scheduling and intermittent wind power comes on to the grid. In the absence of dependable export markets, and energy storage facilities like hydrogen and compressed air, nuclear plant load following will be essential if nuclear is to grow in Ontario.

The nuclear industry advertises baseload but the IESO wants load following. This conflict should come as no surprise. A letter on load following in the December 2005 edition of this Bulletin pointed out that the IESO had said in July 2005, in it's 10 Year Outlook, that Ontario's future generation supply mix will place an increasing reliability value on the capability of units to load-follow, provide operating reserve, and automatic generation control (control of grid frequency). The message was clear yet the Canadian nuclear industry still went droning on about nuclear as reliable baseload with no mention of load following. They did such a good job that the Ontario Power Authority (OPA) report of 2005 December 9 on the future electricity supply mix for Ontario contained many references to nuclear as being too inflexible, and useful as a baseload source only.

The assumption that Ontario could not, apparently, depend on nuclear to meet daily load fluctuations was one more reason for the government's proposed supply mix.

The future nuclear electricity supply plan for Ontario is a little confusing. The government is saying that it will maintain the present 14,000 megawatts of installed nuclear (including the two shutdown Pickering units) into 2025 by building two new units. However, Ontario Power Generation (OPG) and Bruce Power have submitted proposals to the Canadian Nuclear Safety Commission for eight new units, presumably ACR-1000s but could be LWRs since the government has yet to decide on the technology. Whether these are in addition to the present operating units and units undergoing refurbishment or are to replace units that will be mothballed, or even permanently shutdown, is not clear.

The government is putting a lot of faith in conservation and renewables. Since the hydro-electric potential is limited that means wind power, supported by natural-gas fired generators, will be a major part of the energy mix. However, since the only significant dispatchable supplies planned for the future will be nuclear and gas, and the supply from the gas units will be restricted because of fuel availability, cost and the environment, it means that nuclear is expected to play a much greater role than the 50 percent grid penetration assumed in the OPA supply mix report or the government's stated 40 percent by 2025.

OPG and Bruce Power apparently understand this. It may have even precipitated their proposal to the CNSC for eight units rather than the government's two units. Being responsible for Ontario's economic future brings a certain clarity of thought that could have made OPG and Bruce Power understandably nervous about the amount of conservation, and wind and gas generation in the government's plan.

If nuclear-electricity is to meet baseload and, at least, intermediate demand in Ontario, and allow for the shutdown of the coal-fired plants, the industry had better change it's tune and start trumpeting CANDU load-following capabilities every chance it gets, and soon. At the same time the experts should be bringing the OPA and the IESO up to speed on nuclear load-following capabilities to dispel any myths they have about it. If CANDU can outperform other reactor designs in load following let us say so. Ontario should be aiming for 70 percent nuclear generation by 2025 instead of the paltry 40 percent, with hydro supplying most of, if not all, the balance.

This would help meet our Kyoto targets as well as give Ontario a secure source of clean electricity far into the future.

Don Jones
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Looking back – and forward

A farewell as editor

This is my last issue as editor of this publication. A year and a half ago I stated my intention to withdraw and now it is finally happening.

It has been more than a decade and a half since I took on the editorship of our Society's major publication. That is a longer period than I have spent in any "job".

It has been an "interesting" experience, the quotation marks indicating it has been both a joy and a pain, both enjoyable and frustrating. The best part has been the opportunity to continue to be involved with our changing nuclear program and, especially, with the members of our great Society. Throughout all that time, my "employers" (the Council of the Society) never gave any orders, never criticized, just let me "do my thing". What a great job, except for the (non-existent) pay !

Over those years I have written more than 60 editorials, many critical of the leadership of our nuclear program, but milder than my actual feelings, in recognition of the ownership of the Bulletin.

I have worked with almost a dozen and a half different presidents of the Society. While individually different all brought an enthusiasm and a dedication to the task of leading an organization of a thousand or so independent professionals. Observing the variation in style of chairing Council has been an ongoing pastime.

For me, the most significant event was the separation from the Canadian Nuclear Association. From its birth in 1980 the Society had been like a child in the CNA family. Begun by Hong Huynh and consummated by Ben Rouben the CNS achieved legal adulthood in 1998 as a separate incorporated organization, while still close to its former parent.

The health of the CNS over the period mirrored that of the Canadian nuclear program. In the early 1990s there were many signs of problems, especially at Ontario Hydro. That erupted in 1997 with the invitation for US "experts" and the subsequent shutdowns of the Pickering A and Bruce A units. The next several years were stressful.

As well as the debacle at Ontario Hydro, the 1990s also saw the eight-year saga of the Environmental Assessment Panel for the Nuclear Fuel Waste Disposal Concept. When it finally reported in 1998, the Panel concluded that the concept was technically feasible but not socially acceptable!

Now there is a new spirit, new enthusiasm, throughout our nuclear program. There is a belief that a new beginning is coming. For those of us who were part of the heady 1950s and 1960s it is almost like those days have returned. And, like in that time, young people are being involved, in the industry and the CNS.

But the future is not without peril. There are still many challenges for the industry and the Society. While I have many concerns about what lays ahead for our distinctive Canadian program I have no doubt that the CNS will grow in numbers and activities.

I will be hanging around for a time in the still nebulous role of "publisher". Perhaps that will allow me to continue to attend meetings and ask the questions those employed feel reluctant to pose.

Fred Boyd

Meet the new editor

As of July 1, 2007, Richard (Ric) Fluke will be the Editor-in-Chief of the CNS Bulletin. Ric had been involved some years ago as Associate Editor but the pressures of work caused him to withdraw. He is still working full-time but, with the promise of help from various CNS members, feels ready to take on the newly created position.

Ric is a Charter Member of the Society, meaning he joined back in 1980. Over the years he has participated in various CNS activities, including lecturing at some courses.

A graduate of McMaster University in Engineering Physics Ric has been in our industry for over 30 years, primarily on safety issues, with Ontario Hydro and now for Nuclear Safety Solutions Inc. (NSS). Currently he is seconded to AECL (Mississauga) working on the safety and licensing of the medical isotopes processing facility associated with the MAPLE reactors at the Chalk River Laboratories.

During his career with the former Ontario Hydro, Ric developed an expertise in radiation shielding design, irradiated fuel properties, nuclear safety and the various disciplines in reactor accident analysis. He has worked on resolving generic issues, managed R&D programmes, developed methods for emergency response planning, and has authored several technical publications.

At AECL, Ric is working on the safety case for the New Processing Facility (NPF). This facility will process irradiated targets (from the MAPLE reactor) to produce medical isotopes. As a project, the NPF is a unique design and not without its challenges and Ric says it one of the most interesting assignments in his career.

Ric lives in Burlington, and finds Mississauga an easier commute than downtown Toronto. He is married and has three "kids", one of whom is also an engineer working at AECL. He enjoys photography and music, and occasionally plays the guitar.

We welcome him to the CNS Bulletin.

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~ Cover Photo ~

The photograph on the cover is a fairly old one of the Point Lepreau generating station near Saint John, New Brunswick, the venue of the 2007 CNS Annual Conference.

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CNS provides Canadians interested in nuclear energy with a forum for technical discussion. For membership information, contact the CNS office, a member of the Council, or local branch executive. Membership fee for new members is $75 annually, $44.00 for retirees, free to qualified students.

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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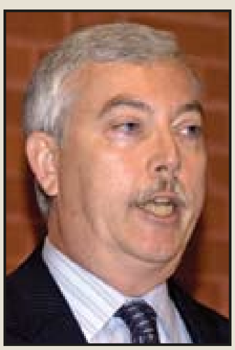
Largest attendance, most exibitors, at Saint John event

Theme: *"Embracing the Future – Canada's Nuclear Renewal and Growth"*

David Hay

Tim Curry



Joe Howieson

The 28th Annual Conference of the Canadian Nuclear Society, held in Saint John, New Brunswick, June 3 – 6, 2007, proved to be the largest and most successful in recent years.

Over a year ago the Council of the Canadian Nuclear Society chose Saint John, New Brunswick as the venue for the society's 2007 Annual Conference, in recognition of the refurbishment of the Point Lepreau nuclear station, scheduled to begin in early 2008. Given that venue, when the organizers of the conference began their deliberations in the fall of 2006, they cautiously set a target attendance of 250 compared to the 300 to 350 at the recent events held in Toronto.

By mid May 2007, weeks before the conference, they had to stop registrations at 450 to stay within the capacity of the Saint John Hilton hotel and associated Trade and Convention Centre. Even though the actual attendance hovered around the 500 mark the host organization managed to provide space for the 27 exhibitors and to feed the enthusiastic crowd.

While the sun shone on the Sunday, June 3, to greet most arrivals, a characteristic Saint John fog settled in for the three days of the conference. Perhaps this increased attendance at the sessions. (The sun returned on the Thursday !)

Despite the good weather about 60 young professionals particpated in a Professional Development Seminar, organized by the North America - Young Generation Nuclear, on the afternoon of Sunday, June 3.

As well as the dozen or so plenary presentations and over 90 technical papers, the conference included several special items, such as: the W. B. Lewis lecture at the Monday luncheon; the presentation of the 2007 Canadian Nuclear Achievement Awards at the conference banquet *(see separate article)*; and a speech by the Premier of New Brunswick, Shawn Graham, at the closing luncheon, in which he stated that his province will initiate a study for a second nuclear unit (which drew a standing ovation).

Following the pattern of the past several years the conference opened with an excellent reception on the Sunday evening, sponsored by AECL CANDU Serivices, where delegates were welcomed by **David Hay**, president and CEO of New Brunswick Power (and honorary chair of the conference), **Eric Williams**, executive chair of the conference and in-coming CNS president, and **Dan Meneley**, CNS president for 2006 – 2007.

Monday Plenary

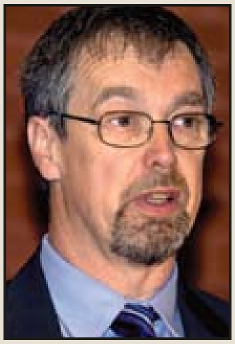
Monday morning saw the first two plenary sessions. The first, titled *Energy and the Future for Nuclear,* was introduced by David Hay who spoke highly of the partnership between NB Power and Atomic Energy of Canada Limited. With the Point Lepreau station supplying 30 percent of NB Power's generation he commented that taking it out of service (for refurbishment) will have the same effect on the New Brunswick sytstem as shutting down all of Ontario Power Generation's nuclear plants in Ontario.

The first speaker was **Tim Curry**, president of the Atlantica Centre for Energy. (Created in June 2005, the Atlantica Centre for Energy provides a unified voice on energy issues within the four Atlantic Canadian provinces, south-eastern Quebec and northern New England - the region commonly referred to as Atlantica.)

Despite the scope of his organization Curry focussed on the prospect of making Saint John a centre for energy, information and health technology, and tourism. He noted that the Irving Oil refinery is the largest in Canada and the generating stations of NB Power produce 50 percent of the province's electricity. "Energy" will be the dominant theme for the next 25 years, he stated.

He was followed by **Joe Howieson**, recently appointed as a vice-president of AECL, speaking on *Team CANDU – Ready for the Marketplace.* Beginning with a list of positive attributes of nuclear energy he went on to describe Team CANDU as an association of five major companies that has delivered six CANDU units over the past decade, on time and on budget. The team is prepared to assume the financial risk of a new plant. He noted that the design of AECL's new ACR 1000 was "frozen" in March 2007. It meets all international licensing standards, he stated in closing.

Rounding out this opening plenary session was **Ian Grant**, director general at the Canadian Nuclear Safety Commission, who titled his presentation *Meeting the Challenge of Regulating an Expanding Nuclear Industry.* He reviewed the creation of the CNSC in 2000 to replace the Atomic Energy Control Board, which had been the nuclear regulatory organization since 1946. The CNSC has two distinct parts, the Commission, which is a tribunal with, currently, five members, all of whom are part-time expect the president, and the supporting staff which now numbers about



Ian Grant

Gregory Smith

Rod Eagles

600. The president is chair of the tribunal and CEO of the staff.

Two new directorates have been created recently, Grant reported, one to look at new nuclear power plants, the other to deal with environmental; assessments.

To a question Grant stated they are still working on guidance documents related to their objective of having "technology neutral" regulations.

With the title of *Renewal and Growth of Generation,* the second plenary session presented a panel of five speakers providing status reports on the Canadian nuclear power program.

First was **Andrew Johnson** of Bruce Power who provided an update on the refurbishment currently underway on Bruce A unit 1 and 2. He began by noting their emphasis on safety and housekeeping. Feeder pipes and four steam generators have been removed on unit 1. By installing bulkheads in the fuelling machine duct it has been possible to work on the feeder pipes without special protective suits. After noting that the turbines were being refurbished he commented that the electrical equipment in general was in worse condition than had been anticipated. A new simulator has been installed, he stated, and training of operators is underway.

Although **Gregory Smith** of Ontario Power Generation titled his presentation as *It's All About Performance* he spoke primarily about developing a business case for the refurbishment of the Pickering B units. This will include the environmental assessment, which is underway, an integrated safety review, and a complete assessment of the condition of all systems of all units.

Concurrently a technical assessment of possible "new build" is underway. Many lessons were learned in the refurbishment of two units of Pickering A, he said.

Smith closed by noting the continued public concern about "waste'. We have done a poor job in communicating, he observed. It should never have been called "waste", he commented.

Claude Drouin, of Hydro Québec, reported on the studies for a possible refurbishment of the Gentilly 2 station. These have included plans for retubing, replacing feeders, replacing components of the shutdown systems and refurbishment of the turbine and generator. A decision of the Québec government is expected this summer, with the final decision of Hydro Québec in mid 2008.

He noted that the radiation fields at Gentilly 2 were five times higher than at Point Lepreau. As a consequence they have contracted with IREQ to develop special equipment for retubing.

Rod Eagles, project director for the Point Lepreau refurbishment, provided what he called the "seventh" update on his project. After years of study and planning the actual start of the refurbishment is scheduled for April 2008. They have been working closely with the CNSC and have developed a single integrated schedule. Extensive training is underway.

Providing a generic picture, **Jerry Hopwood,** of AECL, spoke of synergies between the several projects planned on CANDU units around the world. With the Point Lepreau refurbishment scheduled to be completed in mid 2009, retubing of Wolsong 1 will take place 2009 – 2010. AECL has a cooperation agreement with Argentina for the Embalse station and other projects.

W. B. Lewis Lecture

At the Monday luncheon, **Dr. Charles Till,** former Associate Laboratory Director at the Argonne National Laboratory in the USA, delivered the 2007 W. B. Lewis lecture. Till was a Canadian and spent a couple of years involved with the start-up and early operation of the NPD prototype station in the early 1960s before moving to Argonne. (This series of lectures was initiated in 1988 by Atomic Energy of Canada Limited in honour of Dr. W. B. Lewis who headed the science program at the Chalk River Laboratories from 1946 to 1963. The invited lecturer is chosen by the R & D Advisory Committee to the AECL Board of Directors.)

Till titled his lecture *Reminiscences of Reactor Development at Argonne*. He began by noting that the principles of reactors were developed over 50 years ago and many different versions were proposed. After some comments about his brief involvement in the Canadian program he spoke mostly about the challenges of developing the Integral Fast Reactor at Argonne and the Idaho National Laboratory. One of the many technical problems they faced was the swelling of uranium metal under radiation, which they solved by putting liquid sodium between the fuel and its cladding. However, funding for the project was discontinued before development was complete. (Till's full lecture will be included on the conference CD and put on the CNS website.)

Monday afternoon saw the first of three periods devoted to technical papers and to the embedded student conference.

President's Session

Late Monday afternoon a special "President's Session" was held, on the topic of *New Applications of Nuclear Energy.* Four interesting, diverse, papers were presented.

In introducing the session that he organized, CNS president Dan Meneley commented that it was intended to look "just beyond today's horizon". "We must work on every option available", he said. "Time is short – we must let the market [make] the selection of options."

The first paper was by **Roger Humphries,** currently with Nuclear Safety Solutions, which he titled, *Everything Old is New Again: Desalination and Other Non-Electric Applications.* He began by stating that "business as usual" is not acceptable; there are too many global problems, such as: population growth, water crisis,

A view of the special reception hosted by a number of New Brunswick companies.

lack of energy, environmental degradation. There is a danger that insufficient energy could lead to war but too much energy production and use could place too high a burden on people and the environment. He noted the development of "energy parks" using nuclear reactors as the source. One in Aktau, Kazakstan (formerly Shevchenko, USSR) based on a BN-360 fast reactor which supplied 135 MWe, 80 000 m^3/d desalted water and district heating. Here in Canada there is the Bruce energy centre that provides space heating and thermal energy for industrial processes and agriculture.

Using nuclear plants for desalination is the ideal solution to problem of global water shortages, he stated, noting: there are abundant supplies of seawater or brackish water; using nuclear does not deplete already scarce natural sources; it is a politically sound solution (no need to "steal" water from your neighbours); and is environmentally sound.

Sermet Kuran, of AECL, followed with a paper on *CANDU for Oil Sands Applications*. There are four possibilities, he said,

- SAGD (steam assisted gravity draining)
- hydrogen (required for upgrading)
- carbonate (developing technology)
- electricity (for process and utility)

AECL is looking at two options: one with the reactor providing 150 MW of electricity plus process steam; the other all steam. Discussion are underway with oil sand companies in Alberta.

Next was **Robert Evans,** of the National Renewable Energy Laboratory of the US Department of Energy, who spoke about *Nuclear Hydrogen Production.* The goal of the Nuclear Hydrogen Initiative program is to develop processes for the production of hydrogen that do not cause any environmental degradation. They are looking at thermal chemical reactions, high-temperature electrolysis and system interface. A major problem is corrosion. The immediate objective is to develop laboratory or pilot plant scale systems with the goal of commercial plants by 2019.

The final paper in this special session was by **Alistair Miller** of AECL on *Alternative Fuel Cycles.* We need at least as much energy as we are now using, he stated, while minimizing CO_2 production, and should use the technologies we have. For electricity production, he proposed existing and advanced nuclear reactor designs, perhaps supplemented by "clean coal" with sequestration (when clean coal & sequestration technologies are proven effective).

Late Monday afternoon saw a special reception and display by local or regional companies interested in participating in the nuclear program. That evening AREVA held a reception for all delegates in the nearby NB Museum.

Tuesday morning was devoted to technical and student sessions with the second plenary session in the afternoon. (The Annual General Meeting of the CNS was held over the lunch period. See *CNS News* for a report on the AGM.)

Tuesday Plenary

The first part of the Tuesday plenary session was on *Directions for Business Success,* beginning with a presentation by **Steve Hamilton,** vice-president of AREVA-NP Canada who titled his talk *Success Criteria for the Evolving Business Environment.* While there is a need for more electricity production there are constraints, he noted, especially for nuclear plants, which require large investment. Further there are impending shortages of qualified workers and of material. Nevertheless nuclear is the way to go, he commented. France committed to nuclear and now has the cleanest air of any industrialized country. Regulatory processes require updating, he contended, to reflect new technology and new standards.

Biff Bradley, Director, Risk Assessment at the US Nuclear Energy Institute, followed with a positive message about *Risk-Informed Regulation and Decision making in the USA.* He noted two key policy statements by the US Nuclear Regulatory Commission:

- Safety Goal Policy Statement - 1986
  - Quantitative health objective
  - Subsidiary objectives (core damage frequency, large early release frequency)
  - Provides quantitative definition of "how safe is safe enough"
- Probabilistic Risk Assessment Policy Statement – 1995
  - PRA should be used in regulatory matters to the extent supported by the state of the art, and with due consideration of other regulatory factors

USNRC Reg Guide 1.174, on the approach for risk informed changes to the licensing basis, clarified the application of the risk-informed approach. The concept of a *de minimus risk increase* was introduced to the regulatory framework. An integrated decision process developed which recognizes PRA as one element of overall decision and provides "acceptance guidelines" for risk metrics that are consistent with safety goal definitions. Risk-informed methods have been used extensively in the USA, he said in concluding, and the USNRC has been a consistent proponent.

That part closed with a panel presenting local and community concerns with four participants: **Craig Wight** from Omnifacts;

Ross Galbraith from the IBEW union; **Peter Corbyn** of the New Brunswick Conservation Council; and **Mark Mosher,** a vice-president of the J. D. Irving company.

After a break the second plenary session began, on the topic *Developing Nuclear Technology.* The first speaker was **Mary Preville** of Natural Resources Canada who provided an update on *Canada's National Generation IV Program.* Generation IV refers to evolutionary and innovative designs for future energy security which will have significantly higher efficiencies (~ 50% compared to present ~ 30%); and are sustainable, economical, safe, reliable and proliferation resistant. GIF (Generation IV International Forum) is an international organization of ten countries set up to coordinate work in different countries. Six reactor designs have been chosen for further development:

•SFR	Sodium Cooled Fast Reactor	Fast	Closed
•LFR	Lead Alloy Cooled Reactor	Fast	Closed
•GFR	Gas Cooled Fast Reactor	Fast	Closed
•VHTR	Very High Temperature Reactor	Thermal	Once-through
•SCWR	Supercritical Water Cooled Reactor	Th. & Fast	Once-t. & Closed
•MSR	Molten Salt Reactor	Thermal	Closed

Canada is concentrating on the SCWR with some links to the VHTR program. The work will be done by AECL and by universities under programs of the Natural Science and Engineering Research Council (NSERC).

John Roberts, of Sheffield University, UK, spoke about the potential for UK – Canada Collaboration both in connection with planned new nuclear plants in the UK and in the development of advanced designs.

Diverting from nuclear power, **Paul Gray,** vice-president, global logistics, MDS Nordion, spoke about the fascinating activities at his company in a presentation titled *Levering Canada's Nuclear Infrastructure for Medical Innovation.* MDS Nordion supplies 50 percent of the developed world's medial diagnostic radioisotopes, he stated. The logistics for Mo 99 / Tm 99m, the favorite isotope because of it short half-life, is very tight; it is less than 48 hours from the time the isotope is taken out of the NRU reactor at the Chalk River Laboratories until it is delivered in appropriate form to doctors all over North America. They continue to rely on the 50-year old NRU while waiting for the completion of the dedicated MAPLE reactors and associated processing facility.

Gray mentioned other developments such as their "Therasphere", irradiated micro-spheres that are particularly effective for cancer of the liver, and labelled antibodies for non Hodgkin's lymphoma.

Closing the session **Murray Stewart,** executive director for the World Energy Congress – Montreal 2010, gave a "sales pitch" for this large gathering sponsored by the World Energy Council. About 5,000 delegates are expected, from all over the world. The Congress is held every three years; in 2007 it is in Rome this fall.

The conference banquet was held Tuesday evening during which the **2007 Canadian Nuclear Achievement Awards** were presented. *(See separate article).* Being in New Brunswick lobster was offered, with most participants enjoying that maritime delicacy. Given the challenge of eating lobster, Babcock & Wilcox Canada provided bibs and, to accompany that, genuine "Sou'Wester" hats along with certificates as members of the "Official Order of the Sou'Wester".

Yvette Amor poses wearing the "Sou 'Wester" hat her company, B & W Canada provided the lobster eaters at the conference banquet.

Wednesday Plenary

Two final plenary sessions were held on the Wednesday morning, the first on *Renewing Human Resources,* with three speakers.

Cathleen Cottingham, of the Electricity Sector Council, began with a presentation on *Strategies and Best Practices for Staff Renewal.* The Council was formed by all of the major electricity companies to study staffing and related problems. She stated that the average age in the member organizations is 44, higher in the nuclear areas. It is necessary to plan 5 to 10 years ahead, she asserted, and we can not count on immigration. Only about 5,000 engineers of all types came to Canada in 2005 and the situation for trades is much worse. Only 100 persons with electrical related trades skills immigrated in 2005.

Debra Gillis, a vice-president of Catalyst Canada, titled her presentation as *WiN: Strengthening Our Talent Base.* Women are needed to meet the demand for knowledge workers, she stated, but there are many impediments and gender misperceptions. She recommended specific programs to assist women in non-traditional roles.

Providing a different perspective, **Gaëtan Thomas,** vice-president, New Brunswick Power Nuclear, spoke about achieving excellence. The elements of excellence, he said, are: strong leadership; self criticism; operation focussed; exceptional equipment performance; training. People are our most important asset, he stated, highlighting commitment, relationships and ownerships. He closed with the acronym TEAM – Together Everyone Achieves More.

The final plenary session began with a panel on the topic *Transferring the Technology,* moderated by **Bill Garland** of McMaster University. Panel members were: **Brenda Barker Scott** of Queen's University; **Sardar Alikhan,** consultant; **Greg Kealey,** Royal Military College; **Elizabeth McAndrew-Benavides,** representing North America – Young Generation Nuclear. A common point was that, while organizations should have programs, professional development depends very much on individual effort.

