CANADIAN NUCLEAR SOCIETY

Bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

DECEMBER 2008 DECEMBRE VOL. 29, NO. 4

- CANDU Maintenance Conference
- CANDU Fuel Conference
- Simulation Symposium
- Prairie Atoms

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Replacing Nanticoke: Truth against the wind?

Bruce Power's recent announcement to proceed with an environmental assessment of nuclear new-build at the site of the soon to be closed Nanticoke coal-fired generating station is getting the cold shoulder from the Government of Ontario. It was not in their plan. Instead, George Smitherman, Ontario's Deputy Premier and Minister of Energy and Infrastructure, is favouring wind and gas to replace Nanticoke.

Although cleaner than coal, burning natural gas (methane) releases carbon and does little to combat climate change. Furthermore, since winds fluctuate hourly, wind needs gas as a backup (see article by Don Jones), further increasing greenhouse gas emissions.

The major technical issue is how to replace Nanticoke's enormous generation of 4000 MWe whilst maintaining a stable grid. Wind and gas cannot make up this capacity at a single site and must be distributed over several locations. This would require major (costly) grid and transmission modifications; else it would not be possible to deliver the electricity supply to meet the demand of the GTA (which is about 10,000 MWe).

Since the load on the grid is primarily inductive (from motors) a careful balance of generation, transmission and reactive compensation is needed in order to maintain voltage stability over a geographically large grid (Electricity 101). Hydro Québec cited grid stability as a major reason to refurbish its Gentilly II reactor.

Other reasons to support Bruce Power's proposal include security of supply - natural gas is needed for home heating and burning it to produce electricity could lead to escalating prices and possible shortages as now experienced in the UK. Gas is too precious to burn for electricity, it is not renewable and it emits greenhouse gases.

Wind and solar are renewable, but should not displace our precious agricultural farmlands. For residents nearby wind farms the throbbing "whoosh" of the turning blades with a frequency similar to a heartbeat is very annoying and a chronic source of stress.

Wind farms are not without environmental impact. Birds can be affected in three ways - disturbance, loss or damage to their habitat and collision. According to the Royal Society for the Protection of Birds (RSPB), wind farms kill thousands of birds annually. Without a complete and proper site evaluation it is not known if Nanticoke would qualify as a suitable site.

The Ontario Government's RFP for solar was met with a flood of proposals, as the Government guaranteed to purchase the output at 42 cents/kw-h, about ten times the average grid price. Wind power is paid 11 cents/kw-h. In 2007 Bruce Power was paid 5.5 cents/kw-h, and Ontario Power Generation 4.8 cents/kw-h making the average price paid in Ontario 5.1 cents/kw-h. From a cost perspective, wind and solar generation does not make sense for large-scale generation.

Bruce Power's proposal makes good technical and environmental sense, and will save consumers a lot more cents! Smitherman should re-think his plan.

In This Issue

The main theme in this issue is the robustness of the CANDU industry to maintain its present fleet whilst demonstrating its readiness for new build. For example, there are reports on three conferences held this fall: the ***8th International Conference on CANDU Maintenance;*** the ***10th International CNS Conference on CANDU Fuel;*** and the ***23rd Nuclear Simulation Symposium*** **all with record attendance.** In addition, **Neil Alexander** continues his review of CANDU industries noting their importance to the economies of Ontario and Canada. We also include a technical paper by **Dé Groeneveld**, AECL Emeritus and Adjunct Professor, University of Ottawa, on *Enhancement of Critical Heat Flux in CANDU Bundles – a Review of the Past 45 Years.*

Don Jones, a frequent contributor to the Bulletin, writes about "***Another Inconvenient Truth***". **Duane Bratt**, Mount Royal College, writes about the opportunities and challenges of nuclear power in Alberta and Saskatchewan in his article "***Prairie Atoms***". It appears the Canadian Prairie Provinces are becoming well poised to participate in the global nuclear revival.

Jerry Cuttler reviews a very old book, "***Roentgen Treatment of Infections (1942)***", which offers a very modern alternative to antibiotics for the treatment of infections.

We also have our regular General News including some interesting announcements by Bruce Power as well as John Luxat's appointment to the AECL Board of Directors (Congratulations, John!). There is some CNS News and last but never least, **Jeremy Whitlock's *Endpoint*** will surely blow you away.

As always, your comments, suggestions and **contributions** are welcome! As we come to the end of 2008 I would like to express my best wishes for a safe holiday and a prosperous new year!

This fall has been a very active time for the Canadian Nuclear Society.

There were three successful conferences held this fall and I was pleased to partake of each. They ranged from the very specialized Simulation Symposium, to the medium-sized CANDU Fuel Conference, to the large Maintenance Conference. Each was well planned and run, thanks to many volunteers who are the strength of the CNS.

Despite the specialized nature of the *23rd Nuclear Simulation Symposium*, which was held in Ottawa in early November, there were about 70 participants. An observation that I found interesting concerned the age distribution of the delegates, which would show on a graph with two peaks. There were the usual attendees of a "certain" age but also a significant number of young people, male and female. That latter group reflects positive trends, that the industry is hiring and that management has realized sending young employees to gatherings such as this can be very beneficial to them and, therefore, to the organization.

The *10th International CNS Conference on CANDU Fuel*, which was also held in Ottawa, in October, drew a larger attendance, of over 150. Although also addressed at specialists it embraced a wider range. It also exhibited the interesting age spectrum of attendees as the Simulation Symposium.

There was an aspect that I found somewhat disturbing at both of these specialized events. When some of the young presenters were asked how their work related to the overall design or analysis problem, most did not know. That is not their fault but one of their supervisors and mangers. A team is much more effective if all members know how their work contributes to the desired goal.

Then there was the large *8th International Conference on CANDU Maintenance*, which was held in the Toronto Convention Centre to accommodate the over 500 delegates and 40 plus exhibits. Although most of the delegates were quite experienced, about 100 turned out for a special session that offered an introductory description of a typical CANDU unit, implying that they were quite new to the nuclear field. While refurbishment is much more than maintenance it was very much on the agenda and an early morning session drew a large audience.

At the same time as these events were being presented there has been active planning for the 2009 CNS Annual Conference. With the choice of Calgary as the venue, a number of additional challenges over the many normal ones face the organizers. There has been considerable pressure to make this conference a promotional one for nuclear which conflicts with the traditional focus on the science and technology. An acceptable compromise appears to be evolving.

Also, the CNS Council has decided to take a hard look at the past, present and future of the Society and will be holding a special session in January. This is intended to reconfirm or modify our objectives, identify goals and establish the basis for a strategic plan for the Society. There is room for a few additional participants. If you believe in the CNS and have ideas on how we can go forward, contact me.

A different approach

In October I had the opportunity to visit the state of Virginia to look at the electricity system there, which includes a significant nuclear component. The aspect that struck me most was how different their approach is, and, how much more logical it appears compared to that of Ontario.

A major factor is that their system is totally private enterprise. But the state government is very much involved in planning and coordination, and sets the rate structure.

Unlike Ontario all producers obtain the same, time of day, rates. This has some interesting consequences. The large nuclear plants benefit by obtaining high rates during peak periods that more than compensates for the low rates over night.

In the non-nuclear area this pricing structure has enabled the building of a very large pumped storage facility in the mountainous western part of the state. Taking advantage of the mountains the utility has built a 2,500 MWe station that typically runs just a few hours each day to meet peak demands. Water from a small lake is pumped up the hill over night (when the rates are low) and discharged on demand. It is designed to be able to start up and reach full capacity in a few minutes.

Another example of the consequence of this rate structure was a plant using modified diesel engines to burn off gas from a land fill. They run at peak load times to obtain the highest rate. This facility was built with private investment without any subsidy.