Closing out the session were two presentations generally related to the panel topic. **John Froats,** president of CANDU Owners Group titled his presentation as *Knowledge Management: A Programmatic View.* He asserted that on average we make 6 to 8 errors peer hour and this will increase if there is a change in the knowledge involved or the individual's experience. There is a need for "error prevention tools" he proposed, such as codification and defined decision making processes. The future demands teamwork, he stated in closing.

Paul Spekkens, vice-president, science and technology development, Ontario Power Generation, was the final plenary speaker. His topic was *Developing the Next Generation of Nuclear Workers at OPG*. The average age at OPG nuclear is 45, he said, with a slight bi-modal peak in the 25 – 29 year bracket resulting from recent hiring. Over the next five years it is expected that 30 percent of the skilled trades people and 50 percent of the engineering staff will retire. Hiring will be based on expected retirement, the projected workload and "make / buy" decisions. There is an urgent need to transfer knowledge and experience to new recruits, he emphasized.

NB Premier

A highlight of the conference was the presence of the premier of New Brunswick, **Shawn Graham**, at the Wednesday lunch. In his short speech he said that energy, especially nuclear enegy, is a key to the province's future. The possibility of a second unit at Point Lepreau is "very interesting" and would be studied carefully. Then, after referring to the refurbishment of the Point Lepreau unit and AECL's agreement with Argentina to train people there, he stated that he would ask his cabinet within a few weeks to approve a study for a "Generation 3" nuclear plant. That was greeted by a standing ovation.

Technical Program

101 technical papers were presented in five parallel sessions: Monday afternoon, Tuesday morning and Wednesday afternoon. Some indication of the scope of topics can be inferred from the subject titles of the sessions:

- Control Room Operation
- Safety Analyses
- Environment and Waste Management
- Plant Life Management and Refurbishment
- Reactor Physics
- Advanced Reactor Design
- Instrumentation and Control
- General Nuclear topics and Standards

At the reception...

- Chemistry and Materials
- Probabilistic Safety Assessment
- Performance Improvement

In addition, there were three student sessions in which a total of 23 papers were presented.

The conference was strongly supported by a number of sponsoring organization: AECL; NB Power; AECON; AMEC –NCL; AREVA; Babcock & Wilcox Canada; Bruce Power; Cameco; Candesco; Canadian Power Utility Services Ltd.; Energy Solutions; E. S. Fox; GE Energy – Nuclear Products; Hitachi; Hatch –Sargent & Lundy; Hydro QuÉbec; Ian Martin; Kinetrics; Lou Champagne Services; Neill and Gunter; Newman Hattersley Limited; Nuclear Logistics Inc.; Nuclear Safety Solutions; Ontario Power Generation; Power Workers' Union; SNC-Lavalin; Team CANDU; Wardrop. Their financial contributions enabled the conference registration fee to be kept much lower than comparable conferences and to include meals. The sponsorship committee consisted of: Neil Alexander, Heather Smith, Pamela Sprague.

Most of the sponsors also had displays. The following additional organizations had displays: Alaron Nuclear Services; ANRIC; Atlantic Nuclear; CNER; Curtis Wright Flow Control; Kanata Electronic Services Limited; Lisle Metrix Ltd.; Organization of CANDU Industries; PermaFix Environmental Services; Unitech; Versatile Measuring Instruments Inc.; WiN Canada.

The conference was organized and run by a large committee of volunteers chaired by Eric Williams, then CNS 1st vice-president. Among the key members were: Ben Rouben, assitant chair and facilities; Kathleen Duguay, NB Power, local arrangements; Ken Smith, treasurer; Keith Scott, plenary program; Krish Krishnan, technical program; Dorin Nichita, audio-visual; Derek Lister, student program. A small army of volunteers assisted in producing a well-run, interesting and enjoyable event.

A CD with all of the technical papers and most of the PP presentations in the plenary sessions will be available from the CNS office.

The 2008 CNS Conference will be held in Toronto, June 1-4, 2008.

At the banquet...

Almost all of the photographs accompanying this article were taken by Terry Campbell and made available by Kathleen Duguay, both of NB Power.

Canadian Nuclear Achievement Awards

A highlight of each CNS Annual Conference is the presentation of awards to those who have contributed siginificantly to the advancement of nuclear science and technology or to the Canadian nuclear program.

As has been the practice for the past several years the awards were presented during a special awards dinner, held on Tuesday, June 5, 2007, during the 28th Annual Canadian Nuclear Society Conference in Saint John, New Brunswick.

Following are descriptions of the awards, the winner, and the susinct citation.

W. B. Lewis Medal – Daniel Rozon

The W. B. Lewis Medal recognizes a Canadian scientist or engineer who has demonstrated a level of technical competence and accomplishment in the field of nuclear science and engineering as exemplified by the late Dr. W.B. Lewis during his involvement in the Canadian nuclear energy programme, 1946 to 1973. It is the highest award for contributions in nuclear science and engineering.

Dr. Daniel Rozon is recognized world-wide as a leading authority on CANDU reactor physics. Dr. Rozon has held the Hydro-Québec chair at Ecole Polytechnique and also established and directed the Groupe d'Analyse Nucléare, where he led the development of the widely used codes DRAGON and DONJON for reactor analysis.. He is the author of the textbook "Introduction to Nuclear Reactor Kinetics" and author or co-author of many important papers on reactor physics and reactor safety. Many of his former students now fill important roles in AECL and nuclear utilities in Canada and elsewhere.

He is a member of the Research and Development Advisory Panel to the Board of Directors of AECL and was a member of the Advisory Council to the Nuclear Waste Management Organization.

Throughout his career, Dr, Rozon demonstrated the level of technical competence and significant accomplishment in the field of reactor physics as well as other areas of nuclear science and engineering that was exemplified by the late Dr.Lewis in his contributions to the Canadian nuclear energy program.

Ian McRae Award – Michael Lees

The Ian McRae Award honours an individual for substantive contributions, other than scientific, to the advancement of nuclear energy in Canada. It is named after the first president of the Canadian Nuclear Association.

Michael Lees has provided leadership in the development of the Babcock &Wilcox Canada nuclear program to a full-service engineering, manufacturing, field-service and life-cycle management organization for the full range of steam generator, heat transport system and other nuclear plant equipment. He assembled the engineering capability and technology for the design and manufacture of PWR and CANDU steam generators for replacement and new-build, furthered the development of project management capability to manage these very large, long duration, high risk projects and the development of full scope life-cycle management services for multi-unit CANDU plants, and supported the development of the Team CANDU partnership and other industry initiatives.

Outstanding Contribution Award – Keith Scott

The Outstanding Contribution Award recognizes Canadian-based individuals, organizations or parts of organizations that have made significant contributions in any field related to the beneficial uses of nuclear energy. These contributions may be either technical or non-technical. Contributions toward improved public safety are specifically included.

Keith Scott is the President (and Founder) of Atlantic Nuclear Services Ltd. Keith's technical knowledge and keen business sense have created a thriving science and engineering company which serves clients in Canada and beyond. Keith began his career in nuclear physics research but soon moved from the laboratory to the management of commercial nuclear projects with particular emphasis on risk management, training and licensing requirements. Over his career Keith has committed himself and his staff to the pursuit of technical excellence and the adoption of professional standards (as demonstrated by his numerous CNS papers on the subject). Always an advocate for looking beyond the borders of the nuclear industry, Keith integrates lessons learned from other industries (space, aviation, financial) into his mentoring activities for licensed staff.

Dan Meneley, CNS President for 2006-2007 (right), presents the Innovative Achievement Award to (left to right) Mukesh Tayal, Laurence Leung, and Ken Kozier. (Absent: Henry Chan)

Innovative Achievement Award – Team of: Ken Kozier; Peter Chan; Laurence Leung; Mukesh Tayal

The Innovative Achievement Award recognizes significant innovative achievement or the implementation of new concepts, which display clear qualities of creativity, ingenuity and/or elegance, and embody an impressive accomplishment in the nuclear field in Canada.

This team of physics, fuel and thermalhydraulics experts identified geometric enhancements to the configuration of the 43-element CANFLEX fuel bundle which could substantially improve its low-void-reactivity characteristics, while remaining within uncertainty margins. The variant design which they developed is a critical factor in optimizing the ACR-1000 fuel-bundle design for the required lattice pitch, while balancing fuel burnup and cost, and maintaining or enhancing physics and thermalhydraulics characteristics. It considerably enhances the ACR's attractiveness in the market. In addition, the same approach holds great promise for other low-void-reactivity fuel products, and should further enhance their performance and increase their attractiveness in the market.

Education and Communication Award – (2 awards) Engin Özberk and Scientists in Schools

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

Engin Özberk is an outstanding ambassador for the nuclear industry. He promotes nuclear science and technology among high school and university students, teachers and the community. He has been a strong supporter of the Deep River Science Academy and augmented the partnership between industry and academia through the creation of the Cameco Research Chair in Nuclear Fuel Science at the University of Ontario Institute of Technology.

Since 1997, Engin has been an active member of the CNS. He chaired the 9th International Conference on CANDU Fuel "Fuelling a Clean Future". At present Engin Özberk is the Director of Business and Technology Development of Cameco Corporation, coordinating several significant investment projects, including the process development activities for the SEU Blending Project to produce a new fuel for the CANDU reactors at Bruce Power.

Engin Özberk's tireless efforts in communicating uranium processing and nuclear power as a clean energy source have expanded over the years into multifaceted activities that endorse collaboration between the industry and universities and contribute to sustainable development of nuclear technology in the future.

Scientists in School (SiS) improves science education in elementary grades (1-8) in Ontario, from Ottawa through the GTA to Waterloo and Barrie. SiS provides classroom workshops (17000 in 2006-07, reaching over 380,000 students) led by local scientists and technical experts who facilitate an enriching experience for students, volunteers and teachers. The workshops are developed to the approved curriculum. SiS trains their presenters, and equips them for delivery in the classroom. Schools select workshops from the annual catalogue, and pay a fee for the delivery of each workshop. This unique program has grown each year in scope and area of coverage since its inception in 1989. SiS has had outreach activities in Newfoundland.

R. E. Jervis Award – (2 awards) Michael Broczkowski; Jared Smith

The R. E. Jervis Award recognizes excellence in research and development carried out by a full time graduate students in nuclear engineering or related fields who is pursuing research involving radiochemistry, radiation chemistry, chemistry in nuclear systems, or the use of nuclear research reactors in applied chemistry or chemical engineering studies. It is named after Robert Jervis a long-time professor of nuclear chemistry at the University of Toronto. The award carries a bursary of $1,000.

Michael Broczkowski is a highly regarded graduate student in the Department of Chemistry at the University of Western Ontario, and one of its most highly respected teaching assistants. His recognition as the Graduate Student Teaching Assistant of the Year in Chemistry in 2005 is the ultimate accolade in this regard. He is well known for his excellent laboratory skills, his ability to mentor new graduate students, and his ability to communicate the results of his research. The department is very proud of his award for the best student presentation at the 2006 Canadian Nuclear Society Annual Conference, especially since the student participation at that meeting was so high (34).

His research is at the core of the NSERC/Ontario Power Generation Industrial Research Chair in this department, and

Jared Smith (left) and Michael Broczkowski.

is recognized internationally as a very significant contribution to the area. The Department's association with the Canadian nuclear fuel waste management program has been a very significant development over the past few years, and Michael Broczkowski's contribution to this has been outstanding.

Jared Smith is one of the best graduate students in physical chemistry in the Department of Chemistry at the University of Western Ontario. He has received awards for excellence in physical chemistry and is an Ontario Graduate Scholar. He has brought prestige to the Department and the University with awards for his presentations at meetings of NACE International (The International Association of Corrosion Engineers) and the Canadian section of the Electrochemical Society.

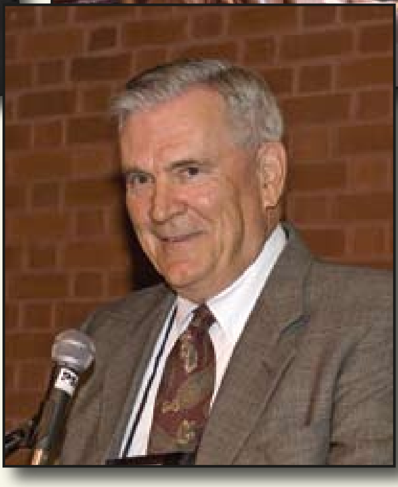
Jared's research is commercially funded by the Swedish Nuclear Fuel Company (SKB), an unusual circumstance for a graduate student in chemistry. He is very well respected by the technical representatives of SKB, and they consider the results of his research a key component of their program to demonstrate the feasibility of copper containers for the safe disposal of high-level nuclear waste. They are particularly pleased with his presentations at a number of international meetings (of the Electrochemical Society and the Materials Research Society).

Jared is a very mature student who has had no difficulty in combining the sometimes incompatible goals of applied and basic research. He has made a very significant contribution to the science of nuclear waste disposal.

Further views of the Annual Conference

Gaelan Thomas (right) presents a gift to NB premier Shawn Graham following the premier's address at the June 5 lunch during the 2007 CNS Annual Conference in Saint John, New Brunswick.

A view of the registration deck.



Charles Till, the W.B. Lewis Lecturer at the 2007 CNS Annual Conference, 4 June 2007.

Reactivity Initiated Accidents and Loss of Shutdown – 20 Years Later

by J.C. Luxat[1]

Abstract

A review of the safety of Ontario's nuclear power reactors was conducted in 1987 after the Chernobyl accident. As part of this review an analysis was performed of a Loss of Coolant Accident in a Pickering A unit with coincident failure to shutdown. This analysis showed that the power excursion was halted by channel and calandria vessel failures leading to moderator fluid displacement. The containment structure did not fail and, at worst, might sufer minor cracking at the top of the dome of the reactor building. Overall the dose consequences of such an accident were no worse than the limiting design basis dual failure event. In the intervening twenty years following this analysis, significant experimental information has been obtained that relates to power pulse behaviour. This information, together with conservatisms in the original analysis, are reviewed and assessed in this paper. In addition, the issue of reactivity initiated events in other reactor types is reviewed to identify the reactor design characteristics that are of importance in these events. Contrary to popular belief the existence of positive coolant void reactivity is not as significant a factor as it is sometimes stated to be. On balance, with appropriate design measures, no one reactor type can be claimed to be "more safe" than another. The underlying basis for this statement is articulated in this paper.

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Introduction

After the reactivity initiated accident in the Chernobyl Unit 4 reactor a review of the safety of Ontario's nuclear power reactors was conducted during 1987 by Prof. Kenneth Hare at the request of the Ontario Minister of Energy (Ref. 1). As part of this review an analysis was performed of a Loss of Coolant Accident in a Pickering A unit with coincident failure to shutdown. This analysis, conducted by Ontario Hydro (Ref.2,3), with independent analysis of channel failures performed by Argonne National Laboratories (Ref. 4), showed that the power excursion was halted by channel and calandria vessel failures leading to moderator fluid displacement. The containment structure did not fail and, at worst, might suffer minor cracking at the top of the dome of the reactor building. Overall the dose consequences of such an accident were no worse than the limiting design basis dual failure event.

This analysis has been judged by some to be speculative and, as a consequence of this judgment, the positive results showing limited consequences have tended to be viewed skeptically, if not negatively. However, in the intervening twenty years following this analysis, a large body of relevant experimental information relating to aspects of fuel and fuel channel behaviour under power pulse conditions has been accumulated. This information includes the collation and systematic assessment of a wide range of experimental fuel behaviour and failures under large power pulse conditions, information on fuel channel failures at high pressure, and information on the energetics of hot fuel-moderator interaction. This information is reviewed and analyzed in this paper to establish its relevance. Additionally, the significant conservatisms incorporated in the 1987 loss of shutdown analysis are reviewed and assessed. Based upon this re-assessment it is demonstrated that the analysis has indeed stood the test of time and remains both relevant and conservative for extremely low frequency reactivity events resulting in early core disassembly in CANDU reactors.

In addition to reassessing the loss of shutdown scenario, the issue of reactivity initiated events in other reactor types is reviewed with a view to identifying the reactor design characteristics that are of importance in these events. The position is advanced that, contrary to popular belief, the existence of positive coolant void reactivity is not as dominant a factor as it is sometimes stated to be. On balance, with appropriate design measures, no one reactor type can be claimed to be "more safe" than another. The underlying basis for this statement is articulated in this paper.

Part I: Reassessment of The Loss of Shutdown Event in a Pickering A Unit

Scope and Purpose of the Reassessment

Since the 1987 analysis was performed a number of significant pieces of information have become available that are of direct relevance to the results of the analysis. Some of the important items are;

- Improved estimates of coolant void reactivity and delayed neutron fractions for CANDU lattices,
- Identification and quantification of fuel string relocation reactivity effects,
- Improved understanding and consolidation of the available international database on oxide fuel behaviour under rapid energy deposition conditions,
- Experimental data on the interaction of molten fuel and moderator liquid following a fuel channel failure,
- Experimental data on failure of fuel channels at high pressure and temperature conditions.

This information is reviewed in this paper and the relevance of this information to key phases of the loss of shutdown scenario is established. It is demonstrated below that this information supports the failure criteria that were employed in the original analysis and that the failure event sequence and consequences remain essentially unchanged by new information.

Additionally, a number of significant conservatisms were applied to key phases in the failure sequence. They were intentionally imposed on the analysis to maximize the energy release to the containment atmosphere. These conservatisms are revisited and their physical reasonableness is re-assessed in order to establish their impact on the calculated consequential challenge to containment integrity. It is shown in this paper that the challenge to containment integrity was conservatively over-predicted in the original analysis – the implication of this finding is that there is greater margin to impairment of the containment envelope than originally predicted.

The reassessment is structured to focus upon the following key phases of the short-term accident progression:

- Neutron kinetics excursion
- Fuel Response during the Power Pulse
- Fuel channel Failure
- Moderator displacement, and
- Containment Response

Each of these areas is discussed below.

Neutron Kinetics Excursion

The variables and parameters governing the reactor kinetics excursion are the void reactivity, delayed neutron fraction and the prompt neutron generation time. Other influencing factors are the reactivity feedbacks, such as fuel temperature (Doppler), fuel string relocation and Xenon burnout.

Of these parameters, the void reactivity has been subjected to the most intense scrutiny over the past decade due to issues relating to the magnitude of the void reactivity uncertainty allowance. This has resulted in a more definitive statement of the void reactivity uncertainty allowance and, by application, in the void reactivity itself. In the 1987 analysis the assumed value of full-core void reactivity was assumed to be +13.4 mk. This corresponded to the upper bound of the uncertainty range at that time. With the revised void reactivity uncertainty allowance the best estimate of full-core void reactivity for a Pickering A equilibrium fuelled core is +15.6 – 2.0 mk = +13.6 mk, which is marginally different from the value used in the original analysis. The relevant coolant void reactivity during the early power excursion is the half core void reactivity associated with coolant voiding in the broken heat transport loop. The half-core void dynamic reactivity of 8.5 mk, which accounted for the effect of the side-to-side flux tilt induced by the coolant voiding, is not significantly different from the current best estimate. Finally, and most importantly, the transient void reactivity during the early part of the transient is governed by the voiding in the affected pass of the broken loop (i.e. quarter core voiding) since coolant void in the other pass develops much more slowly.

The total delayed neutron fraction assumed in the analysis was 0.005849 (β = 5.849 mk). This value is marginally higher than the current best estimate value of 0.00550 (β = 5.550 mk) which is 5% lower. The effect of variation in the value of β is addressed by the dynamic sensitivity analysis discussed below.

Fuel string relocation reactivity was not included in the original analysis. The assumed break was a guillotine rupture of a reactor inlet header and, therefore, a rapid insertion of approximately -0.7 mk from fuel string relation is assured. On account of this incremental and rapidly inserted negative reactivity, the original initial positive reactivity transient is over-predicted and the power excursion will develop over a slightly longer time period. The difference in the transient power excursion does alter the energy deposition transient and does alter the timing of the first fuel channel failures – failures delayed by approximately 0.3 seconds, as shown below.

The effects of variations in the different neutron kinetics parameters on the energy deposition in the fuel are quantified by evaluating the dynamic sensitivity variables as follows. The energy deposition sensitivity variables are defined with respect to the following variables and parameters:

- The neutron flux $\eta(t)$ in normalized full-power units,
- The normalized energy deposition $E_d(t)$ in units of full-power-seconds deposited from time $t = 0$ to time $t = \tau$.
- The net reactivity transient, $\rho(t)$
- The transient void reactivity $\rho_{void}(t)$ and
- The transient fuel string relocation reactivity, $\rho_{fuel\_string}(t)$
- The total delayed neutron fraction, β

The change in energy deposition up to a time t = τ is evaluated using these dynamic sensitivity variables and the following perturbation equation:

$$SE_1(\tau) = \frac{\partial E_d(\tau)}{\partial \rho}$$

$$SE_2(\tau) = \frac{\partial E_d(\tau)}{\partial \rho_{void}} = SE_1(\tau)$$

$$SE_3(\tau) = \frac{\partial E_d(\tau)}{\partial \rho_{fuel\_string}} = SE_1(\tau)$$

$$SE_4(\tau) = \frac{\partial E_d(\tau)}{\partial \beta}$$

$$E_d(\tau) = \int_0^{\tau} \eta(t)dt$$

The sensitivity variables, SE_1 and SE_4 associated with the original analysis assumptions are shown in Figure 1 and the change in energy deposition relative to the original assumptions

$$\Delta E_d(\tau) = SE_2 \Delta\rho_{void} + SE_3 \Delta\rho_{fuel\_string} + SE_4 \Delta\beta$$

is shown in Figure 2 and Table 1. These results show that the original analysis remains conservative, primarily because of the effect of fuel string relocation negative reactivity that was not included in the original analysis.

It is important to note that the sensitivity of energy deposition does not change significantly when the reactor becomes prompt super-critical – in fact the sensitivity shows a marked increase only at times greater than 1 second after achieving prompt criticality. This behaviour is very different from reactors, such as PWR or fast breeders with much shorter prompt neutron generation times, for which there is a very rapid escalation of neutron flux immediately following prompt criticality.

Table 1: Effect of Changes in Reactor Kinetics Parameters on Timing of Fuel Melting and Fuel Channel Failure

	Original Analysis Assumptions	Revised Analysis Assumptions
Time of first fuel melt relocation [seconds]	3.3	3.6
Time of first fuel channel failure [seconds]	3.7	4.0

Fuel Behaviour

A large body of experimental data on uranium dioxide fuel behaviour under Reactivity Initiated Accident (RIA) conditions has been accumulated since 1987. This data encompasses many different fuel designs including PWR, VVER, BWR and prototypical CANDU fuel. The tests were performed predominately in test reactors with very short pulse widths (half-power pulse widths in the region of 4 ms), although one set of test data from the Russian IGR reactor involved much wider pulse widths similar to those in CANDU.

This experimental data base has been reviewed and assessed relative to CANDU fuel and power pulse conditions (References 5,6) and relative to LWR fuel (References 7,8). The results of this work reported in References 5 and 6 establish that this data is a) relevant and b) can be utilized, with appropriate analytical corrections, to assess CANDU fuel response. Specifically, with regard to fuel behaviour under loss of shutdown conditions, the experimental data supports the predicted fuel failure mechanisms and the impact on subsequent fuel channel failures. The dominant failure mode is associated with the formation and relocation of relatively limited and localized quantities of molten fuel sheath and UO_2 material.

Consider now the sensitivity of molten fuel relocation to energy deposition. Energy deposition is highest in the outer elements of the bundles experiencing the highest transient powers during the power excursion. This localizes the number and location of channels, as well as the bundle locations and element positions in bundles that will experience earliest fuel melt formation. None of these considerations are significantly changed by variations in the kinetics parameters controlling the power excursion that was discussed in the previous section. However, what does change somewhat is the time over which the melt formation and relocation occurs. As noted above, the effect of fuel string relocation reactivity is to delay the transient power escalation. As the local energy deposition increases, the central melt region in the fuel pellets in the outer fuel elements of the highest powered bundles will increase. Increasing the amount of fuel melting increases the internal driving force for melt relocation due to the volumetric expansion when solid UO_2 liquefies. This volumetric expansion will increase the interfacial contact pressure between the outer surface of the fuel pellet and sheath, thereby increasing the heat transfer rate between the two fuel element components. Additionally, the surface region of the fuel pellet receives a larger fraction of energy deposition than the central region because of the "self-shielding" flux depression within an element. Rapid escalation of fuel sheath temperatures in the affected pass of the broken loop will occur and relocated molten fuel cannot re-solidify at the outer edges of a pellet.

In the unbroken pass of the broken loop the coolant flow remains high and there is significantly less void than in the affected pass of the broken loop. Therefore, both the fuel elements and the pressure tubes in this pass will experience high convective cooling for a longer period of time. This will delay fuel channel failures in this pass relative to the affected pass – an effect which was not credited in the original analysis, where for conservatism it was assumed that channels in the two passes would behave identically based upon their initial element ratings and energy deposition in the fuel.

Rapid relocation of molten Zircaloy and UO_2 onto the pressure tube occurs from the outer elements at the bottom of the fuel channel. The molten UO_2 relocation is expected to be mildly forcible – in the nature of a "squirting" flow driven by the large increase in UO_2 linear expansion that occurs during the solidus-to-liquidus transition, as has been observed in separate effect rapid direct electrical heating (DEH) tests performed on fuel element segments at AECL Chalk River. However, should there be any appreciable delay in the localized relocation of molten material onto the pressure tube, then the superheat of the molten material at the pellet centre will increase while the molten fraction of the pellet will rapidly increase until most of the pellet is melted. This will occur for the outer elements of the highest powered bundles. Fuel melting in the other rings of elements in the bundle will not yet have started while this melt escalation occurs in the high powered outer elements. This dependency on energy deposition in a fuel pellet is shown in Figure 3. Additionally, expansion of fission gas in the melt will assist the process of forced ejection of molten material from the pellet onto the pressure tube.

The important point is that, irrespective of whether a lesser or greater forced ejection of molten fuel material occurs, the molten material ejection will be localized to outer elements of high powered bundles in a localized group of channels in the broken loop. Fuel channel failures are driven by this localized overheating and limited melt relocation and not by widespread gross melting of fuel in an entire channel – conditions that the fuel channel could not develop without prior rapid failure. This failure behaviour in a CANDU loss of shutdown accident should not be confused with the formation of large quantities of molten material in an LWR vessel and the subsequent discharge of this molten material into containment – the so-called high pressure melt ejection scenario in LWR severe accidents that can lead to direct containment heating phenomena.

Fuel Channel Failure

Failure of a fuel channel was predicted in the 1987 analysis to occur shortly following relocation of some molten fuel material. This conclusion remains valid and is supported by a series of separate effects test data from various experiments performed in the COG R&D program – albeit that the tests were not specifically designed to address loss of shutdown conditions. Nevertheless, these test results do demonstrate very clearly the fact that channel failures will occur very rapidly once heat loads and deformation conditions are pushed to extremes on pressure tubes and calandria tubes.

First, from the results of contact boiling tests it is observed that at high channel pressures, typically greater than 6.5 MPa, with relatively high heatup rates at power levels representative of decay heat, rapid localized deformation of pressure tubes occurs which invariably results in pressure tube failure due to localized thermal creep strain. In LOCA/loss of shutdown conditions the fuel channels experience high pressures in the range of 5 to >14 MPa when molten fuel relocation starts – depending upon the heat transport pass and loop. These pressures in the channels, together with the very high heat flux onto the surface of the pressure tube wall ensures both rapid thermal creep strain failure of the pressure tube and the calandria tube following melt relocation.

Second, experiments involving molten Zircaloy interaction with a ballooned pressure tube contacting a calandria tube, as well as separate effects experiments investigating fuel channel rupture under conditions simulating extreme flow blockage in a channel, have been performed subsequent to the 1987 analysis. The results from these tests indicate that channel failure occurs very shortly after melt relocation for pressures above 5 MPa and for relatively small amounts of relocated molten Zircaloy-4 (approximately 120g). As discussed above, the molten material undergoing relocation will include significant amounts of UO_2 in addition to Zircaloy-4 and will have mass of the order > 1kg. The UO_2 melt has higher thermal capacitance and higher temperature and will experience significant increase in volumetric fission heat generation rate once it relocates out of the element (due to the higher thermal neutron flux at the pressure tube relative to the outer elements of the fuel bundle). Additionally, the mass of locally relocated material from outer elements onto the bottom of the pressure tube will increase over a short period of time.

The experimental information regarding rapid channel failures is consistent with the predicted results of the analysis, which indicated channel failure occurring within about 0.22 to 0.5 s of molten material contacting the inner wall of the pressure tube, depending upon the local pressure and melt conditions. Increasing the local temperature, amount of melt or melt temperature reduced the time to channel failure. This is consistent with observations from the channel flow blockage experimental tests. This conclusion can be further demonstrated by the data plotted in Figure 4 which shows the relevant conditions of the experiments and the conditions associated with the loss of shutdown scenario. As is clearly apparent from this figure the loss of shutdown conditions are significantly more severe than the experimental tests and projected failure times are consistent with those calculated in the 1987 analysis.

The consequences of channel failure on the moderator displacement response and calandria vessel failure remain valid. In particular, the interaction of fuel debris, including the limited amount of molten fuel will behave according to the forced interaction model used in the original analysis. This is supported by the results of recent CANDU Owners Group (COG) experiments on molten fuel-moderator interaction (MFMI) conducted at AECL's Chalk River Laboratories.

Containment Response

In the 1987 analysis a number of significant conservative assumptions were applied to the analysis of the containment response. Since containment integrity is a major governing factor for off-site releases it was considered prudent to apply these conservatisms in order to bound uncertainties. This was necessary given a) the very short time period over which the analysis was performed, and b) the very high profile of off-site releases from the Chernobyl Unit 4 accident. The two most important assumptions were:

- Although the pipe break was assumed to be a RIH guillotine rupture (in order to maximize the coolant voiding), the break discharge was assumed to occur directly in the reactor building (RB) to maximize pressure and hence maximize the loading on the containment envelope.
- The coolant discharge from the ruptured channels in the calandria was assumed to discharge directly into the calandria vault. This leads to the earliest and largest steam discharge from the calandria vault into the reactor building.

In reality, an inlet header break discharges into the fuelling machine vault and from there into the reactor building volume. Such a flow path will reduce the steam discharge into the RB and limit the rate of pressure rise in the RB. Secondly, when the fuel channels fail and initiate displacement of the moderator fluid, a significant amount of the initial steam discharge will be condensed in the cold moderator fluid during the displacement transient. Additionally, a significant fraction of the energy of the ejected fuel debris will be transferred to metal structures in the calandria which will result in delayed steam generation from this source. Removal of discharge energy by these two heat transfer mechanisms will reduce the rate and amount of steam discharged into the calandria vault, thereby reducing the steam discharge rate into the RB. In addition, discharge from failed channels is initially into the calandria vessel and the flow rate from the vessel is limited by the area openings – part of the discharge being directed into the fuelling machine vault via the calandria relief ducts and part into the calandria vault via the rupture area in the vessel.

The effect of reduced steam discharge rate and the short term integrated mass discharge into the RB was clearly apparent in the original sensitivity results performed for three different steam discharge scenarios – the base case, early termination and worst case scenarios.

If the following assumptions are made:

- heat transport system break occurs in the fuelling machine vault (consistent with the postulated break location)
- the steam discharge rate is limited by the opening areas on the calandria vessel with half the flow going into the FM vault and half into the calandria vault, and
- energy removal by direct contact condensation of steam discharged into the calandria vessel prior to and after vessel failure is taken into account,

then the peak reactor building pressure for the three different cases is estimated to be reduced as follows:

1. From 160 kPa(a) to approximately 140 kPa(a) for the base case (190 channels fail within 2.5s of calandria vessel failure)
2. From 157 kPa(a) to approximately 137 kPa(a) for the early termination case (90 channels fail within 2.5s of calandria vessel failure), and
3. From 180 kPa(a) to approximately 160 kPa(a) for the upper bound case (390 channels fail within 2.5s of calandria vessel failure)

Since the design pressure of the containment structure is 142 kPa(a), then only for the upper bound case does the reactor building pressure exceed design pressure. The most likely channel failure process will involve a limited number of channels (2 to 3) failing initially in the affected pass of the broken loop followed by a significantly more gradual failure of additional channels in the broken loop over the next 20 seconds - approximately 40 based upon the energy depositions experienced in the various fuel channels. However, retaining some conservatism and assuming that the total number of failed channels remain the same for the three cases, but occur over a period of 20 seconds, then the peak RB pressures for the three cases are further reduced such that in all cases the pressure is below the design value. Therefore, based upon these more realistic assumptions, containment integrity is assured with significantly greater margin than originally predicted in the 1987 analysis. Not even minor cracking of the dome concrete will occur.

Findings and Conclusions of the Reassessment

Reassessment of the 1987 analysis of a large break LOCA in a Pickering NGS A unit accompanied by a loss of shutdown has shown the following:

1. The impacts of findings regarding reactor kinetics parameters over the last 20 years have had a small net effect on the calculated power excursion in such an event. The effect is primarily to reduce the rate of power escalation because of the negative fuel string relocation reactivity effect.
2. Experimental data on fuel behaviour under power pulse conditions and rapid heating leading to melting do not contradict the governing phenomena, behaviour and key assumptions made in the 1987 analysis.
3. Experimental data regarding fuel channel failure under high pressure, temperature and heat flux conditions and with molten fuel element material (Zircaloy-4 sheath material) exhibit rapid failures that are consistent with those calculated in the 1987 analysis.
4. Reassessment of the effects of major conservatisms applied in calculating the pressurization of containment shows that the 1987 analysis significantly over-predicted the peak pressure in the reactor building. Therefore, it can be concluded that the margin for integrity of the containment envelope is significantly higher than originally stated in the 1987 analysis. Most probably not even minor cracking of the dome concrete will occur.

The important overall conclusions that can be drawn are as follows:

- The discharge of steam from a failed calandria vessel must consider the available physical heat transfer mechanisms and compartment volumes. This becomes the dominant discharge into containment volumes over and above the discharge from the initiating LOCA pipe rupture and determines the extent of over-pressurization of the containment envelope. Thus, containment integrity margins can be expected to be larger than in Pickering A for designs which have water filled reactor (calandria) vaults (Pickering B, CANDU-6) or shield tanks (Bruce A & B, Darlington) which will further condense steam discharged from a failed calandria vessel, or for plants which have large multi-unit shared containment volumes (Bruce A & B, Darlington). Since Pickering A has acceptable margin it may be inferred that the margins for other CANDU plant will also be acceptable.
- The original 1987 analysis was considered at the time by some, and to this date by others, to be speculative. This reassessment has demonstrated that the analysis was in fact robust and the conclusions remain significantly conservative and essentially unchanged by knowledge gained and discoveries made in the intervening years.
- CANDU plants are capable of withstanding extremely unlikely events causing early core disruption without significant risk to the public.

Part II: Reactivity Initiated Accidents in Water Reactors

Over the years a lot has been written and said about mitigating the effects of fast reactivity initiated accidents in water reactors. In the early days of nuclear power development there was a divergence in views between the light water reactor (LWR) and heavy water pressure tube reactor proponents. This was reflected in many instances by blanket statements regarding the acceptability of designs having positive reactivity coefficients, for example the position stated in the classic text by T. Thompson, page 622 of volume 1, [Reference 9] with a footnote regarding rebuttal comments by W.B. Lewis and D.G. Hurst. It is worth noting that these issues regarding positive reactivity feedback in water reactors did not deter the development of fast breeder technology in the same period – even though these reactors had large prompt positive reactivity feedback mechanisms.

The occurrence of the Chernobyl Unit 4 accident re-ignited this latent controversy and the same arguments centred about positive coolant void have reappeared, but now with an assumed moral imperative of preventing such an event from occurring again. The competitive nature of a reactor market that essentially disappeared in North America after TMI-2 and Chernobyl has given these arguments a sharper, and some might say nastier edge. They have also caused confusion in regulatory jurisdictions where conformance to international standards has become a necessity – albeit that the international standards may have in-built technology bias.

Given this background it is desirable that some of the inherent features of different designs be re-examined and put into perspective – otherwise invalid conclusions could be drawn by some regarding the relative safety of different reactor types. This will be addressed below in the context of rapidly developing reactivity initiated accidents.

Item 1: Positive reactivity holdup (defect)

Reactivity is like an accountant's double column ledger – there are positive and negative entries (credit and debit columns). For example, in CANDU there is positive coolant void reactivity which on a normalized-beta basis is approximately +$2.5 for full core voiding or +$1.5 for half-core voiding. PWR's have a positive moderator temperature reactivity feedback of the order of +$8 to +$12 for rapid under-cooling events (e.g. steam line break) and a very rapid positive reactivity of up to +$1.5 for a single rod ejection accident.

Item 2: Prompt neutron generation time

CANDU, because of it's distributed fuel lattice, has a prompt neutron generation time of approximately 0.89×10^{-3} s, whereas PWR, with their tight lattice cores have prompt neutron generation times in the order of 0.18×10^{-4} s.

Considering these two items the following observations can be made.

1. A +$1.5 increase in reactivity can be inserted over approximately 2.5 or more seconds as a coolant voiding ramp in a CANDU, whereas the same magnitude of reactivity increase can occur as an approximate step change associated with high pressure ejection of a control rod in a PWR. With this magnitude of reactivity increase taking both reactors super-prompt critical, the time taken for the reactor power level to increase by a factor of 5 is approximately 1800 ms in a CANDU and 6 ms in a PWR. Clearly, the rate of power rise in a PWR is beyond the physical capability of any shutdown system and necessitates that there be prompt large fuel temperature (Doppler) feedback to limit the magnitude of the power excursion. Given the significantly longer time taken for the power level to escalate to the same level in a CANDU, there is ample time for fast-acting engineered shutdown systems to act.
2. The above observation indicates that positive coolant void can be safely accommodated by fast-acting shutdown systems in reactors with prompt neutron generation times of the order of 1 ms. It also suggests that it was the lack of a fast-acting shutdown system in Chernobyl Unit 4, and not necessarily the positive coolant void reactivity that was the root cause for the extremely large and damaging power excursion. The Chernobyl shutdown system was woefully slow requiring 12 seconds to drive the rods from fully out to fully in the core. A fast acting shutdown system such as either of the two independent systems in CANDU would have terminated the power excursion without any extreme consequences – probably only limited fuel sheath failures at most.
3. The larger the amount of reactivity holdup in a reactor (the reactivity defect) the larger is the required reactivity depth of engineered shutdown systems. Hence, for steam line breaks in a PWR there is an issue of re-criticality which requires operation of two shutdown systems – rods plus boron addition.

The above observations indicate that one should not claim that one well engineered reactor type is "inherently safer" than another well engineered reactor type. Conversely, a poorly engineered reactor system when coupled with poor safety culture can be more susceptible to damaging events, irrespective of the reactor type. This is a lesson we should not forget and most definitely it is a lesson that should not be misused in order to gain a perceived competitive advantage.

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Figure 1: Dynamic Sensitivity Of Energy Deposition To Reactor Kinetics Parameters
SE_1 = Sensitivity to reactivity (FPS/mk)
SE_4 = Sensitivity to delayed neutron fraction (FPS/mk)

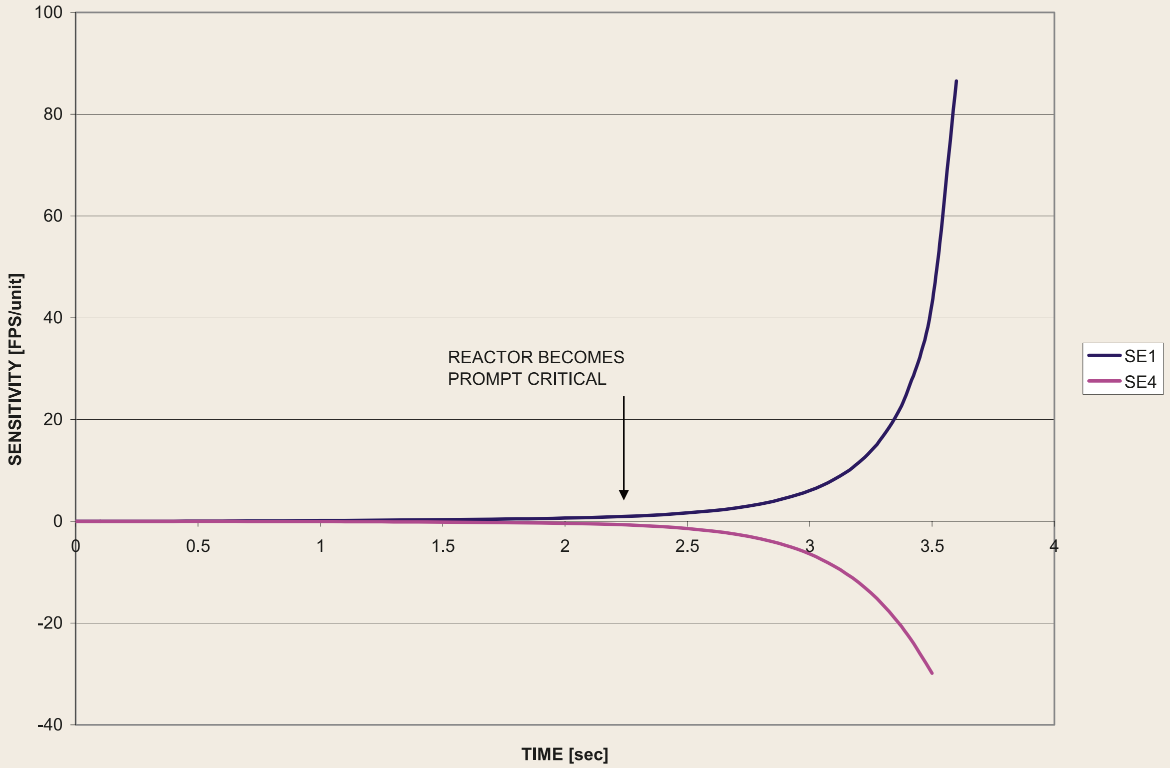


Figure 2: Change In Energy Deposition Due To Reactor Kinetics Parameters
Reactivity = Fuel string relocation = -0.7mk
Beta = 5% reduction in total delayed neutron fraction

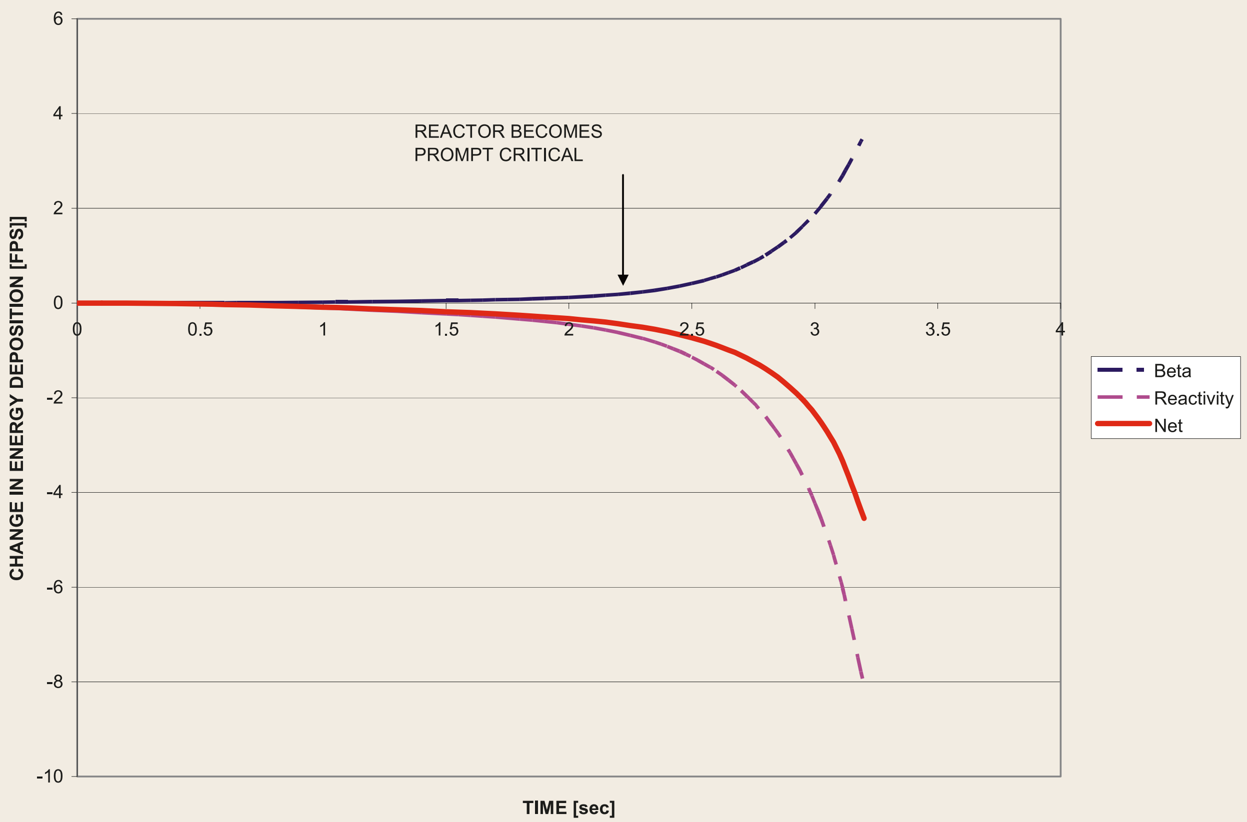


Figure 3: Energy Deposition In Full-power-seconds Required For Onset Of Fuel Melting As A Function Of Initial Element Linear Power Rating

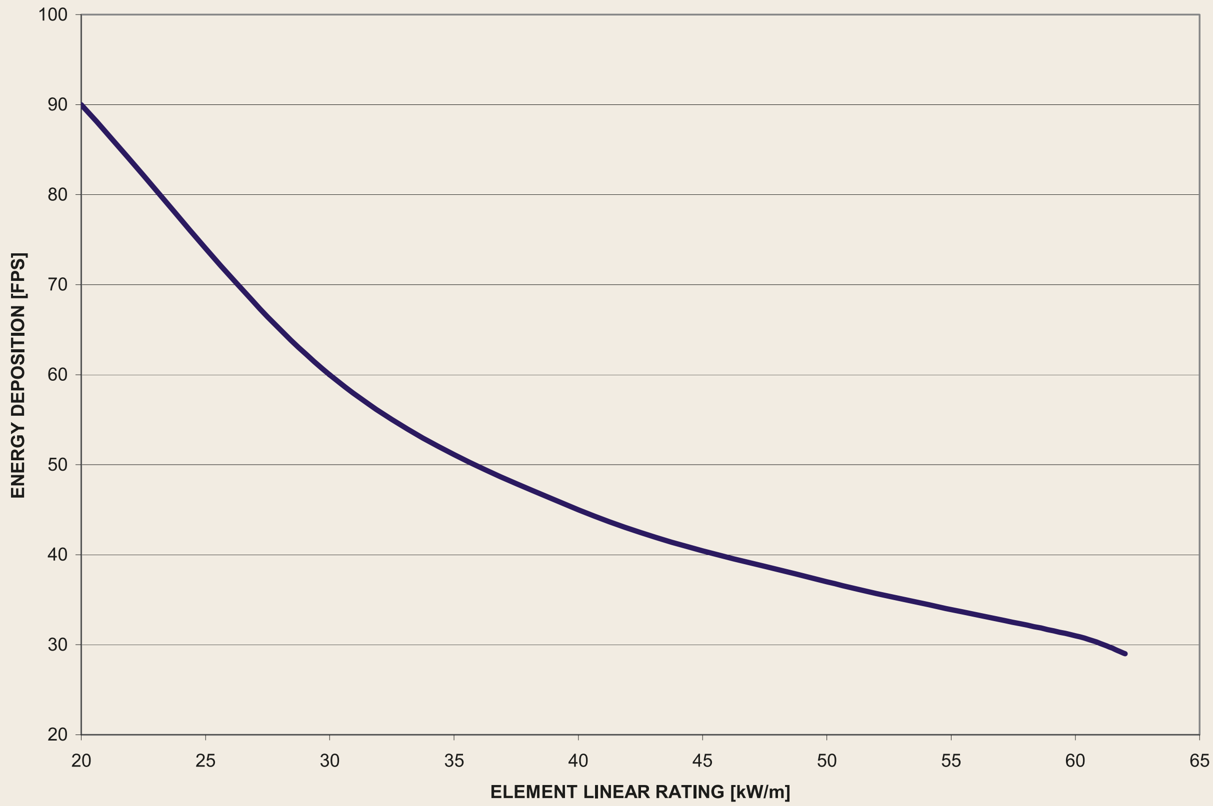
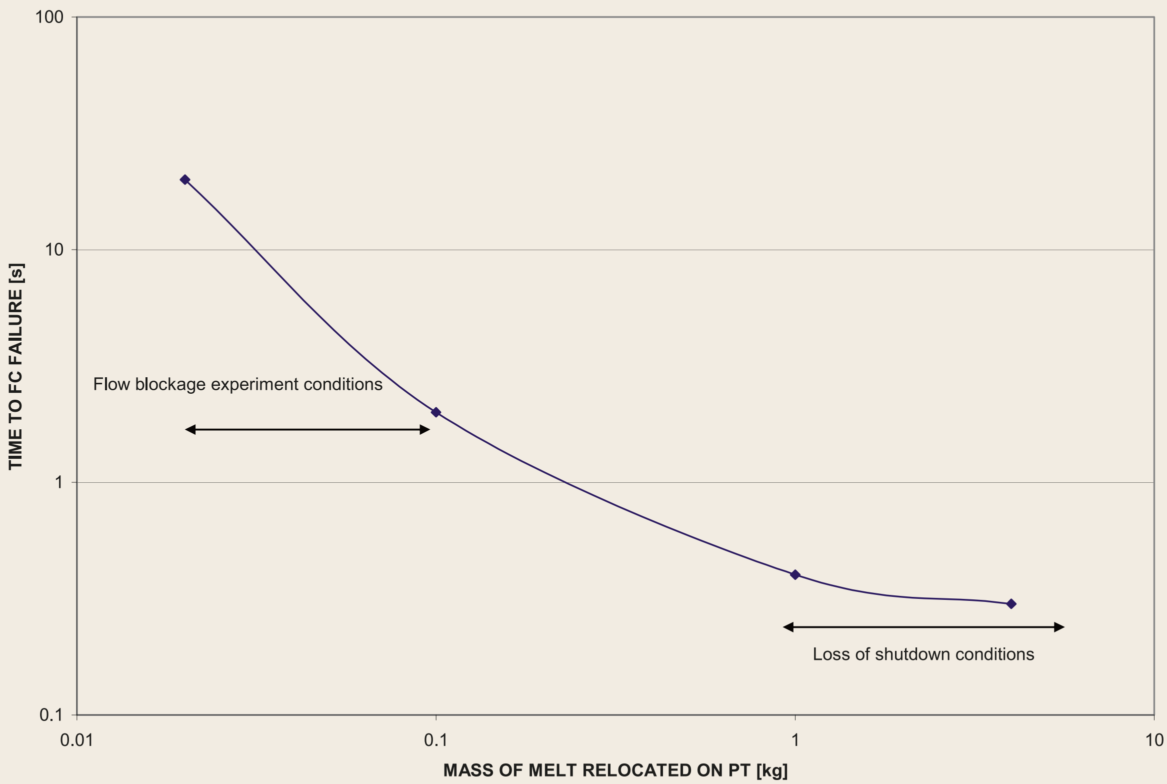


Figure 4: Time To Fuel Channel Failure After Melt Relocation As A Function Of Melt Mass Relocated



Bruce A Refurbishment – An Update

by Rob Liddle

***Ed. Note:** On June 13, 2007 the first new steam generator was placed in Unit 2 of the Bruce A nuclear station. Just days previously, Rob Liddle, of Bruce Power's communication group, provided some words and photographs on the status of the huge refurbishment project underway and shortly afterwards provides a photograph of the installation of the first steam generator. With great thanks to Rob we offer a slightly edited version of his contribution.*

Running slightly ahead of schedule on the critical path work, the Bruce A Restart Project has not been without its challenges.