For someone who believed in the publicly owned Ontario Hydro (before poor management and political interference destroyed it) this example of a regulated privately owned system was quite enlightening.

As this year closes I extend a wish to all for a fulfilling new year.

Fred Boyd

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~ Cover Photo ~

Located in northern Saskatchewan, the McArthur River mine is the world's largest, high-grade uranium deposit.

– Photograph courtesy of the Cameco Corporation

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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 $80 annually, $47.00 for retirees, free to qualified students.

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10th International CNS Fuel Conference

by Fred Boyd

Over 150 participants attended the **10th International CNS Conference on CANDU Fuel** held at the Delta Hotel in Ottawa, October 5 – 8, 2008, to share their experience on the various aspects of producing reliable fuel for CANDU type nuclear power plants.

The locale for this popular event has been somewhat peripatetic. The first three conferences of this series were held at Chalk River, in 1986, 1989, 1992. Since then they have been held, every two or three years, in diverse locales such as Niagara Falls, Kingston, Belleville.

Perhaps indicative of the changing Canadian nuclear program, the age distribution of the attendees was interesting. There was the usual cluster of quite "mature" participants but also a significant number of young people, with relatively few in between. A modest number of delegates from overseas supported the "international" aspect of the conference. These came from France, India, Korea, Romania, and the International Atomic Energy Agency.

In typical fashion there was an opening reception on the Sunday evening, which gave delegates the opportunity to meet with colleagues from other organizations.

Conference chair, **Lawrence Dickson**, Atomic Energy of Canada Limited, Chalk River Laboratories, opened the conference proper the Monday morning, introducing and thanking the members of the organizing committee and acknowledging the support of the IAEA in assisting overseas delegates. Then followed a short plenary session with three presentations.

In a presentation titled, *IAEA PHWR-Related Fuel Programs*, **John Killeen**, of the IAEA, provided an overview of that Agency's programs related to CANDU type fuel. Although the IAEA has programs related to the full nuclear fuel cycle, particularly fuel fabrication and fuel performance, he emphasized that the Agency does not do design or development but is focussed on supporting member states in their programs. This includes several programs related to PHWR fuel.

Lawrence Dickson

John Killeen

Patrick Reid

Matthew Kaye

He went on to talk about some specific aspects. Current codes do not, he said, accurately predict fission gas release. The IAEA is preparing a monograph on zirconium that will be published in 2009. He commented that delayed hydride cracking was primarily a Canadian problem.

Patrick Reid, of AECL, presented the second plenary paper, titled *The ACR-1000 Fuel Bundle Design*. He began with an overview of the ACR 1000 design concept and its emphasis on passive safety. In giving a detailed description of the fuel bundles for the ACR 1000 he noted that the central element was of a larger diameter and had no fuel. This is to control the coolant void reactivity in a loss-of-coolant accident.

The final plenary presentation, by **Dr. R. N. Jayari**, Chief Executive of the Nuclear Fuel Complex, India, was on *PHWR Fuel – An Integrated Approach in the Indian Context*. He began by providing an overview of the Indian nuclear power program beginning in the 1950s. There are now 15 "CANDU type", 220 MWe units operating and two 540 MWe PHWR units being commissioned. (The smaller plants are based on the Douglas Point pilot plant.) Seven types of PHWR fuel bundles have been developed, he said. Current burn-up is about 7,000 MWD/tonne but they hope to achieve 20,000 MWD/tonne. MOX fuel is being studied and new techniques for welding of the end plates have been developed.

The remainder of the three-day event was devoted to technical papers in three parallel sessions, grouped under the following headings:

- CANDU Fuel and Fuel Fabrication
- Design and Development of Fuel, Fuel Cycles and Fuel Performance
- Fuel Model Development
- Safety / Fuel Safety / Design and Development of Fuel and Fuel Cycles
- Fuel Performance
- ACR Fuel and Spent Fuel Management
- Fuel Safety / Fuel Fabrication / Fuel Model Development
- Advanced CANDU Reactor and Design and Development of Fuel and Fuel Cycles

At the beginning of the Tuesday session on Fuel and Fuel Fabrication, **Alistair Bain**, retired from AECL – CRL, gave a paper on the *History of the Development of CANDU Fuel*, which, he said, was based on the chapter he wrote in the seminal text, *Canada Enters the Nuclear Age*. He commented that his motivation for presenting this paper was that the multiple authors of that text had agreed to omit names and he wished to record the contributions of many of his colleagues.

There were after-lunch speakers on the second and third days.

On Tuesday, **Matthew Kaye**, a professor at the University of Ontario Institute of Technology (UOIT), provided a broad overview of the origins of UOIT and its current programs related to nuclear energy. UOIT, which is situation on the campus of Durham College in Oshawa, opened in 2003, with the first class graduating in 2007. There are now about 5,500 students.

It is the only Canadian university giving a degree in nuclear engineering. Nuclear related programs include: nuclear engineering, health physics and radiation science, applied science in nuclear power. Two masters programs are now being offered in nuclear engineering, a MASc. and a M.Eng.

UOIT has intern programs with Ontario Power Generation and with the nuclear utilities in Argentina and Romania. It emphasizes "mobile learning technology", with every student having a laptop loaded with course-specific software. The Faculty of Energy Systems and Nuclear Engineering has 12 professional and 5 support personnel.


Terry Jamieson

On the Wednesday, **Terry Jamieson**, VP Technical Support at the Canadian Nuclear Safety Commission outlined current programs of the regulatory agency. After briefly describing the structure of the organization – a quasi-judicial tribunal of seven appointed members and a support staff of about 700 mostly professionals – he mentioned some recent activities. Pre-licensing reviews of reactor designs have been re-instated with one contract with AECL for the ACR 1000 and negotiations underway with Areva and Westinghouse for the designs they are submitting in the Ontario bid.

A number of Regulatory Documents have recently been issued, among them:

RD 360	Life Extension
RD 310	Safety Analysis for New NPP
RD 337	Design requirements for New NPP
RD 346	Site Evaluation

He noted that RD 337 is based on an IAEA guide and is "technology neutral". (The PP version of Jamieson's talk is available on the CNSC website: www.nuclearsafety.gc.ca)

The technical sessions on the Tuesday were terminated in mid-afternoon to allow delegates to congregate for the traditional group photograph and prepare for a dinner cruise on the Ottawa River.