About a dozen major contractors with a workforce of 1,700 tradespeople share space inside the Units 1 and 2 Construction Island. They share support services, provided by project management contractor AMEC NCL, and they share the consequences when one part of the project advances ahead of schedule or another falls behind. They also share Bruce Power's safety values and are well on their way to surpassing five-million hours without an acute lost time injury.

Retubing

On May 17, AECL's Bruce retube team began severing pressure tubes in Unit 2. The team used remote-controlled tools for the task, operated from a state-of-the-art Retube Control Centre (RCC).

The RCC is a two-storey structure located between the Unit 1 and 2 reactor vaults on the same elevation as the station's turbine floor. The lower level of the RCC houses the controls for the Unit 2 vault, while the upper level is still being established for the Unit 1 controls.

The tools themselves are mounted to pairs of work tables on automated work platforms on both ends of the reactor. Each work platform, attached to ball screws, goes up and down via a Y-drive while the work tables go from side to side on X-tracks. From the tables, the tools can access three rows of fuel channels.

The current operation involves a series of Shield Plug Insert and Removal Tools (SPIRTs) and Pressure Tube Severing Tools (PTSTs).

"The SPIRT homes in and locks onto the end fitting," said Ken Brown, Resident Engineering Manager for the retube team. "It extends a ram that picks up the shield plug and brings it back to the tool. The work table aligns the Pressure Tube Severing Tool with the end fitting. The severing tool extends and severs the pressure tube from the end fitting."

The PTST uses a rotary drive with a carbide blade. It is equipped with a vacuum system for debris and also a microphone.

"There are three ways to confirm the pressure tube is cut," Ken said. "The travel-distance of the cutter, the free spin of the cutter or torque levels and the sound it makes; a very distinctive crack."

A view of the first new steam generator being lifted into place into unit 2 by the huge Mammoet crane on June 13, 2007.

After the pressure tube is severed, the SPIRT reinserts the metre-long shield plug.

The Restart Project was announced on Oct. 17, 2005. Preparations got underway almost immediately but work didn't begin in earnest until the project's environmental assessment was accepted by the Canadian Nuclear Safety Commission on July 5, 2006.

During the summer, Babcock & Wilcox (B&W) completed

To give an appreciation of the size of the steam generators, this view shows tradespeople from Comstock Canada working in a temporary storage building on new steam generators for Unit 2. Comstock is a subcontractor on SNC-Lavalin Nuclear's steam generator replacement team.

the installation of existing bulkheads in the Unit 2 reactor vault and a massive cleanup ensued to remove legacy contamination and reduce tritium to levels that would not require workers to wear respiratory protection or air-supplied plastic suits. A pressure test in late summer confirmed the vault was isolated from the station's common containment system.

The retube team was given priority access to the vault on Sept. 25 and worked to remove closure plugs from the 480 fuel channels. Over the winter months, the team removed the lower segment of each feeder tube and completed laser scanning to provide as-found measurements. E.S. Fox Ltd. is using the data and original specifications to manufacture new segments for installation after new fuel channels have been installed.

In early June, work crews were preparing the Unit 1 vault for a high heat window to boil residual coolant out of the reactor's ancillary systems. Most of the heavy water coolant had already been drained, bulkheads installed and the vault isolated. The retube team was working on the installation of work platforms.

Steam Generators

In Unit 2, the installation of the first new steam generator - perhaps the most symbolic milestone of the entire project - was installed on June 13. The steam generators were the beginning of the end for Bruce A back in 1995, when Unit 2 was mothballed because of stress corrosion cracking in the vessels.

SNC-Lavalin Nuclear manages the steam generator replacement team and is also responsible for clearing away the pipes, cables and structural interferences that impede change out. They've employed one of the world's largest cranes for the task and already it has lifted two steam drums out of the way and removed four of the unit's old steam generators out through the roof of the reactor building. The individual steam drums exceed 250 tonnes and the steam generators, each about the size of a school bus, weigh more than 100 tonnes.

Bruce Power has taken delivery of eight new steam generators from B&W for Unit 2 and eight more are on the way this year for Unit 1.

The Unit 1 and 2 Restart Project also includes turbine generator overhauls and 178 balance-of-plant projects ranging from the installation of secondary control areas to fire protection upgrades.

In 2006, Bruce Power became the first Canadian company in a generation to embark on the regulatory process towards building new reactors. The company also identified a need to refurbish the four existing reactors at Bruce B as they reach the end of their current life cycles during the next decade.

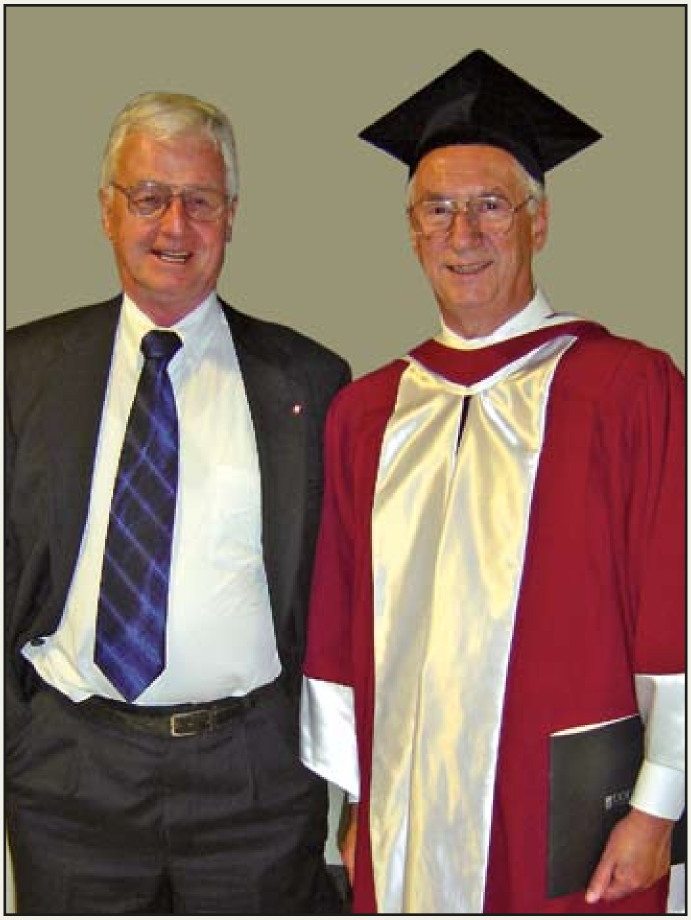
With other nuclear operators considering the same options there is plenty of work to be shared if it comes about. As always, arguments persist in the media about industry cost overruns and project delays, in spite of recent success abroad. There is a lot riding on the successful delivery of the Bruce A Restart Project.

"It would not be an overstatement to say that the future of our industry and this company is inextricably linked to the success of our Restart Project," said Duncan Hawthorne, Bruce Power President and CEO. "I am confident we have the skills and capabilities on our site and through our contractual arrangements with high quality companies to successfully deliver this important project."

Go to the excellent Bruce Power website for up-to-date information on the refurbishment project.

Electrical Engineer David McDonald and Electrician Joel Merswolke monitor a test of the Pressure Tube Severing Tool on a reactor mockup in Bruce Power's Technical Mockup Building.

UOIT Graduates First Nuclear Engineers



George Bereznai, Dean of the School of Engineering Systems and Nuclear Science, is seen (R), in all of his graduation glory, following the first convocation of the University of Ontario Institute of Technology, June 1, 2007, with Don Anderson (L), former vice-president at Ontario Hydro, who attended the ceremony with current executive vice-president of Ontario Power Generation, Pierre Charlebois (who was not available for the photograph).

On June 1, 2007, the University of Ontario Institute of Technology held its first convocation since its creation just five years ago. Among the almost 700 graduates were the first 40 from the nuclear engineering program.

Despite the youth of the university and its technical focus the convocation was carried off with all of the pomp and decorum associated with the ceremony at much older institutions despite what may be considered less than auspicious venue.

The ceremony was held in the General Motors Centre in Oshawa, a hockey arena. However, the organizers had installed a large purple curtain across the middle of the rink area and erected a stage, for dignitaries and presentation of degrees, in front. The ample seating of the half arena provided more than sufficient seating for guests.

There were actually two ceremonies, one in the morning, the other in the afternoon. The nuclear class was in the morning ceremony, which included Bachelors of Arts; Engineering; Engineering and Management; Science in Nursing; and Science. The afternoon session included Master of Information Technology Security; Bachelor of commerce and Bachelor of Education. The two largest groups were nursing and education.

After senior university representatives and invited dignitaries, all robed, were seated on the stage, classes of graduating students marched in, each proceeded by a student carrying a "gonfalon", a flag that hangs from a crosspiece They originated in the medieval republics of Italy as ensigns of state or office. Many universities around the world have adopted gonfalons as college or institutional insignias.

Among the officials on stage was George Bereznai, Dean of the School of Engineering Systems and Nuclear Science, who greeted each of the 40 graduates from the programs he oversees. There were actually 36 who received a Bachelor of Engineering, Nuclear Engineering degree, three a Bachelor of Science in Health Physics and Radiation Science and one a Bachelor of Engineering Management, Nuclear. Eleven of the 40 were women.

Opening the ceremonies, the Provost, Richard Marceau, noted the historic nature of the event as the very first convocation of UOIT. President Ron Bordessa continued that theme by telling the graduating students that they were special, "cream of the crop". He congratulated them not only on their graduation but also for having the vision, four years previously, to enrol in a brand new university. "You are all risk takers", he told them.

Bordessa then called on David Sanborn Scott to receive an honorary Doctor of Science degree. Sanborn has been a long-standing advocate of fuel cells, hydrogen technology and a supporter of nuclear energy as the source.

In his acceptance speech, Sanborn referred to the beginning of the University of Victoria, where he established an Institute for Integrated Energy Systems. "There is something special about original students and professors", he commented. He went on to extol the virtues of nuclear energy and suggested that some of the graduates in related disciplines should consider journalism as communicating the benefits of nuclear energy is desperately needed. Nuclear and hydrogen form a solution to the challenge of an energy source that meets the environmental challenge, he stated. In closing he urged the graduating students to have "a will to engage in history".

After the presentation of the degrees the Provost invited everyone to enjoy refreshments. "This has been the first step in making a great university", he said in closing the ceremony.

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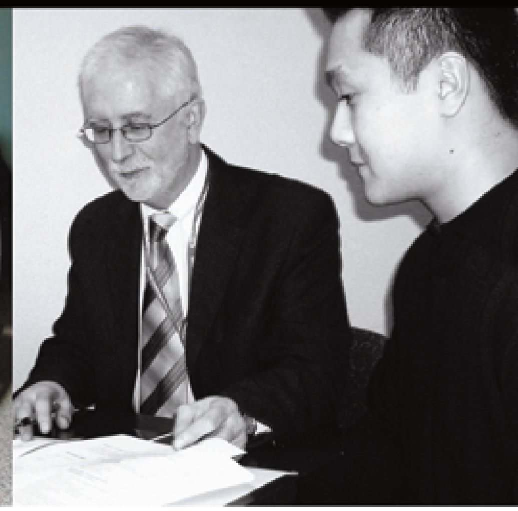
AMEC NCL is the project management contractor for the Bruce Units 1&2 restart project; the largest nuclear refurbishment project in the world. This is a four year project and incorporates, amongst many other activities, the replacement of the steam generators, a first for a CANDU plant.

Some of AMEC NCL's key responsibilities include: project, contract and construction management, along with the provision of procurement engineering and design authority services on behalf of Bruce Power. The first restarted unit is expected to be online in 2009.

For more information visit: www.amecncl.com



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The International Reactor Physics Experiment Evaluation Project (IRPhEP)

by J. Blair Briggs[1], Enrico Sartori[2], and Lori Scott[3]

Ed. Note: The following paper was presented at PHYSOR-2006, ANS Topical Meeting on Reactor Physics, organized and hosted by the Canadian Nuclear Society at Vancouver, BC, September 10-14, 2006. See a report on PHYSOR in Vol. 27, No. 4, December 2006 issue.

Abstract

Since the beginning of the Nuclear Power industry, numerous experiments concerned with nuclear energy and technology have been performed at different research laboratories, worldwide. These experiments required a large investment in terms of infrastructure, expertise, and cost; however, many were performed without a high degree of attention to archival of results for future use. The degree and quality of documentation varies greatly. There is an urgent need to preserve integral reactor physics experimental data, including measurement methods, techniques, and separate or special effects data for nuclear energy and technology applications and the knowledge and competence contained therein. If the data are compromised, it is unlikely that any of these experiments will be repeated again in the future. The International Reactor Physics Evaluation Project (IRPhEP) was initiated, as a pilot activity in 1999 by the by the Organization of Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Nuclear Science Committee (NSC). The project was endorsed as an official activity of the NSC in June of 2003. The purpose of the IRPhEP is to provide an extensively peer reviewed set of reactor physics related integral benchmark data that can be used by reactor designers and safety analysts to validate the analytical tools used to design next generation reactors and establish the safety basis for operation of these reactors. A short history of the IRPhEP is presented and its purposes are discussed in this paper. Accomplishments of the IRPhEP, including the first publication of the IRPhEP Handbook, are highlighted and the future of the project outlined.

1. Introduction

Since the beginning of the Nuclear Power industry, numerous experiments concerned with nuclear energy and technology have been performed at different research laboratories, worldwide. These experiments required a large investment in terms of infrastructure, expertise, and cost; however, many were performed without a high degree of attention to archival of results for future use. The degree and quality of documentation varies greatly. Often a comprehensive and detailed report was prepared, but in many cases, the results may appear only in a series of internal reports (e.g., progress reports), or in logbooks. There is an urgent need to preserve integral reactor physics experimental data, including measurement methods, techniques, and separate or special effects data for nuclear energy and technology applications and the knowledge and competence contained therein. If the data are compromised, it is unlikely that any of these experiments will be repeated again in the future.

The International Reactor Physics Evaluation Project (IRPhEP) was initiated, as a pilot activity in 1999 by the by the Organization of Economic Cooperation and Development (OECD) Nuclear Energy Agency (NEA) Nuclear Science Committee (NSC). The project was endorsed as an official activity of the NSC in June of 2003. The IRPhEP is patterned after its predecessor, the International Criticality Safety Benchmark Evaluation Project, (ICSBEP), but focuses on other integral measurements such as buckling, spectral characteristics, reactivity effects, reactivity coefficients, kinetics measurements, reaction-rate and power distributions, nuclide compositions and other miscellaneous types of measurements in addition to the critical configuration. The two projects are closely coordinated to avoid duplication of effort and to leverage limited resources to achieve a common goal.

2. Purpose

The purpose of the IRPhEP is to provide an extensively peer reviewed set of reactor physics related integral benchmark data that can be used by reactor designers and safety analysts to validate the analytical tools used to design next generation reactors and establish the safety basis for operation of these reactors. While coordination and administration of the IRPhEP takes place at an international level, each participating country is responsible for the administration, technical direction, and priorities of the project within their respective countries.

3. Evaluation Process

The evaluation process entails the following steps: (1) Identification of experimental reactor physics related data; (2) Verification of data, to the extent possible, by reviewing original and subsequently revised documentation and by talking with experimenters or individuals who were associated with the experiments or the experimental facility; (3) Evaluation of the data and quantification of overall uncertainties through various

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types of sensitivity/uncertainty analyses; (4) Compilation of the data into a standardized format; (5) Performance of sample calculations of each experiment with standardized reactor physics neutronics codes; and (6) Formal documentation of the work into a single source of verified and extensively peer reviewed benchmark reactor physics data.

4. IRPhEP Handbook

The work of the IRPhEP is documented in an OECD NEA Handbook entitled, "International Handbook of Evaluated Reactor Physics Benchmark Experiments." The first edition of this Handbook, the 2006 Edition (See Fig. 1) spans over 4400 pages and contains data from 16 different experimental series that were performed at 12 different reactor facilities. Included are evaluated data from five liquid metal fast reactors (JOYO, BFS-1, BFS-2, ZPPR, and ZEBRA), one gas cooled reactor (HRT-10), one heavy water reactor (DCA), one light water reactor (CROCUS), two pressurized water reactors (VENUS and DIMPLE), and two VVER reactors (ZR6 and PFACILITY).

Seven of the 16 evaluations are published as approved benchmarks. The remaining nine evaluations are published as DRAFT documents only. Draft documents have been reviewed by the IRPhEP Technical Review Group (TRG); however, all action items could not be completed or reviewed in time for the final publication or, in most cases, the TRG requested the opportunity to review the revised evaluations, one last time, before giving final approval.

Figure 1: OECD NEA "International Handbook of Evaluated Reactor Physics Benchmark Experiments" – Published on DVD.

The Handbook is organized in a manner that allows easy inclusion of additional evaluations, as they become available. Annual publications are anticipated. The 2007 Edition of the Handbook is expected to include additional data from ZPPR, VENUS, and ZEBRA and new data from the VHTRC, PROTEUS, and ASTRA gas cooled reactor facilities; the KRITZ pressurized water reactor facility; the STEK liquid metal fast reactor facility; and the TCA and MB-01 light water reactor facilities. The information and data included in this Handbook are available to OECD member countries, to all contributing countries, and to others on a case by case basis.

5. Contents of an IRPhEP Evaluation

5.1 Identification and Types of Measurements

Each experiment has a unique identifier that consists of two parts. Part 1 consists of the Reactor Name, Reactor Type, Facility Type and a Three Digit Numerical Identifier. Part 2 of the identifier includes the Measurement Type(s). Identifiers take the following form:

(Reactor Name)-(Reactor Type)-(Facility Type)-(Three-Digit Numerical ID)
(Measurement Type(s))

Identifier elements and their meanings are given in Table 1.

5.2 Format

The format for IRPhEP evaluations is patterned after the format used by the ICSBEP. The general format is: (1) describe the experiments, (2) evaluate the experiments, (3) derive benchmark specifications, and (4) provide results from sample calculations. Code and cross section information, including typical input lists, are provided in Appendix A. Additional information may be provided in subsequent appendices. The format is the same for all evaluations. Seldom, if ever, are all types of measurements made in a particular series of experiments. However, sections for all measurement types are retained in the format, and it is simply stated, when applicable, that no such measurements were made. A detailed IRPhEP Evaluation Guide [2] can be obtained on the following two Internet Sites: http://nuclear.inl.gov/irphep/ and http://www.nea.fr/lists/irphe/. The guide is also published as part of the IRPhEP Handbook.

The ICSBEP format [3] for critical or subcritical measurements is very well known. Except for the expansion to include other types of measurements, there is only one minor difference between the two formats, a specific section for temperature has been added to Section 1.

The types of information and format presentation are essentially the same for each measurement type. Therefore, the details of each subsection are only stated once.

6. Archival of Primary Documentation

Since the inception of the IRPhEP, the NEA has been collecting primary documentation and has been transforming those documents into electronic form to facilitate data retrieval and dissemination. An archive of those documents has been estab-

Table 1: Identifier Elements and Their Meanings.

REACTOR TYPE		FACILITY TYPE		MEASUREMENT TYPE	
Pressurized Water Reactor	PWR	Experimental Facility	EXP	Critical Configuration	CRIT
VVER Reactor	VVER	Power Reactor	POWER	Subcritical Configuration	SUB
Boiling Water Reactor	BWR	Research Reactor	RESR	Buckling & Extrapolation Length	BUCK
Liquid Metal Fast Reactor	LMFR			Spectral Characteristics	SPEC
Gas Cooled (Thermal) Reactor	GCR			Reactivity Effects	REAC
Gas Cooled (Fast) Reactor	GCFR			Reactivity Coefficients	COEF
Light Water Moderated Reactor	LWR			Kinectics Measurements	KIN
Heavy Water Moderated Reactor	HWR			Reaction-Rate Distributions	RRATE
Molten Salt Reactor	MSR			Power Distributions	POWDIS
RBMK Reactor	RBMK			Nuclide Composition	ISO
Fundamental	FUND			Other Miscellaneous Types of Measurements	MISC

lished at the NEA and contains the following:

- IRPHE/B&W-SS-LATTICE, Spectral Shift Reactor Lattice Experiments
- IRPHE/ZEBRA, AEEW Fast Reactor Experiments
- IRPHE/JOYO MK-II, core management and characteristics database
- IRPHE/JAPAN, Reactor Physics Experiments carried out in Japan
- IRPhE/HTR-ARCH-01, Archive of HTR Primary Documents
- IRPHE-SNEAK, KFK SNEAK Fast Reactor Experiments
- IRPhE/STEK, Experiments from Fast-Thermal Coupled Facility
- IRPhE-DRAGON-DPR, OECD High Temperature Reactor Dragon Project
- IRPhE/RRR-SEG, Experiments from Fast-Thermal Coupled Facility
- Experiments in VENUS- Project on the Physics of Plutonium Recycling
- IRPHE/AVR, AVR ñ Experimental High Temperature Reactor
- IRPHE-KNK-II-ARCHIVE, KNK-II fast reactor documents, power history and measured parameters
- IRPHE/BERENICE, effective delayed neutron fraction measurements
- IRPHE-TAPIRO-ARCHIVE, TAPIRO fast-neutron source reactor experiments

7. Conclusions

The activities of the IRPhEP systematically: (1) consolidate and preserve the international reactor physics information base, (2) identify areas where more data is needed, (3) draw upon the resources of the international reactor physics community to help fill those needs, and (4) identify discrepancies between calculations and experiments. The project is expected to eliminate a large portion of the tedious and redundant research and processing of experimental data and will greatly streamlined the validation process. Benchmarks produced by the IRPhEP will provide new dimension to validation efforts and will greatly expand the collection of available integral benchmarks for nuclear data testing and uncertainty determination. The International Handbook of Evaluated Reactor Physics Benchmark Experiments is expected to be a valuable resource to the reactor physics, criticality safety, and nuclear data communities for decades.

Acknowledgement

The authors would like to acknowledge the efforts of all past and present contributors to the IRPhEP Executive Committee and Technical Review Group and all individual contributors.

References

1) "International Handbook of Evaluated Reactor Physics Benchmark Experiments", NEA/NSC/DOC(2006)1, OECD NEA Nuclear Science Committee, March 2006.

2) "Evaluation Guide for the International Reactor Physics Experiments Evaluation Project (IRPhEP)", NEA/NSC/DOC(2006)2, OECD NEA Nuclear Science Committee, 20 Jan 2006.

3) "International Handbook of Evaluated Criticality Safety Benchmark Experiments", NEA/NSC/DOC(1995)3, OECD NEA Nuclear Science Committee, September 2005.

The Montreal Lectures: 2 August - 2 October, 1944

by J.E. Arsenault

Introduction

The Second World War began in the summer of 1939 and spurred atomic science in the direction of weapons development. The United Kingdom (U.K.) was far ahead until about the summer of 1941, at which time the United States (U.S.) began to have serious interest in atomic weapons. Seen from Europe, the U.S. was a greater distance from the theatre of war and was deemed to be a safer place to conduct atomic research. In addition to good research centres it also had greater financial, manpower, and material resources.

Early attempts at full collaboration between the U.K. and the U.S. met with little success and this led to the formation of a joint British-Canadian atomic weapons effort in 1942, with research laboratories located in Montreal, which were well up and running by spring 1943. The Montreal Laboratory (ML) initially was administered by the National Research Council (NRC) and scientific direction was provided by the U.K. The ML was the foundation from which the Canadian nuclear industry evolved to the present time.

Interest in atomic weapons development by the U.S. had been greatly accelerated by the Japanese attack on Pearl Harbour on 7 December 1941. By the beginning of 1943 it was spending 10 times as much as the U.K. on atomic weapons research. From then on, the U.S. set the Allied agenda for the development of atomic weapons, in varying degrees of collaboration with the U.K. and Canada. This spending, which grew to about $2B by the middle of 1945, was directed by the U.S. Army Corps of Engineers under the Manhattan Project, officially established on 13 August 1942, and led by Gen. Leslie R. Groves from 17 September 1942.

National Research Council Montreal Laboratory

The ML was organized originally as a joint British-Canadian project, a follow-on from the research done in Britain at various universities, with a focus on basic science aimed at atomic weapon research and development. The British contingent was led by Dr. Hans von Halban, Jr., who with the aid of the NRC quickly assembled a team of talented British, Canadian and foreign nationals into four divisions. Initially the ML was to be governed by a Policy Board consisting of C.D. Howe, Minister of Munitions and Supply, Malcolm MacDonald, British High Commissioner and Dr. C.J. Mackenzie, NRC acting president. Below this was a Scientific Board consisting of Halban, Dr. George C. Laurence (NRC staff scientist), and the division heads.

The U.S. had at first expressed full support for the ML but just as it was being set up it had a change of mind based on security and patent issues, that resulted in the cessation of formal information exchange and material supply, including heavy water and uranium oxide. Added to this was the emerging problem of lab management. Halban, who was a competent researcher, proved to possess poor project management skills and essentially operated the ML as a personal fiefdom, such that the Canadian contingent felt shut out of a project that was costing their government considerable sums.

Although much valuable work was accomplished at the ML, by the summer of 1943 morale had sunk so low due to the lack of a clear mandate and poor management, that, at different times, both Canada and the U.K. considered abandoning the project. Principally Canada was not happy with the isolationist management style practiced by Halban and how the U.K. was managing liaison with the U.S. Just in time, the ML was saved by the Quebec Agreement.

Quebec Agreement

During the war the Allies conducted high level coordinating meetings to gauge the progress of the war and to set priorities. One of the most fateful for Canada took place in September 1943 at Quebec City, in the old Citadel overlooking the Plains of Abraham. The top priority was the timetable for the invasion of Europe but there were other important issues discussed, including the nagging issue of cooperation between the U.S. and the U.K. in the nuclear field, which had dragged on for over a year with little progress. Finally on 19 September 1943, an agreement was signed by Prime Minister Churchill and President Roosevelt which set out the broad terms of cooperation. Canada was a signatory in recognition of the fact that it was supplying uranium oxide and heavy water to the Manhattan Project and was the home of the British-Canadian project at the ML.

The Quebec Agreement stated that there shall be "complete exchange of information and ideas" in the nuclear field and provided for the formation of a Combined Policy Committee (CPC) to be located in Washington, D.C., consisting of three members from the U.S., two from the U.K., and C.D. Howe from Canada, to provide direction to the now joint American/British/Canadian effort in atomic energy. Almost immediately thereafter, the first of several groups of British scientists arrived in the U.S. and joined the Manhattan Project at various locations including, Oak Ridge, Los Alamos, and Berkeley. The issue of what to do with the ML became a main concern for Dr. James Chadwick, head of the British Mission and advisor to the British representative on the CPC.

A Proposal

The situation at the ML did not improve immediately after the Quebec Agreement because of ongoing U.S. concerns over security issues, especially with respect to the numerous foreign nationals working there. Chadwick soon concluded that the ML inevitably would be abandoned unless it was given a clear mandate and this he conceived to be the design and construction of a natural uranium heavy-water plant for the production of plutonium. His lobbying effort met with some success but there was resistance because the U.S. already had a similar but small-scale project (0.3 MW) ongoing at the Argonne Forest Preserve location of the University of Chicago and graphite-moderated plutonium production piles (250 MW) already under construction at Hanford, Washington. These projects made Chadwick's proposal somewhat redundant but it was agreed that a pilot plant (10 MW) offered the possibility of exploring a more efficient method of plutonium production. Formal project acceptance would be required as the U.S. controlled the necessary heavy water and uranium metal for the plant.

At the CPC meeting on 17 February 1944, Chadwick received acceptance of the concept to build a pilot plant in Canada and a subcommittee consisting of Chadwick, Groves, and Mackenzie was appointed to make a final recommendation. The subcommittee report recommended that the pilot plant should go ahead and this was presented and accepted at the CPC meeting on 13 April 1944.

Matters then moved forward quickly and the first change was to replace Halban with Dr. John Cockcroft who had been working on atomic research and radar in the U.K. and arrived at the ML on 26 April 1944. On 25, 26 and 27 May 1944 representatives from the ML visited the Chicago group, where the world's first natural uranium, heavy-water reactor had gone critical on 15 May 1944, to take advantage of the resident expertise. Further meetings took place on 12 June 1944 when the Chicago group visited the ML. Security continued to be an issue and on 13 July 1944 an agreement was reached on information exchange between the Manhattan Project and the ML. At last the pilot plant, which became known as the National Research Experimental (NRX) reactor, could go ahead in earnest with agreed information exchange, and uranium metal and heavy water to be supplied by the U.S., which code-named the project the Evergreen Area. The U.S. also supplied irradiated slugs of uranium for the ML to work out plutonium extraction processes. The starting design parameters for the pilot plant included operation at a nominal 10 MW to produce about 0.2 kg of plutonium per month and to be completed in February 1945.

The Lectures

In July 1944 the Canadian Department of Munitions and Supply awarded a design and construction contract to Defence Industries Limited (DIL), a wartime subsidiary of Canadian Industries Limited (CIL) which was in turn a subsidiary of International Chemicals Industries (ICI), a large British concern and a source of U.S. patent worries. DIL subsequently placed a contract for the actual construction of the pilot plant with the Fraser Brace Company on an expropriated 10,000-acre site along the Ottawa River, which became known as the Chalk River Laboratory (CRL). By this time DIL was a competent engineering company with extensive experience in civil construction but with no familiarity with highly secret, emerging nuclear science and technology.

To remedy this situation the scientists and engineers at the ML prepared a series of 43 lectures for the DIL operating staff, to facilitate the transfer of their early design concepts and preliminary calculations into the hands of a commercially driven enterprise. The first lecture was given on 2 August 1944 and the last was presented on 2 October 1944, all at the ML. Table 1 shows the organizational structure of the ML in terms of divisions and staff size, the presenters and their titles, and the number of lectures delivered by each person. The staffing levels are as of October

Table 1: The Montreal Laboratory Organization and Lecturers

Director: Dr. J. D. Cockcroft

DIVISION (No.staff)	LECTURER (Nationality)	TITLE	Qty.
Administration (44)	Dr. W. Kemmer (U.K.)	Senior Scientific Officer	7
Nuclear Physics (21)	Dr. W.B. Sargent (Can.)	Acting Division Head	1
	Dr. J.V. Dunworth (U.K.)	Senior Scientific Officer	3
	Dr. L. Kowarski (U.K.)	Principal Scientific Officer	1
Theoretical Physics (16)	Dr. G. Volkoff (Can.)	Division Head	6
Technical Physics (48)	Dr. G.C. Laurence (Can.)	Division Head	1
	Dr. D.G. Hurst (Can.)	Section Head	6
	Mr. W.J. Ozeroff (Can.)	Junior Research Physicist	2
Chemistry (45)	Dr. L.G. Cook (Can.)	On loan from Alum. Co.	6
Engineering (32)	Mr. R.E. Newell (U.K.)	Division Head	8
	Mr. H. Greenwood (U.K.)	On loan from ICI.	1
Health (2)	Dr. J. S. Mitchell (U.K.)	Section Head	2
Extramural (13) (Ottawa, Hamilton, Toronto)	n/a	n/a	n/a

1944 but the organization structure is as of October 1945.

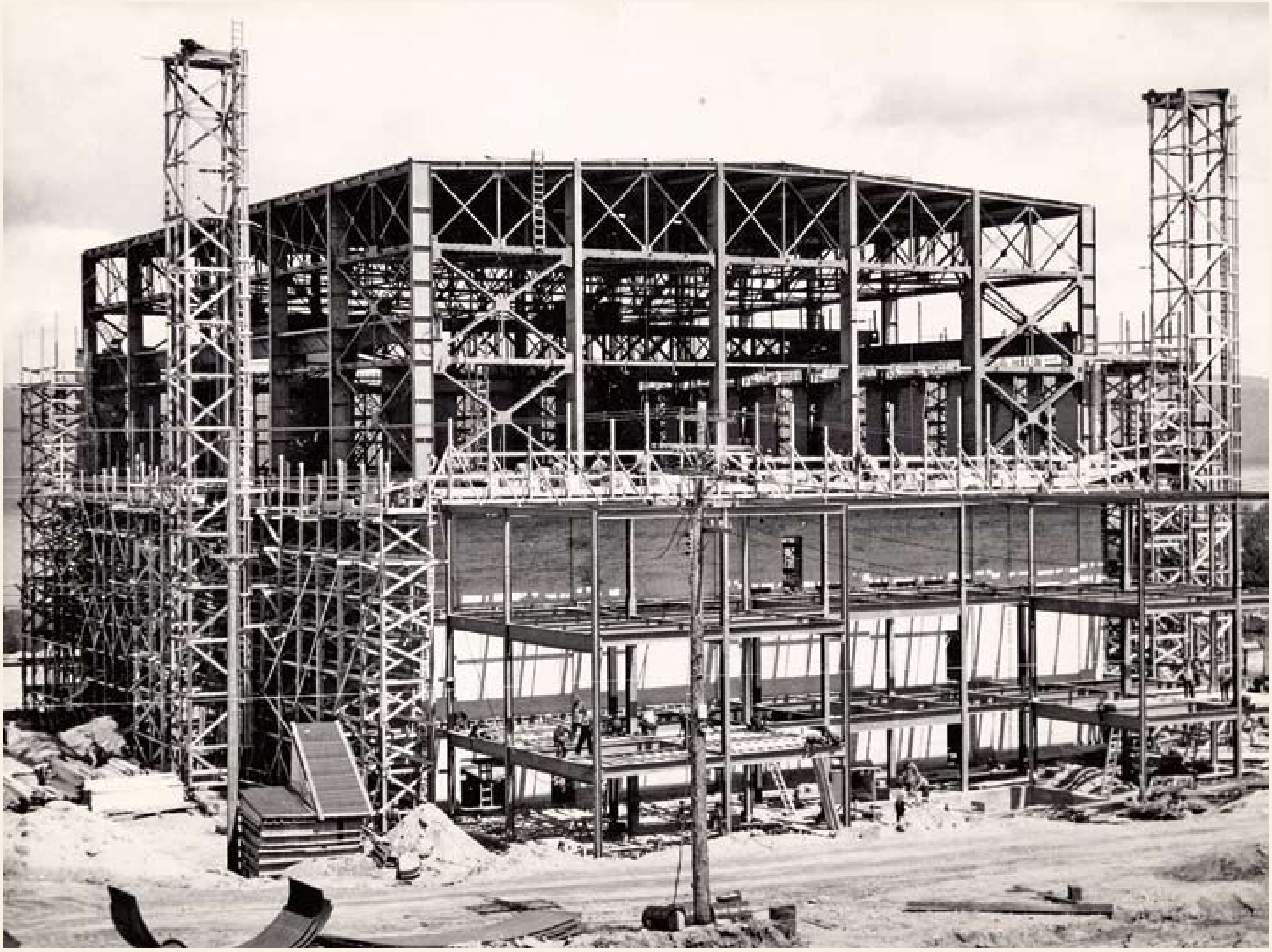
The list of lectures, originally typed by a ML stenographer in August 1944, is given in Appendix A It includes the lecture number, date, lecturer, title and a brief abstract. (Note: Although 43 lectures are listed, there were, in fact, 44 presentations, as Lecture 12 was given in two sessions.) Appendix B contains the biographies for the presenters, either taken from a C.D. Howe press release of August 1945, or compiled by the author, from various sources.

By 1945, the ML had essentially relocated to Chalk River and had grown to a staff of 417 under Cockcroft. All of the lectures are stored and are available at the Public Records Office at Kew near London. It is not known to what extent they may exist in Canada.

Aftermath

The NRX pilot plant had several scheduled completion dates with delays due to a multitude of issues (shown during construction in Figure 1). It was not until 22 July 1947 that it went critical. Complementing NRX at CRL was a chemical plant for the extraction of plutonium. During the development of NRX, a small research reactor named Zero Energy Experimental Pile (ZEEP) (0 MW) was constructed at CRL to assist in optimizing the reactor lattice design. It went critical on 5 September 1945. Although conceived in wartime, NRX evolved to become a first-class research reactor and for several years produced the highest neutron flux of any reactor in the world. On 29 January 1992 NRX was shut down for the last time and on 12 December 1993 it was decided to decommission NRX.

Chadwick's vision of 1943 finally came to fruition at CRL with the National Research Universal (NRU), a 200-MW reactor. Authority to proceed was received on 13 December 1950 and it went critical on 3 November 1957. NRU, among other capabilities, had the capacity to produce 5.0 kg of plutonium per month, slated for export to the U.S. to help in financing the reactor project. Amazing as it may seem, NRU is still operating 50 years later and now produces isotopes for medical purposes.



A view of the NRX building under construction in 1945.

Acknowledgements

For assistance in the preparation of this article I would like to thank: Richard Nishimura of AECL at Chalk River, for his effort in locating the List of Lectures; Tom Wiwcharuk of the W.B. Lewis Public Library at Deep River, for the NRX photo; the staff of the Harriet Irving Library at the University of New Brunswick, for assistance with the Manhattan District History microfilm records; Fred Boyd for his helpful ideas, Tom Lukowski for a thorough review; and Lyn Arsenault for patient typing, editing and formatting.

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Appendix A – Index to Lectures Given in 1944 to D.I.L. Operating Staff in Montreal Training Course

N0.	DATE	LECTURER	SUBJECT
1	Aug. 2	Dr. N. Kemmer	Structure of the Atom - Introduction to the most important physical concepts occurring in atomic physics.
2	Aug. 3	Dr. L.G. Cook	The Periodic System – The occurrence and chemistry of isotopes, isobars and natural radioactive elements. Artificial radioactivity.
3	Aug. 6	Dr. N. Kemmer	Structure of the Nucleus – Qualitative survey with special stress on orders of magnitudes (size, energy). Packing Fraction.
4	Aug. 7	Dr. D.G. Hurst	Types & Nature of Radiations – p, ?, ?, ?, n (slow and fast). What they are and some of their properties such as charge, mass, speed, energy. Explanation of energy scale in electron-volts and million electron-volts. Ionization by charged particles.
5	Aug. 8	Dr. L.G. Cook	The Special Chemistry of Minute Amounts – Radioactive colloids; Co-precipitation; Adsorption; Fractional precipitation; Solvent extraction. Isomeric Nucleus & Stability of isotopes, co-crystallization.
6	Aug. 9	Dr. D.G. Hurst	Further Discussion of Ionization – Schematic Ionization chamber, current collection, mobility's effect of various gases, ? ray, and ? ray ionization chambers designed for the pilot plant. Ionization caused by various a, ??and ?.
7	Aug. 10	Dr. G. Volkoff	Critical Size – The idea of critical size, and its relation to k and M. Sample numerical values. Smallest overall size does not necessarily correspond to highest k, nor the smallest quantity of X-metal. The action of a reflector. The effect of J-rods on the Critical level of polymer. The fundamental ideas for the control of a pile.
8	Aug. 13	Dr. L. Kowarski	Introduction to Pile Theory
9	Aug. 14	Dr. N. Kemmer	Nuclear Disintegration - Nuclear decay and disintegration fission.
10	Aug. 15	Dr. L.G. Cook	Artificial Radioactivity – Ideas of nuclear stability. New isotopes and isobars. General chemistry of 23, 25, 49 and fission products.
11	Aug. 16	Dr. N. Kemmer	Nuclear Fission – Continuation of lecture #9. Packing friction.
12	Aug. 17	Dr. N. Kemmer	Properties of Subatomic Projectiles – Neutrons etc.
12A	Aug. 17	Dr. N. Kemmer	Discussion of the Neutrino
13	Aug. 20	Dr.J.V. Dunworth	Pile Running – Description of mode of action of control rods, level control etc. Development of the fundamental equation giving the reproduction factor.
14	Aug. 21	Dr. D.G. Hurst	Neutron Density – Detection of slow neutrons by boron coated or boron filled chambers. Cross-section for disintegration and discussion of resulting ionization. Details of slow neutron chambers. Detection of fast neutrons by recoil. Other methods (i) Slow neutrons by boron thermo-piles, ??rays from Cd, or included radio- activity. (ii) Fast neutrons by slowing down in paraffin and detecting as slow.
15	Aug. 22	Dr. J.S. Mitchell	Biological Action of Radiations – Tolerance of dose r-units. Principles of Protection.
16	Aug. 23	Dr. D.G. Hurst	Detection of Individual Particles by Counting Methods – ??particles and protons by proportional counters. Slow neutrons by BF3 and fission counters. Fast neutrons by H recoil and counting the protons. Ionization Amplication (sic), ??&???rays by Geiger counters.

17	Aug. 24	Dr. R.G. Newell	General Description of the Pile – Heat production and cooling water system from the engineering point of view.
18	Aug. 27	Dr. G. Volkoff	Discussion of the Reproduction Factor ēk' – Definition of ēk'. Description of factors affecting ēk' (number of fast neutrons emitted per slow neutron absorbed in X-metal, fast fission contribution, "trap", thermal utilization). The need for some slowing down material to avoid excessive "trap" losses. The necessity of not having too much slowing down material to avoid competitive absorption of slow neutrons. The effect on ēK' of changing the X-metal to moderator ratio. Sample numerical values.
19	Aug. 28	Dr. G. Volkoff	Migration Length – The migration length "M" of neutrons in a lattice. Definition of M. The zig-zag path of a neutron. Relation of M to scattering mean free path and average number of collisions. Average number of collisions made by slow neutron before being captured. The effect on M of changing the X-metal to moderator ratio. Sample numerical values.
20	Aug. 29	Dr. Kemmer	Survey of the Physical Properties of the most important substances used in Neutron Systems
21	Aug. 30	Mr. W. Ozeroff	Indicating Instruments – Galvanometers, Vacuum tubes - short discussion of properties of triode. D.C. Amplifiers. Special problems due to small currents; Stability of voltage supplies; Grid current; Grid-cathode resistance; Time-constant.
22	Aug. 31	Dr.J. Dunworth	Period of the Pile – Factors Effecting the Reproduction Constant k –Effect of delayed neutrons. Examples of variations of intensity with time. Effects of absorbers, temperature, poisoning etc. on k.
23	Sept. 4	Dr. G. Volkoff	Relation of Power Output to Neutron Density – The two aspects of a pile: a) heat source, b) neutron source. Relation between the two aspects. The need for elaborate "plumbing" shielding. The length of time a pile can be expected to run at a steady output. Rate of production of 23 and 49.
24	Sept. 5	Dr. Mitchell	Biological Action of Radiations – continuation of Lecture #15.
25	Sept. 6	Dr. (sic) Newell	General Description of the Pile and its Water System – Detailed description of the pile with explanation of reasons for each design feature under the following headings: a) Calandria, b) X-metal rods and cooling tubes, c) Reflector, d) J-rods, e) Thermal shields, f) Rod removal procedure, g) shut-off rods, h) Control rods, i) Polymer system, j) Catalytic units, k) Self-serve plugs, m) Experimental plugs, n) Engineering instruments.
26	Sept. 7	Dr. Volkoff	Description of the Physical Features of the Pile – A consideration of the principal structural features of the pile from the point of view of the topics treated above. 1. The Reactor Tank and X-rods. 2. The Reflector. 3. The Thermal Shield. 4. The Biological Shield. 5. J-rods. 6. Control and shut-down rods. 7. Cooling arrangements. 8. The experimental facilities.
27	Sept.10	Dr.J.V. Dunworth	Control of the Power of the Pile – Operating control and explanation of factors influencing it.
28	Sept.11	Mr. R.E. Newell	Detailed Description of the Cooling Water System – Detailed description of cooling water system from treatment plant onwards with explanation of reasons for each design feature. Relevant Instrumentation.
29	Sept.12	Mr. W.J. Ozeroff	Shut-Off Amplifier – Purpose and characteristics. Pulse amplifiers and counters.
30	Sept.13	Dr. L.G. Cook	The Extraction and Purification of 23 – Uranium 233
31	Sept.18	Dr. G. Volkoff	Discussion of Thorium Rods and of Heat Production in the Pile – Continuation of Lecture 26. Cooling after shut down. Borst-Wheeler Curves.
32	Sept.17	Dr. (sic) R.E. Newell	Description of the Air Cooling System in the Pile – Detailed description of cooling air system from treatment plant onwards with explanation of reasons for each design feature.
33	Sept.14	Dr. D.G. Hurst	Radiation Instruments proposed for Control of the Pilot Plant
34	Sept.19	Dr. L.G. Cook	Health Problem and Safety – Protective measures Isotope Separation. Standard Methods; 1) Chemical Exchange, 2) Distillation, 3) Diffusion, 4) Thermal diffusion, 5) Centrifugation, 6) Mass Spectrograph, 7) Electrolysis, 8) Chemical Extraction.
35	Sept.20	Dr. D.G. Hurst	Radiation Instruments for Health & Other Purposes – Air Monitoring, Water Monitoring.
36	Sept.21	Mr. R.E. Newell	Heat Transfer – Heat removal from the pile: a) X-metal rods, b) Reflector, carbonate rods, side shields and plugs, c) Tube sheets and end shields, d) Polymer. Theory upon which design features have been based.
37	Sept.24	Dr L.G. Cook	Extraction and Purification of 49 – Plutonium
38	Sept.25	Dr. Laurence	The Use of the Pilot Plant for Research Purposes – How this will affect the operation of the plant.
39	Sept.28	Mr. R.E. Newell	Control of the Pile – Operating Controls
40	Sept.27	Dr. B.W. Sargent	Physical Measurements with the Pile – Varied uses to which the pile may be put.
41	Sept.26	Mr.H. Greenwood	Problems of Metallurgy and Corrosion – Properties of uranium. Preparation of metal. Corrosion of Uranium. Sheathing. Corrosion of Aluminum sheathing.
42	Oct. 1	Mr. R.E. Newell	Control of the Pile – Continuation of Lecture #39 – Aims to be achieved with the pile and organization for achieving them.
43	Oct. 2	Mr. R.E. Newell	Polymer Recombination System, Self-Serve Sampling Tubes, Spare Instrument Holes.

Dr. Leslie G. Cook was born in 1914 and his education began at Brantford Collegiate in Paris, Ontario. He entered the University of Toronto and graduated in 1936 with a B.A. in Physics and Chemistry. He trained at the Kaiser Wilhelm Institute in Berlin from 1936 to 1938 under Dr. Otto Hahn and received a Doctorate in 1938. Cook was present at the Institute during the latter part of 1938 when Hahn and Strassmann discovered nuclear fission. He received additional training at the Cavendish Laboratory at Cambridge. When he returned to Canada he took a position in the Research Laboratories of the Aluminum Company of Canada and was placed on loan to the Montreal Laboratory in 1942. There he worked in the Chemistry Division and was involved with chemical (solvent) separation of plutonium and uranium isotopes from irradiated uranium. (Compiled from various sources by author.)