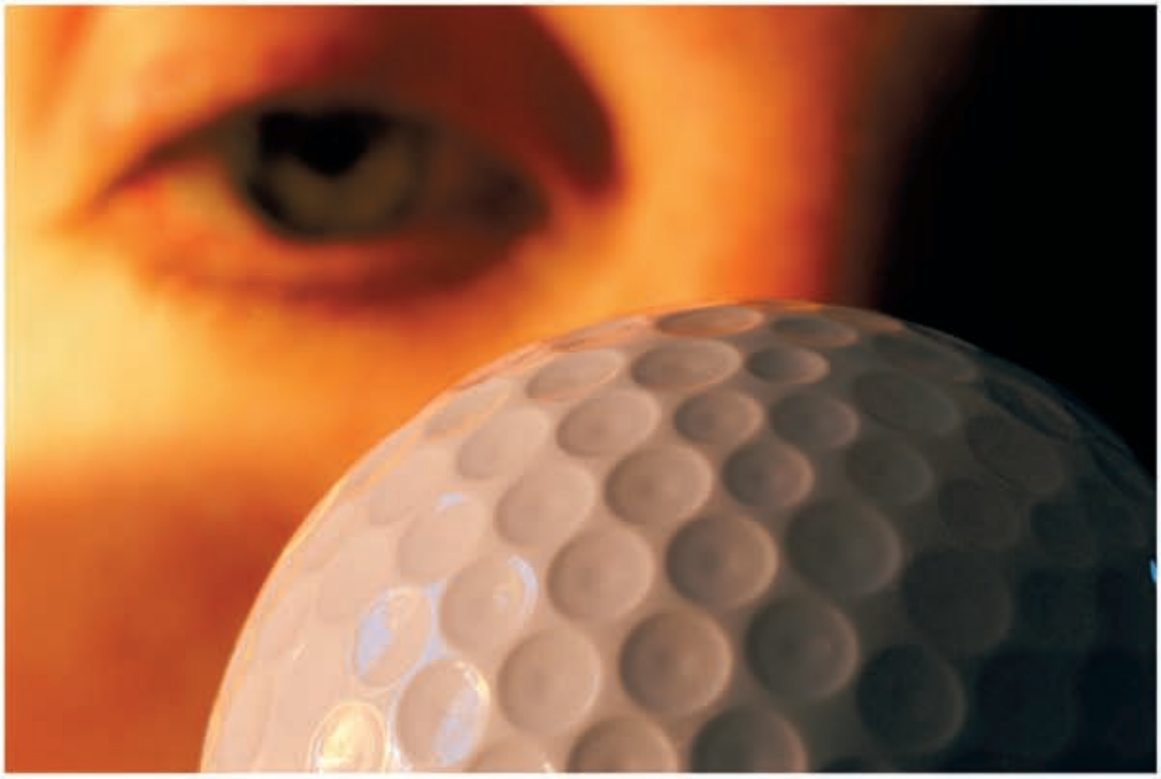
The organizing committee was chaired by Lawrence Dickson with the Technical program chaired by Holly Hamilton, both of AECL. Other members were: Noel Harrison, Stephen Livingstone, Bernie Surrette, John Montin, all of AECL, and Denise Rouben, CNS.

Supporting the event through sponsorships were: AMEC; Bruce Power; CANDU Services (AECL); Cameco; Comstock; Ontario Power Generation; Power Workers' Union; Stern Laboratories; TMS and UOIT.

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

Accompanying photographs are mostly courtesy of Bernie Surrette.


Arranging everyone for the traditional group photograph was a challenge.



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8th International Conference on CANDU Maintenance

Large attendance at Maintenance Conference

With all of the CANDU plants conducting maintenance or refurbishment, the organizers of the ***8th International Conference on CANDU Maintenance*** recognized that a larger venue than a typical hotel would be needed and chose the Toronto Convention Centre. They were right.

This edition of this popular event, held 16 – 18 November 2008, drew well over 500 delegates and hosted over 40 exhibitors The exhibits overflowed from the perimeter of the very large room used for plenary sessions and meals into the adjacent broad corridor.

Respecting the pressing schedule of those involved with maintenance or refurbishment the organizers kept to a two-day event but packed a great deal into that limited time. As well as 78 technical papers (with each allotted ½ hour) there were two plenary presentations, two lunch speakers, a "Refurb Managers' Panel" early morning of the second day and an introductory "CANDU Configuration Overview" Session later that morning.

The exhibits opened on the Sunday evening with a modest reception but only a fraction of those registered attended.

Paul Lafrenière, conference executive chair, officially opened the conference on the Monday morning with greetings for the delegates. He noted many new faces among the attendees and new ideas at the exhibits.

He then introduced the first plenary speaker, **Robert Fisher**, Chief Nuclear Officer and Executive Vice President at Bruce Power. Fisher is relatively new at Bruce Power after more than 25 years of wide experience in nuclear operations in the USA. He previously was Vice President Operations for Exelon. Like many senior people in the US nuclear industry he served six years in the US Naval Submarine Fleet.

With an energetic style similar to that of a sport coach Fisher spoke of the need for excellence. "Only the strong will survive", he said. If excellence is not pursued we will move backwards, he stated, adding that it is necessary to challenge the existing mindset. Each person must strive for perfection and urge others to do the same. He said that attitude had been lost at Bruce Power and needed to be recovered. If Bruce [Power] is to be number one, he said, all involved must be accountable. He closed by stating that Bruce WILL be first class, second to none.

Paul Lafrenière

Robert Fisher

Michael Lees

Michael Binder

The second plenary speaker, **Michael Lees**, President, Babcock & Wilcox Canada, was much more low key. Presenting a supplier's perspective he noted four necessary factors for success: leadership; teamwork; continuous improvement; value to the customer. He said that in his environment the customer expects more; competition is increasing; and he has "resource constraints" such as the retirement of his skilled workers.

B & W Canada has a program to continue to improve. It includes; identifying champions of change; identifying areas for improvement; measure performance; continuous feedback; and top-down leadership. The last, he claimed, is critical to obtain employee "buy-in". After emphasizing that to achieve improvement it is essential to measure performance, he provided a few examples of the application of this approach including a new design for the tube support plate of a PWR steam generator.

Before the morning break, **Peter Angell**, technical program chair, outlined the arrangement for the parallel sessions of technical papers.

Although there were no further plenary presentations, there were two luncheon speakers and an after dinner one.

The luncheon speaker on the Monday was **Michael Binder**, President of the Canadian Nuclear Safety Commission. He was appointed to that position in December 2007 after Linda Keen had been dismissed as a consequence of the NRU isotope situation. Prior to his appointment at the CNSC he was at Industry Canada where he was Assistant Deputy Minister, Spectrum, Information Technologies and Telecommunications. He holds a Ph.D. in physics from the University of Alberta.

Binder began by providing the context in which the CNSC operates, noting the growing energy demand, especially for electricity, and the demand for uranium (which the CNSC regulates) for nuclear plants around the world producing that electricity. He briefly described the structure of the CNSC which is a quasi-judicial commission supported by a staff of over 700 mostly technical professionals. The CNSC objective, he said, is to be the best nuclear regulator in the world.

CNSC is striving to improve the clarity of the licensing process, he stated, and has issued a number of new "regulatory documents". For nuclear power plants CNSC has initiated a combined process for environmental assessment and site licensing and has joined a new government initiative, the Major

Project Management Office, which will coordinate the activities of different federal departments associated with large projects such as a nuclear power plant.

The Tuesday luncheon speaker, **Alan Butterfield**, Vice President, Maintenance and Engineering, Air Canada, brought a perspective from another advanced technology industry – airlines. In his role he is responsible for Air Canada's maintenance programs, core engineering, fleet management, airworthiness, maintenance operation control. This includes oversight of vendor management functions. He came to Air Canada in 2007 from United Airlines of the USA where he was Vice President of Airframe and Line Maintenance.

Butterfield began by noting that there are many parallels between the nuclear power industry and the airline industry. Both are highly regulated. For airlines, this involves the country of origin [of the aircraft] as well as the country of operation. Although the original equipment manufacturer is regulated by the country in which it is situated, the airline is regulated by its country and is ultimately responsible.

He commented that maintenance is [financially] a "black hole"; money goes out, not in. That makes it often difficult to convince CEO's about the budget. His budget, he noted later, is about $1 billion per year. Almost as an aside he showed a photograph of a new fancy first-class seat (or position) that will cost about $1/2 billion to install in Air Canada's fleet.

As an example of some of the unusual (and costly) situations that arise he described an incident of a B 777 jetliner having to land at a small airport in Alaska because of eroded blades in one of the engines. A replacement engine cost $25 million and it took six days to get it to the site. Together with the technical crew required, the repair cost $2.2 million and the aircraft was out of service for 14 days.

A transparent flow of information is needed, he said, and showed a typical chart he uses to gather and record all the necessary information for a particular problem. Air Canada is moving to have vendors hold the inventory for parts. That will increase the cost of individual components but reduce the airline's overall cost.

After the conference dinner on the Monday evening, **Dr. J. P. Pawliw-Fry** gave a motivational talk focussed on "how to get to the next level". Pawliw-Fry is head of an organization called the Institute for Health and Human Potential which is active in the USA, Canada and Australia. The handout he distributed said the Institute "is a training and development company that focuses on increasing emotional intelligence in individuals and organizations".