Dr. John V. Dunworth was educated at Cambridge University and lectured there before becoming engaged in radar work and moving to the Montreal Laboratories. Together with Dr. J.S. Mitchell, he was one of the first to recognize that cobalt 60 would be much better than radium for therapy purposes. Dr. Dunworth's name appears on the bronze plaque at the University of Montreal Medical Building, commemorating the Montreal Laboratory. (Compiled from various sources by author.)

Mr. H. Greenwood was on loan to the Montreal Laboratory from Imperial Chemical Industries. He performed metallurgical experiments at McGill University, regarding corrosion of uranium-silicon alloys under conditions in a nuclear reactor. (Compiled from various sources by author.)

Dr. Donald G. Hurst was born in 1911 at St. Austell, Cornwall, England and moved one year later to Canada with his family. He attended McGill University and received degrees of Bachelor of Science, Master of Science and Doctor of Philosophy (1936). He began his career in nuclear energy with post-doctoral work in the United States at the University of Calfornia, where he worked on Dr. E.O. Lawrence's cyclotron (1936/1937). He spent two years at Cambridge University on an Exhibition of 1851 scholarship, performing research on Dr. J.D. Cockcroft's cyclotron. In 1939 he joined the Physics Division of the National Research Council, in Ottawa. He moved in 1944 to the Montreal Laboratory and then to Chalk River in 1945. (Compiled from various sources by author.)

Dr. Nicholas Kemmer was born in 1911 in St. Petersburg, Russia. His father moved the family to London in 1916 in conjunction with railway work and they were resident there for about six years. Subsequently they moved to Hanover, Germany, in 1921. Eventually he entered the University of Gˆttingen and was trained in the emerging field of quantum mechanics. In 1933 he became a doctoral student at Zurich, Switzerland. In 1936 he obtained a scholarship at the Imperial College in London and later moved to the Cavendish Laboratory at Cambridge University where he did research work with Drs. Hans von Halban and Lew Kowarski after they arrived there in 1940. He moved to the Montreal Laboratory with Halban and acted as an Information Officer even though he was by now a renowned theoretical physicist. He was proficient in three languages (Russian, English and German) and is credited with suggesting that element 94 should be named plutonium. (Compiled from various sources by author.)

Dr. Lew Kowarski was born in 1907 in St. Petersburg, Russia. During the Russian Revolution he was moved by his father to Wilno, Poland. In 1928 he received a degree in Chemical Engineering and took an industrial position in Paris. While working he prepared a Doctor's Thesis and eventually began research at the CollÈge de France. There he joined Drs. Pierre Joliot-Curie and Hans von Halban in experiments on neutron emission and became a naturalized citizen of France. When France was invaded in June 1940 he escaped with Halban to the Cavendish Laboratory at Cambridge University and continued the work that showed evidence of neutron emission from fission in a heavy water uranium oxide slurry. He remained there when Halban became director of the newly formed Montreal Laboratory in 1942 (a joint British-Canadian project) and their apparatus also was moved. In April 1943, Dr. J.D. Cockcroft took over the Laboratory and Kowarski joined him to become the chief scientist involved with the design of the Zero Energy Experimental Pile (ZEEP). (Compiled from various sources by author.)

Dr. George Craig Laurence began the research on uranium fission in the National Research Laboratories in 1940. He was joined in this work the following spring by Prof. Sargent of Queen's University. Dr. Laurence was born in Charlottetown in 1905, graduated from Dalhousie University with Bachelor of Science degree in 1925, and Master of Science in 1927 while holding a National Research Council bursary. He held an Exhibition of 1857 Scholarship in the Cavendish Laboratory of Cambridge University under Prof. Ernest Rutherford, receiving a degree of Doctor of Philosophy from Cambridge. Since 1930 he has been a member of the staff of the Physics and Electrical Engineering Division of the National Research Council, having charge of the work in laboratories concerned with radium, x-rays and strength of materials. He was elected a Fellow of the Royal Society of Canada in 1941. He carried out research on radiation from radioactive materials, on applications of x-rays and radium gamma rays in industry, and on radiation standardization for medical radiology. In the Montreal Laboratory he directed research in general and engineering physics, and the development of special instruments for the operation of the Petawawa plant. (From C.D. Howe press release.)

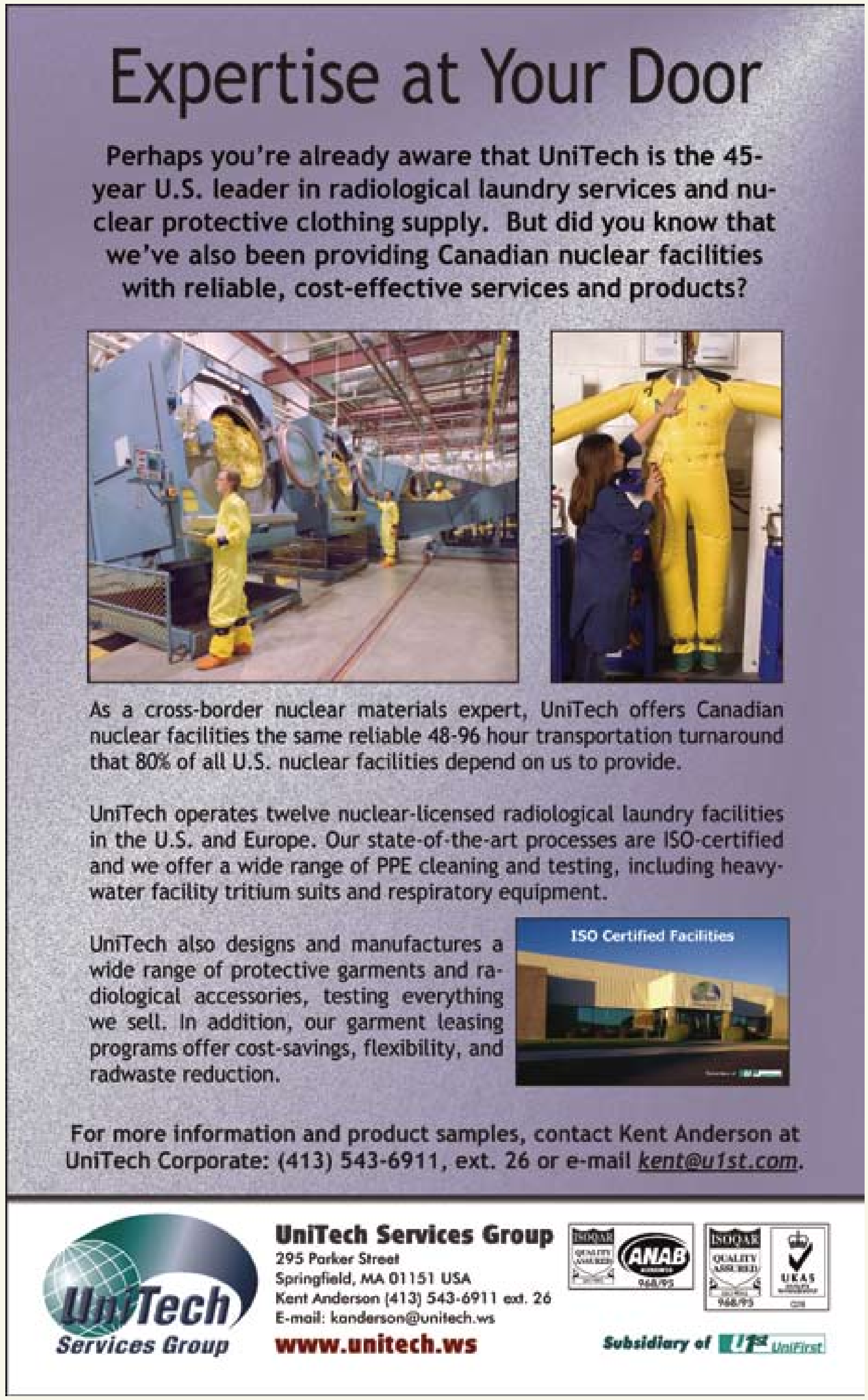
Dr. J. S. Mitchell was associated with Surgeon-Commander C. B. Pierce at the Montreal Laboratory of the National Research Council in directing research on the applications in medicine and biological research of radioactive materials obtained by the fission of uranium. Dr. Mitchell was the Medical Officer in Charge of the Radiotherapeutic Centre, Addenbrooke's Hospital, Cambridge, England, and is also a Fellow of St. John's College, Cambridge. (From C.D. Howe press release.)

Mr. Ronold (sic) Edward Newell under whose direction the basic engineering design of the Petawawa plant was carried out in the Montreal laboratories was born in England and educated in the University of Cambridge, graduating in 1926. He was associated, in England, with Metropolitan Vickers from 1927 to the end of 1928, and from then until he came to Canada in 1942 was a member of the staff of Imperial Chemical Industries. In 1942 he joined the Montreal Laboratory, of National Research Council. He had, however, been connected in a consulting company with a uranium research project in England the previous year. During his association with Imperial Chemical Industries he was responsible for the design of gasoline plants and ammonium plants in England and his designs have been copied even on this continent. In fact, he had visited Canada on a previous occasion to assist in the installation of the ammonium plant of Consolidated Smelters Corporation, Calgary, which is based on his design. (From C.D. Howe press release.)

Mr. J.W. Ozeroff came from Shore Acres, British Columbia and graduated from the University of British Columbia. At the Montreal Laboratory he took part in the design and construction of vacuum tube devices known as "kicksorters" as well as Geiger counters. He appears in a photograph with Halban and Cockcroft taken on 18 December 1943. (Compiled from various sources by author.)

Professor B. Weldon Sargent supervised the section of the Montreal Laboratories that was engaged in research in nuclear physics. Before joining the Montreal laboratory in 1942, he had collaborated during the summers of 1941 and 1942 in work on uranium fission at the National Research Council Laboratories in Ottawa. Prof. Sargent, who had been released by Queen's University to participate in uranium work, was born in Williamsburg Township, Ontario, in 1906. His University career brought him the Medal in Physics on his graduation with the degree of Bachelor of Arts in 1926. He held an N.R.C. bursary in 1927–28, obtained his Master of Arts degree from Queen's University in 1928. He held an Exhibition of 1941 (sic) Overseas Scholarship in the Cavendish Laboratory, Cambridge from 1928 to 1930, and received the degree of Doctor of Philosophy from Cambridge University in 1930. He was a member of the teaching staff of Queen's University from 1930 to 1941. Dr. Sargent was elected a Fellow of the Royal Society of Canada in 1941. He made important contributions to the knowledge of the behaviour of the beta rays emitted by radium and similar substances, and is perhaps best known for his discovery of an important principle connected with the emission of beta rays which has been called "Sargent's Law". (From C.D. Howe press release.)

Professor George Michael Volkoff directed the theoretical and mathematical work of the Montreal Laboratory of the National Research Council. His services had been lent to the project by the University of British Columbia. Prof. Volkoff was born in Moscow, Russia in 1914 but moved to Canada with his family in 1924 and became naturalized as a Canadian citizen on reaching the age of twenty-one. He was educated in the public schools of Vancouver and continued with high school in Harbin, Manchuria where his father was Professor of Engineering in the Polytechnical Institute. He returned to Canada in 1930 to the University of British Columbia, receiving the degree of Bachelor of Arts with the Governor General's Gold Medal in 1934 and degree of Master of Arts in 1936. He obtained the degree of Doctor of Philosophy in 1940 in (sic) the University of California. During this period he was engaged in theoretical research at Princeton University on the forces within the nucleus of the atom which are responsible for the energy released in radioactivity and in uranium fission. Later he continued the study of nuclear forces at the University of California with particular interest in the atomic constituents of heavy water. (From C.D. Howe press release.)



GENERAL news

Government accepts NWMO proposal

On June 14, 2007 the Minister of Natural Resources, Gary Lunn, announced that the federal government had accepted the Adaptive Phased Management (APM) option for managing used nuclear fuel recommended by the Nuclear Waste Management Organization's (NWMO)

It was on November 3, 2005, that Elizabeth Dowdeswell, then president of NWMO, released the organization's 450 page "Final Study Report". *(See Vol. 26. No.4 December 2005 issue.)* She reported at that time that the experience of the eight-year "Seaborn panel"(the EA panel on deep geologic disposal) had shown that the challenge was not technical but an issue of values and ethics. Therefore, in the three years since NWMO had been created in 2002, they had emphasized consultations with a wide range of Canadians. She stated that three goals had emerged: assume responsibility now; do not make arrangements irreversible; make safety and security paramount.

When it was created in 2002, the NWMO was required by the *Nuclear Fuel Waste Act* to consider three technical methods: deep geological disposal in the Canadian Shield; centralized storage either above or below ground; and storage at nuclear reactor sites. In assessing the three, each was found to have distinct advantages but none perfectly met all of the objectives citizens said were important. This led the NWMO to develop a fourth approach: Adaptive Phased Management, which builds on the strengths of the others.

Adaptive Phased Management includes both a technical method and a management system. The method is implemented in stages with the end goal of centralizing all of Canada's used nuclear fuel in one location, and isolating and containing it deep underground in a suitable rock formation. The management system is phased and adaptive, with explicit decision-points to incorporate new social learning and technological innovation as it is implemented. At each stage options, including a contingency for temporary shallow underground storage, can be evaluated and the plan modified before proceeding.

The NWMO will now begin planning and designing a site-selection process, collaboratively with Canadians as it had in the past. Throughout this process, the Government of Canada will continue to provide oversight as required by the *Nuclear Fuel Waste Act.* It is expected that the site-selection process for a centralized storage location will take several years.

A view of the OPG Engineering Building at UOIT.

OPG Engineeering Building opened at UOIT

On March 30, 2007, a ceremony was held at the University of Ontario Institute of Technology (UOIT) for the official opening of the Ontario Power Generation Engineering Building.

Tom Mitchell, OPG's chief nuclear officer, and Dr. Ronald Bordessa, president of UOIT, joined UOIT students, faculty and staff; OPG partners; municipal and provincial government officials; local dignitaries; and members of the business and academic community to mark the opening of the three-storey, 40,000-square-foot, state-of-the-art facility and to celebrate UOIT's significant community partnership with OPG.

Construction began on the OPG Engineering building in spring 2005, with students, faculty and staff moving in for the start of classes in September 2006. The building includes 17 laboratories, including: a rapid prototyping and manufacturing lab; a combustion and engines lab; a mechatronics lab; and an emerging energy systems lab with solar, wind, hydrogen and fuel-cell technology. Each piece of equipment was carefully selected to educate students about technologies of the future and the building itself has already become a showcase for the delivery of engineering education.

In addition to providing $2 million annually over a five-year period to support the OPG Engineering building, OPG provides experienced mentors and program counselling to students and faculty. UOIT established Canada's only degree program in nuclear engineering through the School of Energy Systems and Nuclear Science in 2003. The first class received degrees at the convocation to be held June 1, 2007.

Shown with the plaque commemorating the official opening of the Ontario Power Generation Engineering building at UOIT on March 30, are, from left: Pierre Charlebois, chief operating officer for OPG; Tom Mitchell, chief nuclear officer at OPG; Ontario Energy Minister Dwight Duncan; UOIT President Dr. Ronald Bordessa.

New Brunswick to study second unit at Lepreau

During a talk June 6, 2007, to the 28th CNS Annual Conference in Saint John, New Brunswick, the province's premier, Shawn Graham, announced that he would ask his cabinet, within weeks, to endorse a study of a second nuclear unit at the Point Lepreau site. He commented that he would like a "Generation III" plant, implying an ACR or other recent designs. His announcement was warmly received by the delegates to the conference.

Putting a slight damper on the domestic enthusiasm was the fact that the premier travelled to France the following week. There he openly met with officials of the giant French nuclear company Areva, which is building a "Generation III" EPR unit in Finland and preparing to build one in France.

CNSC recommends panel review for Bruce new build EA

On May 7, 2007, the Canadian Nuclear Safety Commission (CNSC) announced its decision to request to the federal Minister of the Environment that Bruce Power Inc.'s proposal for the site preparation, construction and operation of up to four new nuclear reactors at the Bruce Power Nuclear site, be referred to a review panel.

Further, in its decision, given its extensive experience with consultation on major nuclear projects, the CNSC proposed that the Commission constitute the panel under the referred panel provisions of the Canadian Environmental Assessment Act.

The Commission, in making its decision, considered Bruce Power's application and project description which includes the possibility of several types of nuclear plants.

As reported in the March 2007 issue, Vol. 28, No. 1, the Bruce "project description" for possible new plants on the Bruce site identified the following designs:

- ACR 1000 (1085 MW) (Atomic Energy of Canada Limited)
- AP 1000 (PWR) (1100 MW) (Westinghouse - Toshiba)
- EPR (PWR) (1600 MW) (Areva/Framatome, France)
- ESBWR (BWR) (1560 MW) (General Electric)
- SWR –1000 (BWR) (1254 MW) (Areva)

Although the "project description" had stated that the Enhanced CANDU 6 was also being considered, the Bulletin has learned that is no longer the case.

The Commission also considered preliminary consultation with the First Nations, the views already expressed by public interest groups and in media reports on major nuclear projects. It further noted that Bruce Power had suggested that the environmental assessment be referred to an early panel.

As of the time of going to press there had been no decision by the Minister of the Environment.

AECL to seek generic design approval for ACR in UK

On May 29, 2007, Atomic Energy of Canada Limited (AECL) announced that it plans to seek pre-licensing approval for its ACR-1000 Advanced CANDU Reactor as part of the Generic Design Assessment process initiated by the United Kingdom Health and Safety Executive (HSE) following the release of the UK government's Energy White Paper a week earlier.

The Energy White Paper, published by Trade and Industry Secretary Alistair Darling on May 23, emphasizes the need for greater energy efficiency and a secure, low carbon energy mix for the long-term. A "consultation" on new nuclear was announced at the same time.

HSE regulates the nuclear industry through its Nuclear Directorate (ND) which is responsible for the safety regulation of nuclear power stations, nuclear chemical plants, decommissioning, defence nuclear facilities, nuclear safety research and strategy and, since April 2007, for civil nuclear operational security and safeguards matters.

HSE has prepared guidance on how the licensing of new nuclear power plants could be dealt with, and in particular, how generic design assessment could be introduced, to allow design issues to be dealt with in advance of site-specific matters. This envisages a 4-stage process for design assessment.

This process is likely to take around 3 years to complete, but could take longer if a number of applications were being considered by HSE simultaneously. At the end of this process, HSE would seek to issue a short statement on the acceptability, in principle, of a licence application being based on the generic design assessed.

This could then be followed by a formal site licence application, which would be considered by HSE following the completetion of the generic design assessment process. This would centre on site-specific issues and those relating to the organisation of the potential operator. Elements of the design considered in depth during pre-licensing would be regarded as 'frozen' and not re examined unless significant modifications were proposed.

On May 23, the same day as the release of the Energy White Paper, Westinghouse announced that it had submitted its AP1000 pressurized water reactor (PWR) for Generic Design Assessment. This was followed by a similar announcement from the French utility EdF, that it would "in conjunction with Areva" submit the EPR design. General Electric (GE) had earlier stated its intention to submit its Economic Simplified Boiling Water Reactor (ESBWR) design.

Recent CNSC decisions

10 year licence for OPG's Western Waste Management Facility

On May 22, 2007, the Canadian Nuclear Safety Commission (CNSC) announced its decision to renew the operating licence for Ontario Power Generation Inc.'s (OPG) Western Waste Management Facility (WWMF) located on the Bruce nuclear generating station property, near Tiverton, Ontario.The licence is valid for a ten-year period, until May 31, 2017.

The decision followed a two-day public hearing held on January 24 and April 11, 2007, in Ottawa. In making its decision, the Commission requested that CNSC staff present status reports to the Commission on the performance of the facilityfollowing the third and seventh year of the licence term. The two status reports will be presented at public proceedings of the Commission.

During the public hearing, the Commission considered written submissions and oral presentations from OPG, CNSC staff and 41 intervenors.

The WWMF has managed low and intermediate radioactive waste for all of the former Ontario Hydro stations (Pickering, Bruce, Darlington) for more than 40 years.

Screening EA accepted for decommissioning of AECL's PTR

Based on consideration of a screening environmental assessment related to the proposal by Atomic Energy of Canada Limited's (AECL) to decommission the Pool Test Reactor located at the Chalk River Laboratories the Canadian Nuclear Safety Commission (CNSC) has concluded that, taking into account the identified mitigation measures, the project is not likely to cause significant adverse environmental effects. The EA was prepared in accordance with the requirements of the *Canadian Environmental Assessment Act* (CEAA).

Further, with respect to the CEAA, the Commission decided not to refer the project to the federal Minister of the Environment for referral to a review panel or mediator.

The Commission therefore will proceed, under the *Nuclear Safety and Control Act,* with its consideration of a licence amendment application from AECL for the proposed project.

New effluent treatment plant at Stanleigh mine approved

The Canadian Nuclear Safety Commission (CNSC) decided to amend Rio Algom Limited's Waste Facility Operating Licence. The amendment authorizes Rio Algom Limited to replace its existing effluent treatment plant at the Stanleigh mine located near the City of Elliot Lake, Ontario with a smaller, more energy efficient effluent treatment facility.

During the public hearing, the Commission considered written submissions and oral presentations from Rio Algom Limited and CNSC staff and a written submission from one intervenor.

CNSC decides on EA Screening Report for Pickering B refurbishment

On April 3, 2007, the Canadian Nuclear Safety Commission announced its decision that a "Screening Report" will be adequate for the required environmental assessment for the proposed refurbishment of the four units of the Pickering B nuclear generating station.

The CNSC decided that it would not, at this time, recommend to the federal Minister of the Environment that the project be referred to a mediator or review panel.

In accordance with the approved Environmental Assessment Guidelines (EA Guidelines), CNSC staff will prepare an Environmental Assessment Screening Report (Screening Report) for the Commission's consideration at a future public hearing. (Ontario Power Generation will provide most of the required information.) If the Commission concludes from the Screening Report that the project is not likely to cause significant adverse environmental effects, taking into account the appropriate mitigation measures, the Commission may proceed with a consideration of the related licence application.

During the public hearing on the Environmental Assessment Guidelines, held on January 24, 2007, the Commission considered written submissions and oral presentations from CNSC staff, Ontario Power Generation Inc. and 64 intervenors.

Government creates Science, Technology and Innovation Council

On June 15,2007 the federal Minister of Industry, Maxime Bernier, announced the creation of a Science, Technology and Innovation Council.

About a month earlier the government had released a document setting out Canada's Science and Technology Strategy titled, Mobilizing Science and Technology to Canada's Advantage, which, among other points, highlighted the need for a single integrated science and technology advisory body with a strong voice.

Howard Alper, of the Academy of Sciences, Royal Society of Canada, was appointed to chair the new council. He has served as Chair of the Board of Governors of the Council of Canadian Academies and on private-sector boards. Dr. Alper is an Officer of the Order of Canada and has received a number of prestigious fellowships and major awards, including being the first recipient of the Gerhard Herzberg Canada Gold Medal for Science and Engineering. He is a past chair of the Partnership Group for Science and Engineering (PAGSE) of which CNS is a member.

PAGSE is a cooperative association of 25 national organizations in Science and Engineering, representing approximately 50,000 individual members from the industry, academia, and government sectors. It was formed in June 1995 at the invitation of the Academy of Science of the Royal Society of Canada to represent the Canadian science and engineering community to the Government of Canada.

L-3 MAPPS to Modernize Wolsong Simulator

L-3 Communications MAPPS has entered into an agreement with Korea Power Engineering Company, Inc. (KOPEC) to modernize the Wolsong Simulator on behalf of Korea Hydro & Nuclear Power Co., Ltd. (KHNP). The Wolsong Simulator is used by KHNP to support operator training for its 700-megawatt-class Wolsong 2, 3 and 4 CANDU* nuclear power plant units in Kyungju province of the Republic of Korea.

With KOPEC serving as project manager, L-3 MAPPS and KOPEC will cooperate in providing new instructor stations, replacing the simulator's RISC/Unix-based computers with PC/Windows-based servers, and replacing the existing simulation models with higher fidelity models generated with the Chorus™ model generation and update facility for the reactor, and with the ROSE® visual simulation environment for the remaining plant systems. In addition, the simulator's Digital Control Computer (DCC) will be replaced by a software-based emulation.

A view of the Wolsong simulator

The original Wolsong Simulator was developed by L-3 MAPPS and was put into service in September 1998. The current modernization effort is expected to take 22 months and follows the recent completion of a similar simulator modernization project for Romania's Cernavoda Unit 1 nuclear reactor.

KOPEC, founded in 1975, is Korea's leading power plant designer and constructor. It has designed 14 nuclear power plants, including the development of Korea's next-generation APR1400 nuclear power plant.