Emotion drives behaviour, he said, but emotion comes before thought. Calm leadership is needed. Then he presented diagrams of the brain and emphasized the action of the Amygdala, the part of the brain, which, he said, is the site of emotional memory. It can "hijack" thought, resulting in decreased working memory. Clear communication can overcome this, he said.

Early on the Tuesday morning there was a breakfast panel with the title "Refurb Managers' Panel" with representatives from Bruce Power, Point Lepreau and Gentilly 2.

John Sauger, Bruce Power, led off with some comments derived from the experience in refurbishing Bruce units 1 and 2. "Get the engineering complete first" he stated as the prerequisite condition. The next condition he mentioned was to ensure the contractors can cope with the size of the project. Refurbishment is NOT just an outage, he emphasized, it is a large capital project that requires experienced people. Finally he urged everyone to share experiences.

Don Sinclair, Point Lepreau, spoke on behalf of Rod Eagles who was unable to attend. He noted that Point Lepreau began planning the refurbishment in 2000. The decision to refurbish the plant was finally made in late 2007 and the actual work began in March 2008. The unit was defuelled by May 10 and work on removing the feeders and fuel channels is underway.

Among the challenges that must be faced he listed: the need for a strong safety culture; delivery of components; creation of "first-of-kind" tools; and the ever-pressing demand for key people. AECL was initially given the overall contract but NB Power has now taken direct management of some of the non-reactor work.

Lastly, **Claude Drouin**, of Hydro Québec, outlined the situation of Gentilly 2 whose refurbishment was only recently decided by the HQ Board of Directors, although planning has been under way since 2001. HQ's Equipment Division will be the overall project manager. Some safety studies are still to be completed. The overall schedule is for a 79 week outage, made up of 7 weeks shutting down the reactor, 6 weeks decontamination, 51 weeks replacing feeders and fuel channels, and 15 weeks commissioning.

After the two plenary presentations on the Monday morning, the balance of the day and all day Tuesday were devoted to four parallel technical sessions. Papers were grouped under the following headings.

- Managing Worker Radiation Dose
- Maintenance Management Programs
- Full Life-Cycle Management
- Managing Maintenance Through Understanding Component Ageing
- Refurbishment
- Designing for Maintainability
- Inspection Techniques
- Maintaining Water Chemistry During Lay-Up
- Applying Probabilistic Assessments to Maintenance
- Computer Aided Maintenance
- Advanced Tooling for Maintenance
- Station Maintenance OPEX
- Mitigating degradation

Running in parallel with the technical sessions on the Tuesday morning was a special session on "CANDU Configuration Overview". This was designed to give those new to the industry an understanding of the various parts of a typical CANDU unit. To the surprise of the organizers this event drew about 100 participants.

This conference was organized under the auspices of the Canadian Nuclear Society by a large organization headed by Paul Lafrenière. Jamie Goodfellow was deputy chair and

chair of the Plenary Program, Bill Schneider, who is chair of the CNS Program Committee and an initiator of the conference, looked after publicity. His son Michael was sponsorship chair and Ken Belfall served as treasurer. Elizabeth Muckle-Jeffs was the event administrator and Denise Rouben of the CNS was the conference registrar.

Conference sponsors (most of whom also had exhibits) were: Acuren; Aecon; AECL CANDU Services; Alaron; AREVA; B&W Canada; Black & McDonald; Bruce Power; E.S.Fox; GE Hitachi; Hydro Québec; Intech; Jamko; Kinectrics; NB Power; NLI Canada; Ontario Power Generation; ProMation Engineering; Schultz Electric; Structural Integrity Associates; ZETEC.

Jamie Goodfellow

A CD with the technical presentations will be available from the CNS office in early 2009.

A special booth was set up to facilitate discussion between delegates particularly interested in refurbishment.

Views of delegates examining the many exhibits.

Setting up booths.

A quiet moment at the registration desk.

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23rd CNS Nuclear Simulation Symposium

by Fred Boyd

A select group of analysts involved in simulation gathered at the Marriott Hotel in Ottawa, November 2-4, 2008, for the **23rd Nuclear Simulation Symposium.**

Despite the specialized topic of the meeting there were about 70 participants. About half of those arrived in time for registration and the pleasant reception held on the Sunday evening prior to the meeting.

At the official opening of the symposium on the Monday morning, welcome messages were given by Honorary Chair, **John Luxat**, of McMaster University and Conference Chair, **Elisabeth Varin**, of Atomic Energy of Canada Limited (Montreal).

Then John Luxat gave the opening plenary presentation on: *Multiphysics Software and the Challenge to Validating Physical Models.* General purpose programs have limitations, Luxat said, and there are steep learning curves in applying them to specific problems. He emphasized that in dealing with coupled problems it is essential to define the interface. In closing he commented that a major challenge is converting general purpose programs to robust application-specific ones. This requires great knowledge, he warned in closing.

The second plenary paper was by **Dé Groeneveld**, AECL Emeritus and Adjunct Professor, University of Ottawa, on *Enhancement of Critical Heat Flux in CANDU Bundles – a Review of the Past 45 Years.* He began by acknowledging a paper by Ron Page of a few years ago which included this topic. The focus of Groeneveld's paper was a review of various methods of increasing the CHF power of CANDU-type fuel bundles. This is particularly important to counteract eroding margins in ageing reactors. Several of these CHF enhancement principles have been used in the design of the CANFLEX bundle.

He noted that a few decades ago most of the concepts were tested in-reactor. Most of those who were involved have retired and problems are being addressed by simulation. Referring to the onset of dryout he commented that this is more critical with PWR fuel.

After the break, **Terry Jamieson**, VP Technical Services, Canadian Nuclear Safety Commission described the current organization of the CNSC and some of its programs. Showing a current organization chart he noted the seven member Commission, which is a legal tribunal, and the structure of the approximately 700 support staff. He commented that the CNSC has asked for a review next year by a team from the International Atomic Energy Agency and is developing guidelines for the application of the "risk-informed" approach to regulatory actions.

Completing the Plenary Session, **Paul Thompson**, Manager of Safety and Environment at Point Lepreau NGS, talked about the **Refurbishment of Point Lepreau Generating Station**.

John Luxat

Elisabeth Varin

Dé Groeneveld

Terry Jamieson

Paul Thompson

The actual refurbishment project began at the end of March 2008. During the scheduled 18 month shutdown the major activity will be the removal and replacement of all 380 fuel channels and calandria tube assemblies, and the connecting feeder pipes. In parallel, many other repairs, replacements, inspections, and upgrades will be conducted. The objective is to enable the station to operate for a further 25 to 30 years.

The project began in 2000 with studies on the feasibility, technically and economically, to conduct the extensive refurbishment. Among the many studies, extensive safety analyses were conducted which showed that fire scenarios dominated the risk.

That afternoon and all the next day were devoted to presentation of technical papers presented under the following categories:

- Reactor Physics
- Computer Codes and Modelling
- Thermalhydraulics

On the Monday evening there was a dinner with a pair of magicians providing entertainment.

The conference organizing committee was chaired by Elisabeth Varin, AECL Montreal. Eleodor (Dorin) Nichita, UOIT, and Guy Marleau, Ecole Polytechnique, co chaired both the Plenary and Technical Program committees. Denise Rouben, CNS, handled registration and other administrative duties. Others involved included: Mohamed Younis, AMEC; Marv Gold, CANDESCO; Ben Rouben, consultant; Ovidiu Nainer, Bruce Power; George Bavrus, OPG; Jeremy Whitlock, AECL.

AECL, AMEC, CANDESCO and OPG provided sponsorships.

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

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The Nuclear Business: Vitally important to Ontario/Canada

by Neil Alexander, President, Organization of CANDU Industries

Ontario was recently demoted to being a "have not" Province. While this was largely because other Provinces, rich in the natural resources we now consider valuable, are doing better, it also demonstrates an underlying weakness in Canada's economy. Historically a manufacturing province, Ontarians are learning very quickly that conventional manufacturing has been globalized. In this fully globalized environment no matter how efficient you are, you cannot compete with economies where the cost of employment is one tenth of your own. Add to this the fact that we chose to manufacture cars and the market for cars is declining and you have a perfect storm that challenges the very backbone of Ontario's economy.

So what do we do? Standard business analysis shows that you have to identify your area of "Positive Differentiation" i.e. that thing that you are good at and which makes a difference. This is where talk of the "knowledge economy" comes from. We are well educated so we will do things that require you to be better educated than other people. It is not a new concept, the UK went that way some years ago and it largely works, over time. The problem is: what do the auto assemblers, lathe operators and machinists do? I think if they wanted to be software engineers they might already have investigated that as a career.

A solid business has to look to more than its positive differentiation it also has to look at the market opportunity, whether or not it can be a leader in that market and finally how any plan of action fits with existing challenges to the organisation. In last month's Bulletin I talked about the massive market opportunity and how Canadian companies have taken a leadership position. In this edition we are looking at how the nuclear business contributes that the considerable issues that Ontario must deal with if it is to shrug off that "have not " status.

Clearly "Nuclear" fits with the idea of a knowledge based economy. Designing a reactor obviously requires tremendous numbers of engineers, scientists, programmers and many others, all of whom will be working at the top end of their trades. But even if we entirely ignore the technology, the scale of a nuclear construction project is a "knowledge" project in its own right, calling for planning, financing and insurance. Even the lawyers get a look in as complex contracts are negotiated and of course they are an accountant's delight.

There are also many other industries that have growing markets; IT (think RIM), pharmaceuticals and others. And yes in the knowledge aspect of the business we can develop and maintain the knowledge here but because the manufacturing is still globalised our factory workers are competing with workers in counties with far lower labour costs and because of that Ontario's workers will remain unemployed.

Nuclear is different. For many nuclear components there is a close relationship between the buyer and the supplier. There needs to be. The numbers of components are smaller, the quality is higher, reliability is paramount and in any case multiple inspections and audits have to take place. As a result the fabrication tends to stay close to the knowledge and so if you have the knowledge you also have the fabrication jobs! This is why OCI has clusters of members in Mississauga, Pickering and Bruce county.

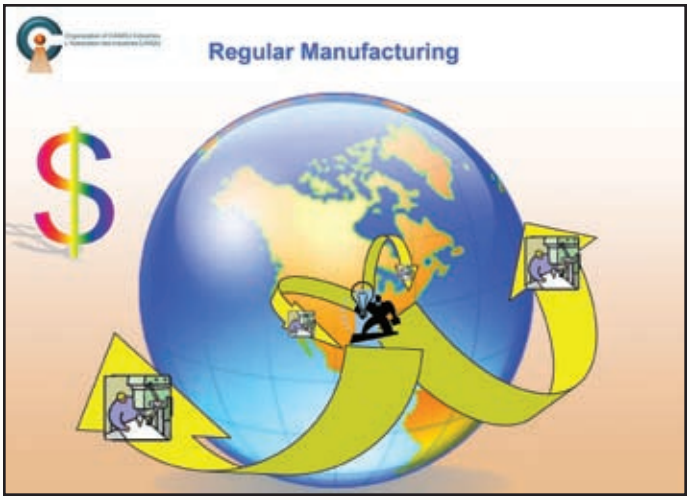
So when we look at the strategic benefit of nuclear in Ontario we see

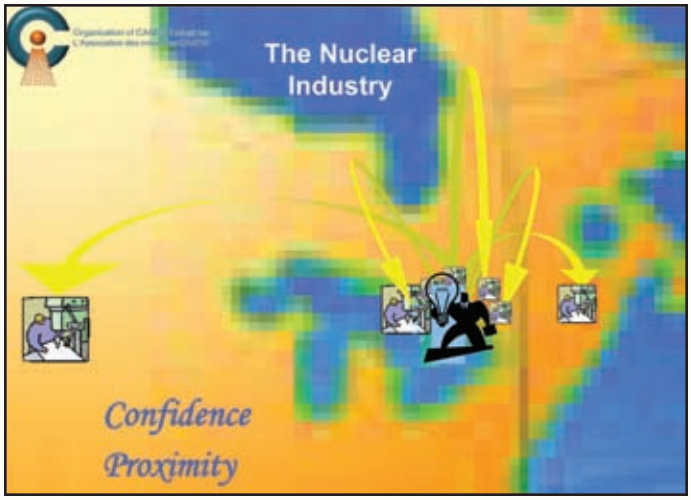
Market Opportunity ✓

Leadership Opportunity ✓

A solution to employment challenges ✓

This is why the province and indeed the nation, needs to be paying close attention to the health of its nuclear industry and the potential for Ontario to profit from a burgeoning world-wide nuclear market. In a perfect world, this is a debate we should have BEFORE decisions are made about Ontario's nuclear future.





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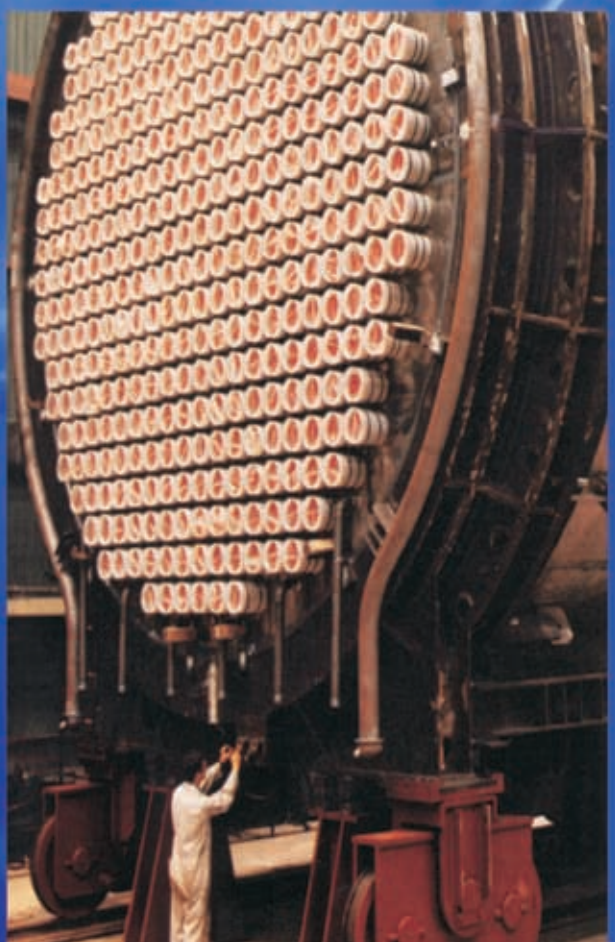

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Another Inconvenient Truth

by Don Jones

*[**Ed. Note:** Don Jones is a CNS member and frequent contributor to the CNS Bulletin. The opinions are those of the author and do not necessarily represent the opinions or views of the CNS.]*

There has been evidence recently of increasing support for wind and other renewables for Ontario, some of it suggested as an alternative to refurbishing or replacing Pickering B and Bruce B. Witness Energy and Infrastructure Minister George Smitherman's request last September to the Ontario Power Authority (OPA) to take a look at increasing the amount of renewables, conservation and distributed generation in Ontario's 20 year energy plan. Also, the report, "Plugging Ontario into a Green Future: A Renewable is Doable Action Plan", put out last November by the Pembina Institute and a coalition of environmental groups, not to mention CBC's The Fifth Estate's "The Gospel of Green", a pro-wind anti-nuclear production that aired last November.