KHNP is the largest power generator in South Korea, owning 29% of the nation's power generation facilities and supplying 40% of its electricity. KHNP operates 16 nuclear generation units at four sites: Kori, Yonggwang, Ulchin and Wolsong.

Euratom celebrates 50th anniversary

The Euratom organization turned 50 on March 26, 2007. It was created by the Treaty of the European Atomic Energy Community, which was signed on 26 March 1957, at the same time as the Treaty of Rome, which led to the European Union.

Euratom was intended to promote nuclear power in the six member states: France, Germany, Italy, Netherlands, Belgium and Luxembourg at a time when energy security was a prime concern. The Treaty originally envisaged common EU ownership of nuclear materials. Politically it was both a counter to US dominance and a means of cooperation with the USA by providing guarantees of peaceful use, being the basis of the first multilateral safeguards system.The Treaty provided a stable legal framework that encouraged the growth and development of the nuclear industry while enhancing security of fuel supply for it and nuclear plant safety. Today Euratom, in its own right, is a member of the Generation-IV International Forum and the ITER consortium building a fusion reactor. It has remained substantially unchanged and is largely independent of EU parliament's control.

CNSC ready for new government directive on regulations

The Canadian Nuclear Safety Commission has stated that it is well placed to meet the requirements of the new Cabinet Directive on Streamlining Regulation (CDSR) that the government put into effect on April 1, 2007.

The CDSR replaces the Government of Canada Regulatory Policy (1999), and introduces several key improvements to regulation in Canada. It outlines a comprehensive management approach with specific requirements for the development, implementation, evaluation and review of regulations. Greater detail is given regarding the principles underlying the former Regulatory Policy and the links between it and performance management requirements. The CDSR places greater emphasis on defining the need for any proposed regulatory requirement.

The CNSC states that it already focuses on defining and addressing real regulatory needs or gaps before amending an existing regulation or introducing a new regulatory approach.

The CDSR encourages regulators to review relevant evidence-based standards from international organizations and to make use of those standards as a basis for their own technical regulations when they fulfill intended policy objectives. In this regard, the CNSC conducts consultations with licensees and other stakeholders early in the process of developing regulatory amendments or documents and incorporates international standards and approaches whenever appropriate.

For more information, please consult the external Cabinet Directive on Streamlining Regulation website, www.regulation.gc.ca.

Cernavoda 2 goes critical

On May 7, 2007, the reactor of the second CANDU unit at the Cernavoda site in Romania sustained a fission reaction for the first time.

A series of low power tests of the reactor's major components and operating systems is being conducted over several weeks before the reactor's power level will be increased in steps until full design power is obtained. The plant is expected to go into commercial service by the fall.

The Cernavoda NPP Unit 2 project, located approximately 165 kilometres east of Bucharest, is the second in a series of 700-MWe CANDU 6 Power Plants that began construction in the early 1980's. Cernavoda Unit I CANDU nuclear power plant has been successfully operating since 1996. A consortium of AECL and ANSALDO Energie of Italy, along with the SNN, were contracted in 2003 to manage the construction of the partially completed Unit 2 power plant and to commission it into service.

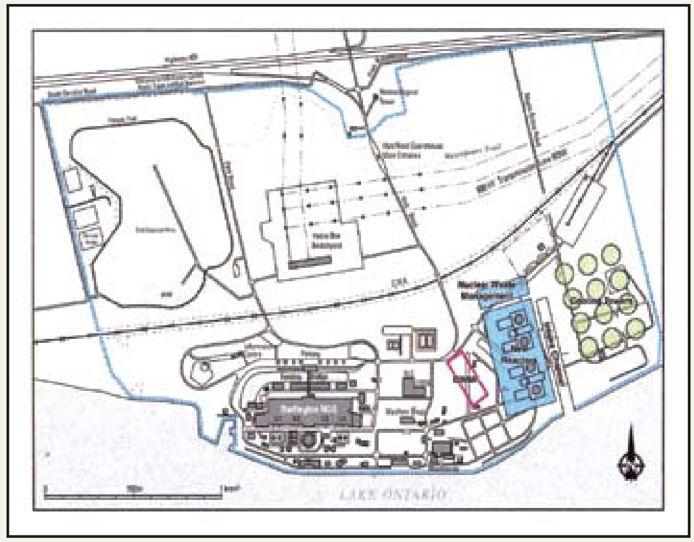
Brazilian firm seeks uranium in NB

The New Brunswick government has signed a five-year agreement with the Brazilian mining company, CVRD-Inco, which gives the company exclusive rights to explore for uranium on 136,000 hectares of land between Sussex and Moncton, for a fee of $4 million. Minister of Natural Resources, Donald Arsenault, said that the province will receive the information gained in the exploration as well as from past exploration by Inco.

OPG files proposal for Darlington B

In April 2007, Ontario Power Generation submitted to the Canadian Nuclear Safety Commission its "Project Description" for a possible second four-unit station adjacent to the present Darlington one. This is to serve as the refernece for the environmental assessment the CNSC has ruled will be needed for a proposed new station. Although the CNSC has not yet ruled it is likely that a full environmental assessment panel review will be required, as has been the case for Bruce Power's proposed new units..

OPG's proposal shows the new four-unit station located on OPG land to the east of the exisitng Darlington station. Two orientations are suggest: one with the four units parallel to the shoreline, similar to Darlington; the other with the four units in a line at right angles to the shoreline as shown in the following drawing.

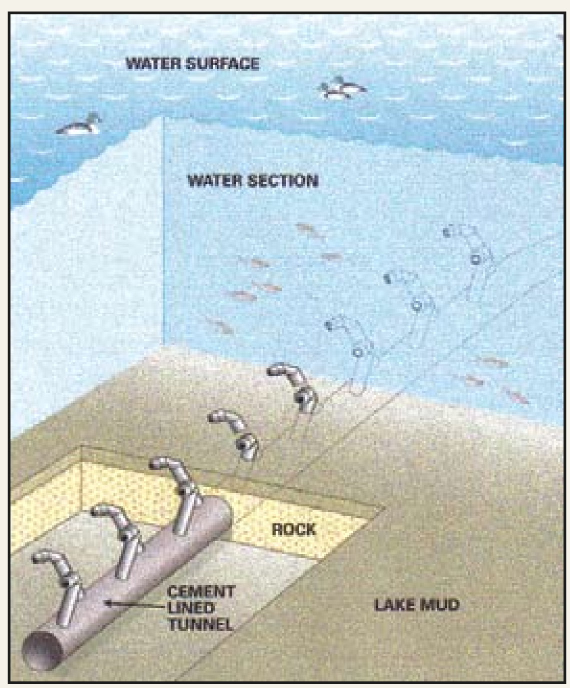


The submitted Project Description lists the following tupes of reactors whose characteristics will be included in the environmental assessment:

- Pressurized Heavy Water Reactors (PHWRs) with designs such as the Enhanced CANDU-6 (EC6);
- Pressurized Water Reactors (PWRs), with designs such as the EPR, AP1000, APWR, OPR 1000 and APR 1400;
- Boiling Water Reactors (BWRs), with designs such as the ABWR and the ESBWR; and;
- Pressurized Hybrid light/heavy water Reactors (PHRs), with designs such as the ACR-1000.

(The CNS Bulletin was informed subsequently that the Enhanced CANDU 6 is no longer being considered.)

The Project Description specifically identified the proposed water discharge design, as illustrated below.



Nuclear pioneers honoured

Rutherford and MacKenzie inducted into Canadian Science and Engineering Hall of Fame

On April 25, 2007, a ceremony was held at the Museum of Science and Technology in Ottawa, to induct three persons into the Canadian Science and Engineering Hall of Fame. Two of the three were pioneers of nuclear science and engineering in Canada, **Chalmers Jack MacKenzie** and **(Lord) Ernest Rutherford.**

The Canadian Science and Engineering Hall of Fame, which is part of the Innovation Canada exhibition at the Canada Science and Technology Museum honours individuals whose outstanding scientific or technological achievements have had long term implications for Canadians.

Ernest Rutherford was born in New Zealand. In 1895, when he was 23 years old, holding three degrees from the University of New Zealand, he went to the Cavendish Lab at Cambridge University in England.

In 1898 he was invited to join the physical laboratory at McGill University in Montreal, which was in one of the best buildings of its kind in the world and had a magnificent range of equipment. He returned to the Cavendish Laboratory at Cambridge as its head in 1907. Although he was a physicist, he was awarded the Nobel Prize in Chemistry in 1908 for his investigation into the disintegration of the elements and the chemistry of radioactive substances. This work was done in Canada while he was at McGill, making him the first person to receive a Nobel Prize for work completed in Canada.

A Maritimer, Chalmers Jack MacKenzie first did engineering consulting work in Alberta. In 1912 he was invited to the relatively new University of Saskatchewan to develop an engineering program. In 1916 he joined the Canadian army but returned to the University of Saskatchewan where he served as the Dean of Engineering for seventeen years. After a period of consulting, in 1939 he was appointed President of the National Research Council of Canada. There he guided Canada's wartime research and later planned the transition to peacetime operations. He was named President of the Atomic Energy Control Board when it was created in 1946 and subsequently, also the first President of Atomic Energy of Canada Limited on its formation in 1952.

Mary Fowlere (L), a granddaughter of Ernest Rutherford, receives the plaque identifying his induction into the Canadian Science and Engineering Hall of Fame from Claude Faubert, president of the Museum of Science and Technology, at a special ceremony, April 25, 2007.

NRC installs neutron reflectometer at CRL

On June 15, 2007, the National Research Council officially inaugurated Canadaís first neutron reflectometer for the Canadian Neutron Beam Centre (CNBC), which is located at the Chalk River Laboratories of Atomic Energy of Canada Limited.

The new reflectometer is supplied with neutrons from AECLís National Research Universal reactor (NRU). NRU has operated since 1957, and has been the birthplace of many scientific achievements. In 1994, Canadian physicist Dr. Bertram Brockhouse won the Nobel Prize in Physics for his seminal work at NRU using neutron scattering to explore materials. In the last three years, scientists from 114 institutions in 14 countries around the world have used the Chalk River facilities for both independent research and collaborative projects with NRC-CNBC.

An aerial view of the Chalk River Laboratories. NRU is the large building with the white roof.

Leon Leppard

Leon Bruce Leppard was a physicist with the Ontario Department of Health who, in that role, became an early member of the Reactor Safety Advisory Committee created by the Atomic Energy Control Board in 1956 to advise on the safety of the nuclear reactors then being planned to be built in Ontario. He was one of two provincial representatives specifically chosen to represent the province's normal interest in health and labour despite the Atomic Energy Control Act of 1946 declaring nuclear matters to be subject to federal law. He remained a member of the RSAC until the mid 1970s.

He died in Toronto on December 20, 2006, at the age of 99.

Leppard was born in Toronto on July 19, 1907. He attended Harbord Collegiate in downtown Toronto and pursued mathematics and physics on an Ontario scholarship at the University of Toronto, graduating in 1930. He then spent two years in Germany at the University of Gottingen under Nobel Prize laureate James Franck. A fellow student was Edward Teller, later renown as the father of the hydrogen bomb. After Adolph Hitler became chancellor in January 1933, Franck, a Jew, resigned and Leppard decided to return to Canada and complete his Ph.D. at U of T.

He then joined the Ontario Department of Health as an expert on radium, which was being refined at Port Hope.

During the Second World War he joined the Royal Canadian Navy but was seconded to the Royal Navy to work on radar. In 1941 his ship, the Queen Elizabeth, was severely damaged by explosives while in harbour at Alexandria, Egypt. Leppard then was appointed senior radar officer at HMS Nile the royal Navy base.

After the war he returned to the Department of Health to head the newly created radiation protection branch where he remianed until his retirement in 1972. He continued consulting with the AECB after retirement.

With the RSAC he worked with colleagues from the Chalk River Nuclear Laboratory and the federal Department of Health to ensure radiation protection for reactor staff and the public. Despite inter-departmental difficulties he led the development of the first Canadian procedures for response to a radiation accident that could impact the public.

Chauncey Starr

Dr. Chauncey Starr, founder and President Emeritus of the Electric Power Research Institute (EPRI) in the USA, died April 18, 2007 in his home in Atherton, Calif., as the age of 95, one day after attending a celebration in his honor at the Institute that was attended by more than 200 of his research colleagues.

Starr earned an electrical engineering degree in 1932 and a Ph.D. in physics in 1935 from Rensselaer Polytechnic Institute in Troy, N.Y. He then became a research fellow in physics at Harvard University. During World War II, Starr worked at the Oak Ridge National Laboratory in Oak Ridge, Tenn., focusing on isotope separation technology. Following World War II, he pioneered the development of nuclear reactor designs, including the first non-military reactor, and the first reactor in space.

Over the next 20 years as Vice President of Rockwell International and founded and became President of its Atomics International Division. He then turned to academia and became dean of the UCLA School of Engineering and Applied Science from 1966 to1973.

Starr formed EPRI in 1972 as a research and development organization to address the challenges faced by the electric utility industry. Over the course of 35 years, EPRI has institutionalized Starr's collaborative vision and spirit to become a valued and versatile technical resource for the industry.

Starr's brilliance and innovative ideas were globally recognized. He was regularly consulted for his insightful opinions on energy issues by world leaders, scientists and energy policy makers. He published more than 400 technical and scientific articles and received numerous honors, including the George C. Laurence Pioneering Award in 2006 of the American Nuclear Society for outstanding pioneering contributions to nuclear reactor safety.

Call for Papers

16th Pacific Basin Nuclear Conference

13-17 October 2008

Aomori, Japan

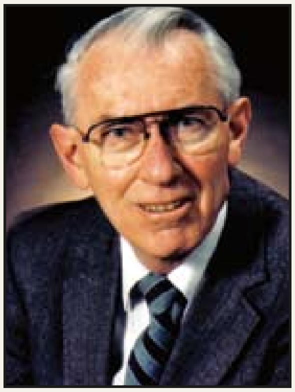
Papers are invited on a wide range of nuclear topics, nuclear power, medical, environment, education, etc.

Deadline for abstract submission (300 words) is 28 September 2007.

Go to the website for more information: www.pbnc2008.org

I Remember John Melvin

by Terry Rogers



John Melvin, B.Eng.,
McGill, 1950

Born: Halifax, N.S.,
February 25, 1929;
Died: Deep River, Ontario,
February 10, 2007

John Melvin and I go back a long, long way, to the early 1940s in high school at St.Leo's Academy in Westmount, the Anglo enclave surrounded by the city of Montreal.

Even then, John was known for his wry sense of humor as well as his common sense. He was one of the few in our school to take up skiing, which wasn't such a big sport then as it later became; that was John ñ he always did his own thing. Later in the 1940s, we were both students in the Department of Mechanical Engineering at McGill, from which John graduated with a B.Eng. degree in 1950. He then went into the real world working for Shell Oil, while I continued on in the graduate program.

John joined AECL in 1954, in the Chemistry and Reactor Research division at Chalk River, where he was working when our paths crossed again. I had been assigned in 1955 by the newly formed Nuclear Division of Canadair Ltd. (Yes, Canadair did once have a nuclear division) to serve as project engineer for the building of the Pool Test Reactor. I was delighted to find that I would be joining John in living at the Staff Hotel in Deep River. The Staff Hotel was a marvellous place to be in the 1950s; both John and I met our future wives there, as did many others who lived there at that time. A fond memory of that period was being a team-mate of John in representing Deep River in a downhill ski meet in Renfrew. John married Joan Smith, originally from Temiskaming, in 1956 and they took up residence in the town where they brought up their four children: Mike, Tom, Jane and Matt.

John moved up through various positions at Chalk River, in the Reactor Research and Development division and the Mechanical Equipment Development branch. John's solid understanding of physical principles and engineering practice coupled with an enquiring mind and good judgment made him a valuable member of the CANDU team. In the mid 1960s he was assigned for a couple of years as Canadian liaison representative to what was then the US Atomic Energy Commission, now the US Nuclear Regulatory Commission, at the Savannah River Laboratory in South Carolina. Later, his assignments took him to Sheridan Park Labs and the family lived in Mississauga for a period before returning to Deep River. His value to AECL was recognized by a transfer to the office of the Vice-President in 1974, then by an appointment as assistant to the Vice-President and General Manager in 1982 and finally by a transfer to the Radiation Application and Isotopes Group management team as a Special Assistant to the Vice-President in 1986. He retired from AECL in 1991.

Over the years, I always looked forward to our families getting together. My wife, Sharon, is a very close friend of Joan; Sharon had been Joan's maid-of-honor at their marriage and Joan had been Sharon's matron-of-honor at our wedding. After the kids were all put to bed, we would talk long into the night, solving the world's, Canada's and AECL's problems. John's professed cynicism and acerbic sense of humor made for many lively discussions. These sorts of activities continued long after the kids had grown up.

John was a very active member of the Deep River community. Arising from his early interest in skiing, he worked with a group in the mid 1960s, Community Skiways Inc., which raised money and bought land to form the Mount Martin Ski Club. Later he participated with another group to buy a block of land from AECL which provides public use for cross-country ski trails as well as many other activities. In addition to being a skier, using the facilities at the Mount Martin Ski Club until a few years ago, John was also a keen golfer and curler.

John was well known in Deep River for his weekly cartoons in the North Renfrew Times. As Al Bancroft said in his moving eulogy to John at his memorial service: "As a community we were treated to a thousand chuckles over twenty or so yearsÖ". I used to look forward to seeing his latest cartoon every time we visited him. As another contribution to Deep River, John also assisted Joan in her task of writing a history of the town for its 50th Anniversary. For many years, John was also very active in the local United Way, much of the time as its president

John would have enjoyed being with many of his old friends at his memorial service on February 14; I can just imagine his wry comments on the praises offered in the eulogies by Al Bancroft and Iain Crocker.

John was a very good friend and kindred spirit; I shall miss him.

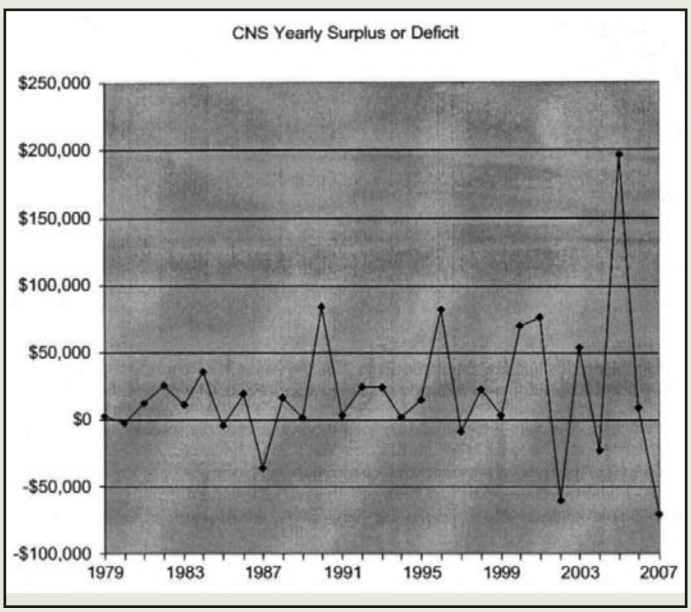
CNS news

CNS Annual General Meeting

The tenth Annual General Meeting of the Canadian Nuclear Society since its incorporation in 1998 was held Tuesday, June 5, 2007 in the Saint John Hilton Hotel; Saint John, New Brunswick, during the 28th CNS Annual Conference, beginning at 11:30 a.m.. *(The CNS was created in 1980 as the technical society of the Canadian Nuclear Association. In 1998 it legally separated from the CNA and was incorporated as a non-profit corporation.)*

After the secretary, Prabhu Kundurpi, confirmed that the 60 plus members present constituted a quorum, president Dan Meneley officially opened the meeting. After welcoming those attending he presented his short report on the year of his tenure, June 2006 to June 2007. *(See his full report reprinted below.)*

Then, Jim Harvie presented his Treasurer's Report. He noted that, while expenditures are fairly uniform from year to year, revenues are quite variable, depending on the number and type of the conferences and courses that are held during the year. Thus, the annual surplus (or deficit) exhibits quite large variations (see graph).



He reported that at the beginning of 2006 a large deficit was anticipated - close to $130K. However, revenues for the year were well in excess of the budgeted amount ($313K vs. $215K) due to successful conferences and courses held during the year. Further, expenses for the year came in about $40K below budget. As a result, the year 2006 ended with a small surplus of approximately $9K. For 2007 we have budgeted for a deficit of $110K. *(Although Council runs from AGM to AGM, the CNS fiscal year is the calendar year.)*

Harvie noted that copies of the Financial Statement for the year along with the Auditor's Report were available. *(Ed. Note: Copies will be enclosed with this issue of the CNS Bulletin, for members only.)* He then moved re-appointment of Timothy Wright as auditor for 2007, which was confirmed by a vote.

Then followed a report from Bill Schneider, program chair, and representatives of the various divisions, committees and branches. Dorin Nichita commented that the Reactor Safety Course continued to be very popular with 50 people attending the last one in March 2007 and a long waiting list.

After all the reports had been received, David Jackson, as past-president, presented a proposed slate of officers and members for Council for the period 2007 ñ 2008. With no nominations from the floor that slate was declared elected by acclamation. *(See accompanying list.)*

At this point, following the practice of the past several years, Dan Meneley presented the ceremonial gavel to Eric Williams, as CNS president for 2007- 2008. *(See photo)*

After briefly outlining the challenges he saw for the coming year, Williams presented a plaque to Meneley to commemorate his year in office.

There being no further business, the AGM was declared closed at about 1:00 p.m.

Outgoing president Dan Meneley presents the traditional gavel to Eric Williams, CNS president for 2007 ñ 2008, at the society's Annual General Meeting in Saint John, New Brunswick, June 5, 2007.

President's Report to the Annual General Meeting

Dan Meneley, President, 2006-07

First, I wish to thank all of the CNS members for their generous ëpro bono' efforts (that is, "**Work for the good of the public rather than for a profit or income**") during the year. I especially thank Bill Schneider for his excellent work as program committee chairman.

This has been a very interesting year. Last week, in scanning the Energy Alberta website, I noticed that they are planning for up to 13 ACR reactors – up to 5 for carbnate extraction, up to 6 for upgrading, and one or two for provincial electricity supply. On Tuesday, the USNRC reported that they expect about 30 new build applications, starting this fall. On the same day, the Washington Post reported that China will build 32 new units by 2020, and up to 300 by the middle of the century.

Looking back over the past year of CNS activity, I see some things promised that were actually done, some tasks that are only partly completed, and some that were not even started. We have left plenty of work to be done by the next Council.

The CNS Bulletin – After long and meritorious service in building up this premier CNS publication, Fred Boyd has chosen to be elevated to the position of Publisher. Ric Fluke, effective July 1, 2007, has accepted the job of editor-in-chief. Ric is actively canvassing for volunteers to help – he is young and energetic, but [still working full-time] he cannot possibly handle all the jobs that Fred has been doing up to now.

Ongoing Conference/Course Program – Planning for the international conference on environmental degradation in nuclear power systems [Whistler, B.C. August 2007]is well underway. CNS also is a participating organization in the 19th international conference on Structural Mechanics in Reactor Technology [Troronto, August 2007].

SI-2008 – Ben Rouben has taken on the task of making local arrangements for the 2008 World Nuclear Institute - Summer Institute. It is expected that 110 Fellows will attend from more than 40 countries, for a period of six weeks starting in July 2008. I will chair the Oversight Committee, because of my broad experience in committing many oversights on earlier jobs.

Alberta Branch – The Branch was formed this year in response recent interest toward nuclear energy-assisted extraction of oil from the tar sands. Though still small in numbers, this Branch is exceptionally active in initiating contacts with various individuals and groups within the province, and in responding to various pro-nuclear requests for information as well as inevitable counter-arguments that have arisen. Thanks to Duane Pendergast and Cosmos Voutsinos for initiating this activity. If you want to help, send an e-mail to Duane and ask him about joining their google group.

PBNC 2010 – Four countries have expressed interest in holding this conference. Canada and Mexico are the two North American counties in this position. Negotiations will be held in the wings of the upcoming PNC meeting in Boston. Canada will ask Mexico to withdraw in favour of Canada.

CCTC 2009 – This is the second EIC conference addressing the technologies associated with adaptation to climate change. CNS participation along this event has been confirmed. Two CNS members will participate in the organization and planning of the conference, as required by the terms of the inter-Society agreement.

Branch Visits – I visited four Branches during the year. More visits would be better, judging from the overall positive response. The Past Presidents Committee may be able to help with this in the coming year.

Topical Position Papers – There is considerable interest in this activity, but the difficulty seems to be in getting individuals to spend some of their spare time on preparing these documents. Again, the Past Presidents Committee should be asked to look into means of stimulating this activity.