In early December David Suzuki said he no longer wanted to be associated with "powerWISE" (the government-utility conservation program) television commercials because of Ontario's ongoing nuclear program. The Ontario Sustainable Energy Association is pushing for an Ontario Green Energy Act that seems to be generating some interest from the government. In Stephen Harper's Throne Speech last November it was proposed that 90 percent of electricity generated in Canada come from non-carbon emitting sources by 2020 so no doubt this will encourage supporters of wind generation, even though the government offered support for nuclear power plant projects. So, can wind do it in Ontario?

An Inconvenient Truth

The inconvenient truth is that the future of industrial wind power in Ontario is tied to the future of natural gas for electricity generation. The Ontario grid needs continuous flexible support to control minute-to-minute frequency variations brought on by normal supply-demand mismatch. This modulating control will be made more difficult with the large-scale introduction of wind generators that are subject to the vagaries of wind. Modulating control refers here to selected generators on the grid responding to manual dispatch to increase or decrease output so that the chosen plant on grid frequency regulation duty (automatic generation control) is kept in the desired operating range. Our current nuclear fleet cannot provide frequency regulation because its modulating control capability is limited.

A base-load run-of-the-river hydroelectric plant is suitable for grid frequency regulation but hydro may not be acceptable for modulating the more significant grid fluctuations brought on by the vagaries of wind. Hydro plants may not be available all the time, there are seasonal fluctuations in water supply, there may be local, provincial or international agreements on water management, or water is being kept in storage for load following or operating reserve. The load following and operating reserve capacity of the hydro plants will become crucial with the phase-out of the coal-fired stations and would not be dribbled away supporting the wind generators.

Even without any possible restrictions on nuclear and hydro it makes little economic sense to run reliable suppliers of steady power, with high fixed costs and low operating costs, at part load to support the intermittent varying output from wind farms. This leaves natural gas and coal for support duty. Since coal is going to be phased out in Ontario by 2014 it leaves natural gas as the future support for wind, providing modulating control and some, or all, of the grid frequency regulation. Due to the simultaneous demands of home heating and electricity generation in the winter there may be gas shortages. Some of these plants may be dual fuelled with gas and oil, not a pleasant thought.

So, in Ontario, if you want wind you also have to burn gas in units with limited turndown capability, operating inefficiently in the upper part of their load range. Like in the movie Wizard of Oz, the curtain behind the windmills needs to be pulled back.

"Green" Germany

German energy utility E.ON is one of the world's largest investor-owned energy services company. Multi-national it is based in Germany and supplies natural gas as well as electricity generated from nuclear, wind, coal and gas. Based on E. ON's German experience to balance the grid, 60 percent of the installed wind power has to be made available quickly at all times from it's fossil fuelled power plants operating inefficiently at part load, generating pollution even on windy days. Also 90 percent of the wind capacity has to be available from "shadow power stations" for periods when wind power is limited.

The Royal Academy of Engineering in the United Kingdom has stated that where fossil fuel supplies the back-up to intermittent renewable supply, like wind, the emissions from the back-up plant running on part-load and reduced efficiency can

reduce or even cancel the environmental benefits gained from renewable operation. In supposedly "green" Germany over 60 percent of electricity is produced from fossil fuels (80 percent of this from coal), just under 30 percent from nuclear, with the balance from hydro, wind, and other renewables. New coal-fired stations will be built to replace the nuclear units that are to be phased-out by 2022, unless the government comes to its senses.

Dash for Gas

The Ontario government is putting too much faith in natural gas for electricity generation, like the United Kingdom did with its "Dash for Gas" from the North Sea in the 1990s. Now the UK is running out of expensive gas and is moving at full speed to build new nuclear units from Areva and Westinghouse. The UK government, through British Nuclear Fuels Limited, once owned Westinghouse but sold it to Toshiba in early 2006 so the UK is no longer a technology vendor. The last nuclear unit built in the UK, Sizewell B, a Westinghouse design, started up in 1995 but planned follow-on units were cancelled because of the availability of low cost gas.

The UK presently has enough coal-fired and gas-fired plants to support it's current crop of windmills but because of its failed energy policy it is planning, against vociferous opposition, to build several more coal-fired plants as old coal and nuclear power units need to be replaced and while the planned new nuclear units work their way through the regulatory process. These coal-fired plants could then be used to support more European Union mandated renewables, mostly wind. Gas-fired stations may also have to be built and the UK is understandably nervous about relying too much on foreign suppliers of gas. Presently over 70 percent of the UK's electricity comes from coal and gas with around 20 percent from nuclear. The UK's Climate Change Act 2008 means to reduce carbon dioxide emissions by at least 26 percent by 2020, against a 1990 baseline. Good luck!

An Unsustainable Future

In Ontario windmills are only possible because of the government's commitment to building large numbers of gas-fired power plants to replace the coal-fired stations. An energy future built on gas is unsustainable. There is no long term future for gas-fired generation in Ontario because of front-end and back-end greenhouse gas emissions, air pollution, high unit energy cost (like wind) to consumer, security issues of foreign supplies, high demand for gas from the United States, declining gas reserves, lost gas legacy to future generations, home heating demands, less and more expensive gas as feedstock to the chemical industry, and, in summary, the waste of a premium non-renewable resource just to generate electricity. Over the next few years even hydro-electric generation may not be too reliable since it will be affected by climate change, putting more pressure on nuclear.

An Unlikely Future

Since Ontario's wind generators require natural gas-fired generation for support it means an unlikely future for the windmills, and their transmission infrastructure, that one day may not be technically or economically compatible with a future all nuclear/hydro power grid. There is certainly no environmental benefit to having windmills on a clean all nuclear/hydro grid. However, the nuclear industry and the grid operator, the Independent Electricity System Operator (IESO), have raised no objections to the Ontario government's proposed generation supply mix and its decision to go with gas and wind, indeed, the nuclear industry supports it. Does this mean that the industry and the IESO are confident that the new nuclear units, that are designed to operate for 60 years, are able to technically and economically support the vagaries of wind in a future without gas? If they are not sure then they should say so now before mass planting of windmills on their concrete foundations begin.

Grid Reliability

Grid reliability is paramount. The IESO is still having problems getting its act together on the load following requirements for generators on a grid without coal-fired units. The Load Following Standard, SE - 38, was put on hold almost a year ago until completion of SE - 61, Exploration of Enhancements to Dispatch Methodology and Processes. This is all to do with the concern of the IESO about maintaining grid reliability with all the changes resulting from the phase-out of the coal-fired generators. This includes more distributed generation, demand response (shedding or adding load), natural gas-fired generation, and intermittent self-scheduling renewables like wind.

An injection of large amounts of wind power at times of low demand is of particular concern. Maybe the IESO is finally having second thoughts about wind and gas and all the intermittent self-scheduling power that will be sloshing around its grid, as well as underestimating the load following capabilities of nuclear power plants. We will have to wait and see.

The Alternative to Gas and (hence) Wind

There is an alternative to building more natural gas-fired power plants in the Greater Toronto Area, and in other locations, to replace the coal-fired stations and that is to increase the arbitrary limit on nuclear from the 14,000 megawatts imposed by the government. Bruce Power showed its willingness to build new nuclear power plants last October when it asked the nuclear safety regulator for a licence to prepare a site at Nanticoke, in addition to new units at the Bruce site.

The government's power plan envisages nuclear supplying 40 percent of the electricity demand by 2027. This should be raised to over 70 percent, with hydro supplying most of the balance. If there is no market for the nuclear generated electricity during the off-peak and overnight hours (export, electric car battery charging, various demand response strategies such as heat and cold storage, hydrogen production, compressed air production etc) the plants can reduce their output, that is, load follow within limits.

The demand on the grid from charging the batteries of electric cars should not be underestimated. The president and CEO of French nuclear giant Areva said in December that it would take an additional 6,400 megawatts of electricity if 10 percent of France's cars were electrically powered. That translates to around 1,700 megawatts for Ontario, based on numbers of registered passenger cars. In France the nuclear energy share of electricity production is about 78 percent from its 59 reactors, with the balance divided nearly equally between hydro and fossil, and the nuclear units contribute to grid frequency control as well as daily and weekly load following. Having many nuclear units available for primary and secondary generation control reduces the wear and tear on individual units.

Conclusion

Wind has no long-term future in Ontario and will be more of a hindrance than a help to grid reliability. The Ontario Energy Board should take a good hard look at the supply mix section of the OPA's Integrated Power System Plan, eliminate wind (at least until practical wind energy storage is available) and increase the nuclear portion of the supply mix so as to replace the gas portion by 2027. Better still, keep back-end cleaned-up coal-fired stations operating past 2014 until sufficient nuclear is on line to avoid the building of any more unsustainable gas-fired generation. Money should be put where it will do the most long-term good.

LETTER TO THE EDITOR

Mr. Fluke

I recently received the September issue of The Bulletin. It contained a lot of educational material that I found interesting without feeling that my understanding was limited because I happen to be an Information Technology guy who believes that nuclear technology has the answers to many of our economic and environmental concerns, not a person educated in the sciences and technologies that gave us the CANDU and the other AECL successes. I joined the CNS because I discovered Jeremy Whitlock's web site and then I got to meet nuclear energy's greatest ambassador in person.

As for Jeremy's Endpoint article, I can only say Amen!

Thank you for your good work and please keep educating the lay membership.

Paul S. Hinman
Edmonton, Alberta

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Prairie Atoms: Maximizing Alberta and Saskatchewan's Participation in the Global Nuclear Revival

by Duane Bratt, Department of Policy Studies, Mount Royal College

*[**Ed. Note:** Dr. Duane Bratt is a CNS member who recently published a paper titled, "Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan". It was prepared as part of the Canada West Foundation's "Going for Gold" series and can be found under the "Publications" sub-menu of the foundations website (http://www.cwf.ca).]*

Alberta and Saskatchewan are poised to join the global nuclear revival. In Alberta, Bruce Power has submitted an application to the Canadian Nuclear Safety Commission for four 1,000 megawatt reactors on the shore of Lac Cardinal just outside of Peace River. The Stelmach government has also recently appointed an expert panel to prepare a comprehensive report on nuclear power in Alberta. In Saskatchewan, Bruce Power, with the full support of the provincial government, is also conducting a feasibility study to determine whether to build two 1,000 megawatt reactors. Meanwhile, Premier Brad Wall has made it a high priority for Saskatchewan to move up the nuclear fuel cycle to add such highly value-added functions as uranium conversion, processing, and enrichment. After all, how does Saskatchewan benefit from the current situation of exporting natural uranium to Ontario or France for conversion and reprocessing? Indeed, there is an expectation of increased uranium mining in both Saskatchewan and Alberta.

These decisions in favour of expanding the presence of nuclear power on the prairies are a result of the combination of growing electricity demand and a need to combat greenhouse gases. Previous problems, like nuclear safety and waste, are now being subjected to close comparisons with other energy sources and are coming out favourably. For example, nuclear has both a better safety record (in terms of fatalities) and waste disposal plan (stored safely on-site instead of emitting into the atmosphere) than coal and natural gas. Moreover, in terms of an environmental footprint (watts per square metre), nuclear is substantially better than renewables like hydro, wind, and solar.

Clearly, the public policy questions have moved away from "should" to "how." There are a number of different ways that Alberta and Saskatchewan can maximize the expansion of nuclear power in their provinces.

Recommendations

1. First, the government of Saskatchewan should strongly encourage either Cameco or Areva to invest in nuclear conversion, processing, fuel fabrication, and enrichment facilities in the province. This encouragement might even involve providing financial incentives. Anti-nuclear groups always raise red flags anytime that there is public money in the nuclear industry, but government subsidies are not necessarily a bad thing. For example, would government money that led to a reduction in GHG emissions by replacing coal with nuclear be wrong? Similarly, what is wrong with government funding that brought in the higher technology (and higher paying jobs) of uranium conversion, processing, fabrication, or enrichment?
2. Second, since there is currently a G8 moratorium on uranium enrichment technology (due to weapons proliferation fears), the federal government should seek an exemption by arguing that Canada is the world's largest exporter of uranium, a major player in reactor technology, and is a non-nuclear weapons state. In short, Canada is a responsible nuclear country, it is not Iran, and it should not be treated like Iran.
3. Third, a Western Canadian nuclear centre for excellence should be established in either Alberta or Saskatchewan. New Brunswick, as part of its own nuclear expansion, was able to convince AECL to establish a centre for excellence in Saint John. This centre for excellence has meant the relocation of nuclear scientists and engineers from Ontario to New Brunswick to conduct research and development. New Brunswick officials believe that AECL's decision will spur on the private sector firms in Team CANDU to similarly move some of their operations to Saint John creating a nuclear cluster. If there is an Atlantic region nuclear cluster, surely there can be a prairie region nuclear cluster.
4. Fourth, to address the growing shortage of skilled nuclear workers, the governments of Alberta and Saskatchewan should encourage its post-secondary institutions to establish educational programs in the areas of nuclear science. In particular, the Universities of Alberta and Saskatchewan should develop undergraduate programs in nuclear engineering and nuclear physics, and NAIT, SAIT, SIAST should create nuclear technician diploma programs. The nuclear industry can support this initiative through advertising career opportunities, hiring recent graduates, and funding scholarship programs.
5. Fifth, the federal government, through the Canadian Nuclear Safety Commission, needs to find ways to shorten the decade or more length of time that a nuclear project takes from initiation to completion. Regulation does play a fundamental role in ensuring public health and safety, but there are ways that some of the red tape can be removed. Many other countries (France, United States, United Kingdom) have begun to streamline their regulatory process by, for example, combining the approval for construction and operation into one step. The Harper government's decision to provide AECL with an additional $300 million in the 2008 budget for the pre-licensing of its ACR-1000 reactor was a good step, but more can be done in this area.

Adopting these recommendations would help ensure that Alberta and Saskatchewan fully maximize the opportunities presented by the global nuclear revival.

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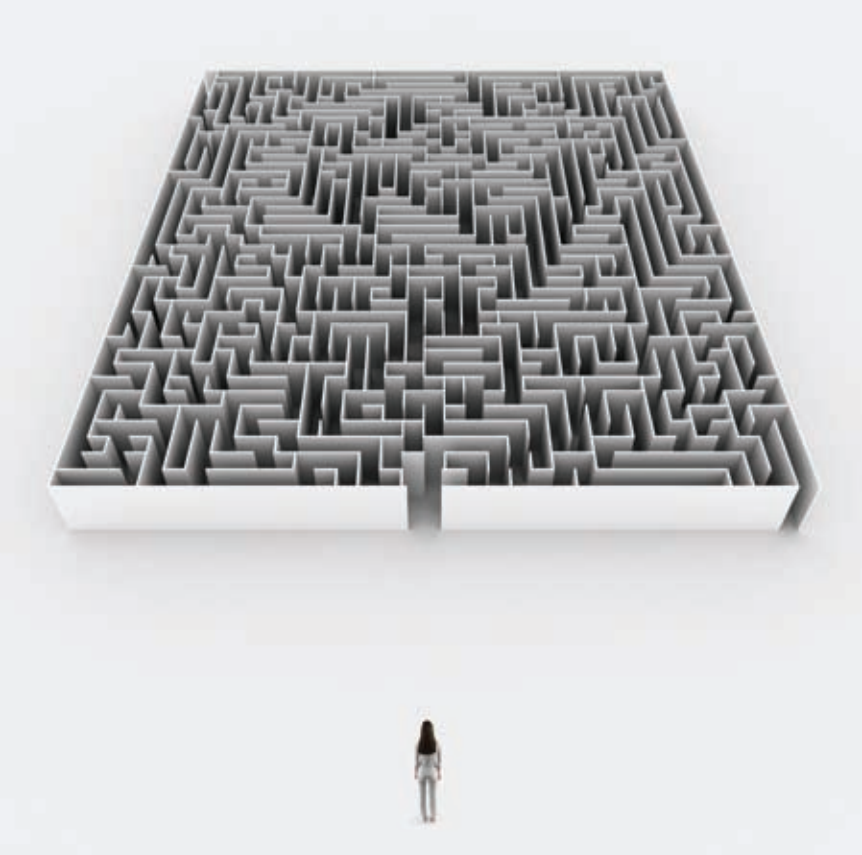