Future of CNS – Membership is increasing, the assets of the Society are growing, and (judging from the support from many companies) the industry is happy with our performance. The only small cloud on the horizon seems to be a shortage of people (office staff, professional volunteers, and course instructors) needed to sustain our continually enlarging scope of work. Hopefully, that problem can be dealt with successfully in the near future.

I thank you for giving me the opportunity to serve as your president. I am deeply honoured.

Chalk River Branch co-sponsors symposium

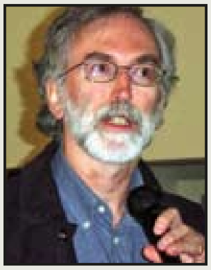
Blair Bromley

The Viability of a Nuclear Power Plant in Renfrew County was the focus of a one-day symposium co-sponsored by the CNS Chalk River Branch and the Algonquin Chapter of the Professional Engineers of Ontario, on Saturday, May 12, 2007, in Pembroke, Ontario.

Over 70 delegates, mostly representatives of the various municipals in the county, listened to five knowledgeable speakers on various aspects of a nuclear power plant and two on the potential economic impacts of building a plant in the area.

After welcoming remarks from **Pravin Shah**, chair of the PEO Algonquin Chapter, **Blair Bromley**, chair of the CNS Chalk River Branch introduced **Cheryl Gallant**, M.P. for the federal riding of Renfrew, Nipissing, Pembroke.

Cheryl Gallant



Bill Garland

Bruce Lang

The first speaker was **Garry McKeever**, an economist who is currently Director, Energy Supply and Competition, in the Office of Energy Supply at the Ontario Ministry of Energy.

McKeever began by reviewing some of the actions by the Ontario government over the past few years, noting the passing of the Electricity Restructuring Act in late 2004, which created the Ontario Power Authority (OPA) and gave the government the power to determine the electricity generation mix. He pointed out that OPA is scheduled to present an *Integrated Power Supply Plan* by mid 2007 which will ensure a reliable, sustainable power supply for twenty years but is to be based on the supply mix in the directive of June 13, 2006 from the Minster of Energy, Dwight Duncan. (That directive limited the contribution from nuclear to 14,000 MW.)

He went on to describe various initiatives such as the growing number of wind generators, and "smart" meters. Both Ontario Power Generation and Bruce Power have proposed new nuclear plants as well as refurbishing existing ones, with the implication that there is no opportunity for another new plant.

Next was **Bill Garland**, a professor at McMaster University, who used interesting slides with animation to explain the basic operation of a nuclear reactor.

He was followed by Bruce Lange, from the Chalk River Laboratory of Atomic Energy of Canada Limited, on the topic of Waste Management. Lange spent most of his talk on the waste management systems at CRL. He concluded by stating that the technology required for managing wastes from NPPs is well understood and well developed.

After a lunch break **Maury Burton** from Bruce Power outlined the process for site and environmental assessments. He described both the environmental review process under the Canadian Environmental Assessment Act and the licensing steps of the Canadian Nuclear Safety Commission (CNSC). As the "responsible authority" under CEAA, the CNSC determines the scope of the environmental assessment (EA). Each step could take three to four years, he commented. To a question, he informed that Bruce Power had budgeted $20 million for the EA for its proposed "new build".

Don Lush, a consultant, covered much of the same topic with further details of an EA and the licensing process of the CNSC.

The presentations concluded with two papers on the potential economic impacts by **Mitchell Wilkie**, Manager of Economic Development Services for Renfrew County and **Tomasz Wlodarczyk**, of the consulting firm Gartner Lee. Both showed that large temporary work force needed to build a nuclear power plant could have a negative effect on housing and the local labour market.

During the closing discussion the question was posed about the possibility of building a nuclear power plant on the large property of AECL's Chalk River Laboratory. A spokesperson for AECL commented that power plants were not in AECL's mandate.

In closing Blair Bromley stated that the PowerPoint presentations would be placed on the Chalk River Branch section of the CNS website (www.cns-snc.ca).

Brent Williams V.P. of NA-YGN

Brent Williams, of Bruce Power, was elected vice-president, president-elect, of the North America ñ Young Generation Nuclear organization at a meeting folllowing a NA-YGN Professional Development Seminar in Miami, May 22-23. In addition to attending the NA-YGN PD Conference, he represented NA-YGN and the CNS at the Nuclear Energy Assembly, also in Miami, May 23-25.

Bruce is the son of Eric Williams, recently reitred from Bruce Power and president of the CNS for 2007 ñ 2008.

The Canadian sector of NA-YGN conducted another Professional Development Seminar on June 2 at Saint John, New Brunswick, the Sunday immeditely before the 28th CNS Annual Conference, which attracted about 60 young professionals. That PD seminar was organized by Willy Cook of the Universityof New Brunswick.

In April, Brent particpated in a seminar of the Industrial Accident Prevention Association (IAPA) as†a representative of NA-YGN and presented a paper connecting safety culture and knowledge capture and transfer as part of an integrated work place culture

He is in the process of developing a proposal for a Best Paper Contest for the International Youth Nuclear Congress 2008 Conference in Switzerland, in September 2008. The Technical Chair for the IYNC2008 conference is Yung Hoang who is the chair of the NA-YGN chapter at Nuclear Safety Solutions (and a Felllow of the World Nuclear Uinveristy ñ Summer Institute.

A "nuclear" family. Eric Williams (L) became president of the CNS on June 5, 2007, while son Brent (R) became vice-president / president of NA-YGN on May 23, 2007.

CNS Council for 2007 – 2008

The following members were elected to form the governing Council of the Canadian Nuclear Society for the year 2007 – 2008 at its Annual General Meeting held in Saint John, New Brunswick, 5 June 2007

Executive

President	E.L. (Eric) Williams	Bruce Power (Automatic Succession)
Past President	D.A. (Dan) Meneley	Retired (formerly AECL)
1st Vice-President	J. (Jim) Harvie	Retired (formerly CNSC)
2nd Vice-President	E.M. (Dorin) Nichita	Univ. of Ont. Inst. of Tech. (UOIT)
Treasurer	J.C. (John) Luxat	McMaster University
Secretary	P. (Prabhu) Kundurpi	Retired (formerly OPG)

Members at Large:

N. (Neil) Alexander	Babcock & Wilcox Canada	
F. (Frank) Doyle	CANDU Owners Group (COG)	*
P. (Pierre) Girouard	AECL	*
C. (Charles) Gordon	Nuclear Safety Solutions (NSS)	
E.M. (Ed) Hinchley	Retired (formerly AECL)	
V.S. (Krish) Krishnan	AECL	
P.J. (Paul) Lafreniere	CANDU Owners Group (COG)	*
S.Y. (Andrew) Lee	Retired (formerly OPG)	
K. (Kris) Mohan	Consultant	
D. (Dave) Novog	McMaster University	*
J. (Jad) Popovic	AECL	
B. (Ben) Rouben	Consultant (Formerly AECL)	
B. (Bikramjit) Sandhu	ANRIC	*
Wm. (Bill) Schneider	Retired (formerly B&W)	
K.L. (Ken) Smith	UNECAN	
M.J. (Murray) Stewart	Energy Council of Canada	
J.J. (Jeremy) Whitlock	AECL	
S.M.H. (Syed) Zaidi	Retired (formerly NB Power)	

*new member

Ex-officio Voting Member:

Murray Elston — President, Canadian Nuclear Association

Ex-officio Non-voting Members:

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

Winners at CNS / CNA Student Conference

Embedded in the 28th CNS Annual Conference in Saint John, New Brunswick, June 3-6, 2007 was the 31st CNA/CNS Student Conference.

There were 23 papers presented over three sessions, grouped into: doctorate, masters and bachelor levels.

Winners of the three categories were:

Doctorate:

1st	Emily Corcoran	University of Western Ontario	*Thermodynamic Modelling of Phase Equilibrium of the Proposed Central Element in the ACR Fuel Bundle and High Temperature X-Ray Diffraction Studies*
2nd	Mike Brackowski	University of Western Ontario	*Surface Analysis on Various Simulated Nuclear Fuel Samples*

Masters:

1st	Rejean Gagnon	Royal Military College	*Safety Analysis of the Homogeneous SLOWPOKE Reactor*
2nd	G. Wei Xu	University of Western Ontario	*Electrochemical Study of Passive Oxide Film formation on Carbon Steel and its Interaction with* H_2O_2

Bachelors

1st	Kevin Daub	University of Western Ontario	*Effects of y-Radiation on Steel Corrosion*
2nd	Veronique Thomas	University of New Brunswick	*Electrochemical and Weight-Loss Study of Carbon Steel Corrosion*

"Badge-Draw" Winners at CNS 2007 Annual Conference

At the end of the 28th Annual CNS Conference and the 31st CNS-CNA Student Conference, on June 6, 2007, 12 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:

- Nienke Smith (of OPG), Kyo Youn Kim (of KAERI), and Kirk Gowdy (of OPG) each won a CNS silk tie.
- Kam Aydogdu (of AECL) won a copy of the book "Unlocking the Atom", by Hans Tammemagi and David Jackson
- Emily Corcoran (of Royal Military College), Lixuan Lu (of UOIT), and Peter Allsop (AECL) each won a CNS sweatshirt.
- Zoe Coull (of University of Toronto), Erin Wishart (of UNB), and Jeremy Whitlock (of AECL) each won a CNS golf shirt.
- Asghar Fathimani (of AECL CANDU Services) and Guillermo Porretti (of AECL) each won a free CNS membership.

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 28ième Conférence annuelle de la SNC et de la 31ième Conférence étudiante SNC-ANC, le 6 juin 2007, 12 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:

- Nienke Smith (d'OPG), Kyo Youn Kim (de KAERI), et Kirk Gowdy (d'OPG) ont chacun gagné une cravate en soie de la SNC.
- Kam Aydogdu (de l'EACL) a gagné une copie du livre "Unlocking the Atom", par Hans Tammemagi et David Jackson
- Emily Corcoran (du Collège Militaire Royal), Lixuan Lu (d'UOIT), et Peter Allsop (de l'EACL) ont chacun gagné un chandail de sport de la SNC.
- Zoe Coull (de l'Université de Toronto), Erin Wishart (de l'Université du Nouveau Brunswick), et Jeremy Whitlock (de l'EACL) ont chacun gagné une chemise de golf de la SNC.
- Asghar Fathimani (de l'EACL, CANDU Services) et Guillermo Porretti (de l'EACL) ont chacun gagné une adhésion gratuite à la SNC.

Félicitations à tous les gagnants!

New members / Nouveaux membres

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

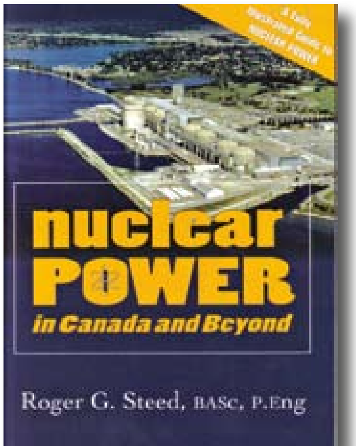
Nous aimerions accueillir chaudement les nouveaux membres suivants, qui ont fait adhésion à la SNC ces derniers mois.

Parvaiz Akhtar
Kathryn A. Albrecht, Mackenzie High School
Daniel J. Albrecht, Mackenzie High School
Jerald C. Albrecht, AECL
Yvette Amor, Babcock & Wilcox Canada
Ivana Arambasic, Carleton University
Eric Araujo, AECL
Hubert (Bud) Arrowsmith, Energy Solutions
Andrew Ashworth, AECL
Parichit Bagga, Carleton University
Masih Balouch, Carleton University
Karen Newman, Hattersley Limited
Anisha Bhasin, Newman Hattersley Limited
Ian Bonnett, GE Nuclear Products
Guy C. Boone, AECL
Warren Bull, OPG Darlington Operations
Anthony Busigin, Special Separations Applications Inc.
Alan Candelma, Newman Hattersley Limited
Craig Canniff
Paul Curle, Curle Technical Services, Inc.
Christopher Deir, Hitachi Canada Ltd.
Paul Desiri, GE Canada Nuclear Products
Guy J.R. Desnoyers, Canadian Nuclear Safety Commisssion
Donald Dickson, NB Power Nuclear
Cory Dumoulin, UOIT
Yousif Dweiri, AECL
Gary Dyck, AECL
Alistair Edwards, Carleton University
Maryam Eskandari, AECL
Andrew Fleming, Carleton University
Garry Fowles
Ross Galbraith, International Brotherhood of Electrical Workers
Jeremy Gamage, Carleton University
Alejandro (Alex) Gidi, Wardrop Engineering Inc. (Nuclear Division)
Rosaura Ham-su, AECL
Jay Harris, Bruce Power
Zhang He, AECL
Thomas Henhoeffer, Carleton University
Bradford Holmes, UOIT
John Jamieson, AECL
Harrison Jolly, AECL
Reza Kadkhodaie, AREVA NP Canada Ltd.
Mark H. Kirshe, EnergySolutions
Anantjit Komal, Carleton University
Saleem Laham, Carleton University
Timothy Lampman, Nuclear Safety Solutions Ltd.
Kalle Leppik, AECL
Shun H. Liang, Newman Hattersley Limited
Terence Loring, Carleton University
Juliet Luiz, AECL
Mehdi Madani, General Electric - Nuclear Products
Krystyna Marcinkowska, AECL
Glenn McRae, AECL
Syed Husain Mehdi, Kinectrics Inc.
Dave H. Millar, Queen's University
Sunjay K. Mistry, AECL
Ali Mohammadian, Newman Hattersley Limited
Virginia Mubarak, Newman Hattersley Ltd.
Michael P. Murchie, Cameco Corporation
Misheck Mwaba, AECL
Robert Najgebauer, Carleton University
Steven Nancekivell, Centre for Nuclear Energy Research
Hanh Hong Thi Nguyen, Newman Hattersley Limited
Richard N. Nishimura, AECL
Allan Ouellet, Hydro-Québec
Andrew Oussoren, McMaster University
Mahesh Pandey, University of Waterloo
Jason Parker, NB Power Nuclear
Nando Pennella, Carleton University
Brian Phelps, AECL
Guillermo Porretti, AECL
Denzil Prabhu, Sulzer Pumps (Canada) Inc.
Mike Ruffolo, OPG
Sam Safaei Sooreh, UOIT
Jeffrey Samuel, Carleton University
Scott Sanford, CNER
Christopher Schuster, Siemens Canada Limited
Allan Scott, Centre for Nuclear Energy Research
David Scott, Newman Hattersley Ltd.
Jingke She, University of Western Ontario
Saurabh Srivastava, UOIT
Karen Stephens, AdvansysTMC
Alan Hoi Ho Tang, Carleton University
Nhan Tran, Carleton University
Nhu Thuy Thi Tran, AECL
Peter R. Tremaine, University of Guelph
Peter J. Valliant, AECL
Graham Van Brunt, Aecon Industrial
Alex Vlahov, Carleton University
Cosmos M. Voutsinos
David J. Wallace, UOIT
Xiaolin Wang, AECL
David F. Wang, AECL
Ross S. Webster, AECL
David Wilder, AECL
Lorraine P. Wiseman, Newman Hattersley Limited
Aleksander Wisniewski, Carleton University
Tat S. Wong, AECL
Sarah W.S. Wong, OPG
Tamara Yankovich, AECL
Mohamed Younis, Nuclear Safety Solutions
Yuepeng Zhang, UOIT

Nuclear Power in Canada and Beyond, Roger G. Steed,

2007, $40.00; General Store Publishing House, web: www.gsph.com ISBN-13:978-1-897113-51-6

Reviewed by Fred Boyd



This substantial size book (8½ X 11 inch format, 410 page) book offers a large number of illustrations, mostly of details of Canadian nuclear power plants, with accompanying text. The major focus is on the mechanical design of the various CANDU reactors. As a result the lengths of the chapters vary considerably. The first six chapters are each very short, from a half page to four pages in length. They deal with the following topics: "Nuclear Fission Explained"; "Reactor Control"; "Reactor Protection"; "Emergency Core Cooling and Containment Systems"; "World's Major Reactor Types"; "Nuclear Reactor Fuel".

Chapter 7, which, at 107 pages, makes up a quarter of the book, is titled "Detailed Views of Canadian Nuclear Power Stations". It lives up to its name with 69 pages of, mostly full-page, illustrations of the mechanical construction and components of Canadian nuclear power plants.

That is followed by two very short chapters titled: "Standby and Emergency Power Supply Generators" and "Keeping Your Fuel Cool".

Chapter 10, on "Nuclear Power and Nuclear Weapons", begins with a short three-page description of "safeguards". The balance of the chapter includes a reprint of an earlier paper on the topic from the International Atomic Energy Agency; a copy of the Treaty on the Non-Proliferation of Nuclear Weapons (NPT) and reprints of several related articles from Jeremy Whitlock's "Canadian Nuclear FAQ" website.

After two one-page chapters on: "Heavy Water Management" and "Radioactive Emissions to the Environment", chapter 13 tackles "Radioactive Waste from Nuclear Power". There is a very brief note on the "Hare report" of the late 1979s but nothing on the extensive work on the deep geological repository concept conducted by Atomic Energy of Canada Limited that evolved from that report. Similarly the notes on the eight-year long "Seaborn panel" and the subsequent passing of the Nuclear Fuel Waste Act are very short. Unfortunately, the text was finalized before the Nuclear Waste Management Organization, set up pursuant to the NFW Act, issued its final recommendation. It does, however, provide several illustrations of fuel bays and dry storage facilities with accompanying text.

Chapter 14 on "Radiation Protection" continues the emphasis on practice and monitoring equipment at nuclear power plants rather than a discourse on sources of radiation and its effect.

Deviating from the strictly "nuclear" aspect, chapter 15 is devoted to "The Conventional, or Non-Nuclear, side of a Nuclear Power Station" with a succinct description of turbines and generators accompanied by several photographs.

Chapter 16 has the intriguing title "Things That Can Go Wrong", but is limited to just three pages!!

Eight pages of colour illustrations are inserted of diverse topics from a photograph of an electric furnace for sintering fuel pellets to a cut-away illustration of a boiling water reactor.

The next three chapters (17, 18, 19) are brief notes on: "The Economy of CANDU Reactors"; "The Lifespan of Nuclear Plants", and "Plant Decommissioning". The first includes the interesting statistic of "output per employee" ranging from 1.45 MW at Darlington to 0.91 MW at Point Lepreau. This is compared to 13.2 MW per employee for NB Power's Mactaquac hydroelectric station.

Chapter 20, titled, "Photographs and Drawings of Canadian Nuclear Power Stations" provides both external views of all of the Canadian plants and cutaway drawings.

Following up on the part of the book's title, "....in Canada and Beyond", chapter 21 offers "Drawings and Descriptions of Reactors Other then CANDUs". These include four drawings and accompanying text of gas-cooled plants in the UK, several PWR and BWR reactors in the USA, the fast breeder reactor Enrico Fermi 1, and Russian RBMK.

Lastly, there is the substantial (70 pages) Chapter 22 on "Reactor Accidents", which covers the NRX accident of 1952, EBR 1 (USA) 1955, Windscale (UK) 1957, NRU 1958, SL-1 (USA) 1961, Enrico Fermi 1 (USA) 1966, Lucens 1969 (Switzerland), Three Mile Island 2 1979 (USA), Chernobyl 1986 (Ukraine). The author provides brief notes on each and then, for the most significant ones, reprints reports from various sources on NRX, Windscale, Three Mile Island and Chernobyl.

The book closes with 10 appendices providing listings of CANDU reactors in Canada and abroad, USA plants, Canadian uranium mines and resources and other topics.

How useful or interesting this book would be for a "general" reader is problematical given its emphasis on mechanical details. However, it would be good background reading for the many young people now entering the nuclear program. While they are working on new designs and new problems this book will show them what exists today. Companies involved with CANDU should consider providing a copy to each new employee.

The Telephone and The Fuel Bundle

by Jeremy Whitlock

One of the quirks of a small nuclear industry is that most of us know most things about it, most of the time. We have one reactor type, one reactor designer, one national lab, a handful of nuclear engineering schools, one Nobel Prize (two if you count Rutherford), one large research reactor, one staggeringly fertile uranium mine supplying the world, and a few thousand gainfully-employed souls.

We know our CANDU reactor runs safer and more efficiently than any other design, and doesn't need a nuclear weapons infrastructure for fuelling. We practically invented nuclear medicine, cancer radiotherapy, superconducting cyclotrons, yadda yadda yadda.

However, now and then a shiny nugget pops up which we happily pocket. Here then, for further edification and mortification around the water cooler, are Five Things You (Maybe) Didn't Know About the Canadian Nuclear Industry:

1. The CANDU fuel bundle of choice today contains 37 fuel pins arranged in rings of 1, 6, 12, and 18. The geometric arrangement of these pins is surprisingly similar to that of the 36 holes in those standard round telephone mouthpieces, in the days prior to the advent of lightweight, plastic handsets. The holes were arranged in rings of 6, 12, and 18, with similar angular offsets per ring. Presumably, the similarity is tied to a common requirement for equidistant two-dimensional spacing: in the fuel bundle's case for reasons of neutronics and thermalhydraulics, while the telephone mouthpiece is concerned more with structural strength and aesthetics.
2. In the 1960s AECL's major science project was ING, the "Intense Neutron Generator". This last brainchild of Wilfrid Bennett ("W.B.") Lewis' stellar career was an innovative 1.5 km linear accelerator intended to slam protons into a lead-bismuth target and spew out unheard-of gobs of neutrons. The design was as visionary as Lewis himself: its thermal neutron flux would exceed the maximum available on earth even today. However, a ballooning price tag and chronic squabbling over siting and mission, led the Trudeau government to pull the plug in 1968. Among ING's legacies was a world-leading accelerator physics capability within AECL that subsequently hatched the world's first superconducting cyclotron design.
3. Advanced fuel cycles may be fashionable today as the world struggles with strategic questions of sustainable supply, non-proliferation, and waste management, but the notion has been fundamental to CANDU design since the outset. Under a thorium fuel cycle the CANDU system can become self-sufficient in fuel-supply. In short, CANDU can burn everything but the kitchen sink (and perhaps even that as well, if it's coated with a thorium glaze).
4. If you thought the 1960s were heady days for Canada's nuclear community, the 1950s were positively stratospheric. Beginning with the invention of cobalt-60 cancer therapy, Canada spent the rest of the decade soaring ahead of the world in nuclear and solid-state physics (with Chalk River's NRX as the main experimental platform), and ended with the debut of the brilliant NRU at Chalk River and the equally brilliant MNR at McMaster University. Dedicated in 1959 by Prime Minister Diefenbaker, the Mac reactor was the largest in the British Commonwealth and a testimony to the foresight, tenacity, and stature of Dr. Henry Thode at the university. The 5 MW MTR-type reactor is something of a phenom in nuclear circles, having risen from imminent closure in the early 90s to comfortable viability today, supported by commercial production of mostly in-house developed isotopes.
5. Chalk River has been visited by many foreign dignitaries in its day, but one of the earliest occurred without hoopla. In 1953 the infant crown corporation AECL was tested early as it dealt with the unprecedented NRX accident from the previous December. During the ensuing 14 months it not only cleaned and repaired the facility, but also upgraded it for more powerful operation (yes, in only 14 months). The accident vaulted Canada to the forefront of both reactor safety philosophy and accident mitigation, but not without help from friends. Admiral Rickover's nuclear navy had tested materials and fuel in NRX, and now the facility's refurbishment became another training opportunity. Among the U.S. secondments during 1953 was 28-year-old Lieutenant Jimmy Carter, commanding a detail of navel personnel. Those who don't believe in fate are given pause by Carter's later job, presiding over the Three Mile Island accident as the 39th President of the United States.

2007

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Sept. 9 - 13 **Global 2007**
Advanced Nuclear Fuel Cycles and Systems
Boisem, Idaho
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Sept. 16 - 19 **ANS Topical Meeting on: Decommissioning, Decontamination & Reutilization**
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Sept. 30 - Oct. 4 **NURETH-12: 12th International Meeting on Nuclear Reactor Thermalhydraulics**
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website: www.aren.ro

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Note re Council listing

The Council listing on the last page is for the 2006 – 2007 Council. Although the executive and members-at-large for the year 2007-2008 were elected at the Annual General Meeting held June 5, 2007 as reported in this issue, the heads of divisions and committees will not be determined until the first Council meeting. The listing will be completely updated for the next issue of the Bulletin.

In the meantime there are a few corrections that should be noted.

- Secretary: Prabhu Kundurpi : correct e-mail address: kundurpip@aecl.ca
- Exec Admin: Ben Rouben: new telephone number: 416-663-3252; new e-mail address: roubenb@alum.mit.edu
- Financial Admin: Ken Smith: new e-mail address: unecan@rogers.com
- Dorin Nichita: Correct phone number is: 905-721-3111 x 2968
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