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CHF and CCP Enhancement in Nuclear Fuel Bundles – revisiting the past 45 years

by D. C. Groeneveld[1]

(Ed. Note: the following paper was presented at the plenary session of the CNS 2008 Simulation Conference, Ottawa, November 2-4)

Abstract

This paper reviews various methods of increasing the CHF power of CANDU-type fuel bundles that can be used to counteract eroding margins in ageing reactors. These methods can be categorized as follows: (i) increasing the bundle surface area by bundle subdivision, (ii) reducing the hydraulic resistance, (iii) optimizing the design of bundle appendage for maximum CHF enhancement with a minimal increase in hydraulic resistance, (iv) strategic positioning of bundle appendages, (v) redefining CHF, and (vi) reducing uncertainties in CHF and flow. The application of several of these CHF enhancement principles have been used in the design of the CANFLEX bundle.

The impact of CHF enhancement methods on post-CHF heat transfer are also discussed.

1.0 Introduction

The power output of CANDU fuel bundles is limited by CHF occurrence. Because of this, there has been a long interest in optimizing the fuel bundle CHF (Critical Heat Flux) and CCP (Critical Channel Power, or power corresponding to the first occurrence of CHF in any fuel channel). An important reason for increasing the CCP is the need to regain operating margins in ageing CANDU reactors. Ageing will result in pressure-tube diametric creep, reduction of reactor inlet-header temperature, and increases the hydraulic resistance of parts of the flow circuits; all of these effects will reduce the CCP with time. These losses can be recovered by remedial action (chemical cleaning of parts of the circuit, pressure tube replacement). Increasing the CCP can complement these actions, and delay pressure tube replacement.

To recover the eroding CHF margins, an extensive CHF enhancement study was undertaken in the 1980s supported by COG (CANDU Operators Group). Several promising concepts for CHF enhancement in 37-rod bundles were tested experimentally in CRL's Freon loop.

In order to asses the impact of any CHF enhancement strategy, one must consider the flow vs. power characteristic of the critical fuel channel, illustrated in Figure 1. The curves shown are for a fixed inlet temperature, outlet pressure and pump system. The top curve represents the hydraulic characteristic: with an increase in power the flow will eventually be reduced because of the higher pressure drop associated with boiling in the fuel channel. The bottom curve is based on CHF tests on simulated fuel bundles

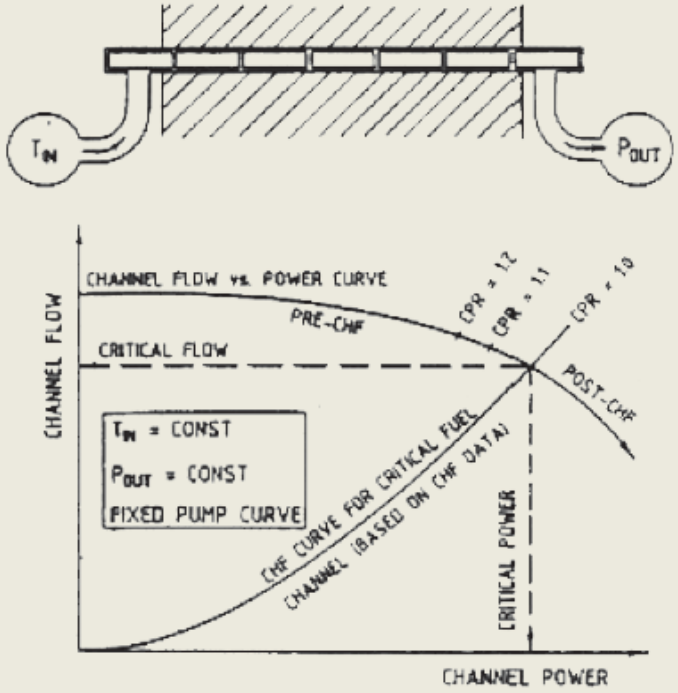


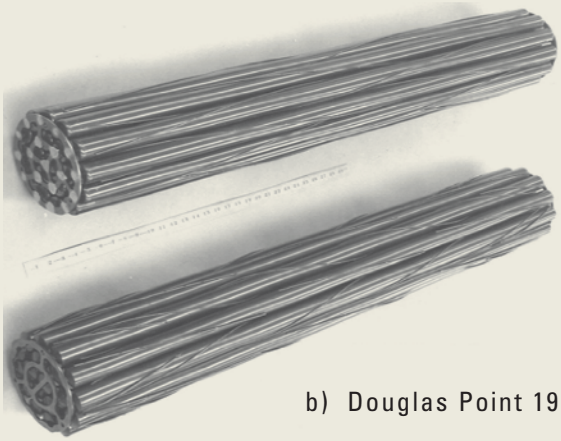
Figure 1: Variation of critical power with channel flow

and shows the dependence of CHF power on flow for a fixed inlet temperature and outlet pressure. A net gain in CCP can be obtained by moving the intersection point to the right, e.g. by moving up the top curve (by lowering the hydraulic resistance), by moving the bottom curve to the right (enhancing the CHF) or by any other method that would result in moving the operating point to the right without affecting the CHF margin.

In the 1970s subchannel codes became available with the promised capability for modeling the thermalhydraulic behavior of fuel bundles. It was hoped that they could provide good estimates of the impact of changes to the bundle geometry on CHF and pressure drop. For example, the ASSERT subchannel code was used in an early assessment of the thermalhydraulic behavior of various candidate fuel designs for the CANFLEX bundle, i.e. the 43-el bundle, 48-el bundle, 51-el bundle etc. However an assessment of the impact of adding CHF-enhancing appendages to bundles was well

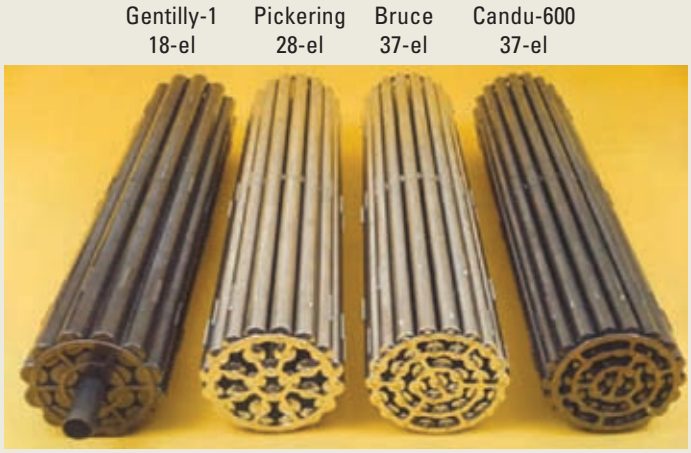
1 Researcher Emeritus, Chalk River Laboratories Atomic Energy of Canada Ltd, and Professor (adjunct) Department of Mechanical Engineering, University of Ottawa.

a) NDP 7-element bundle



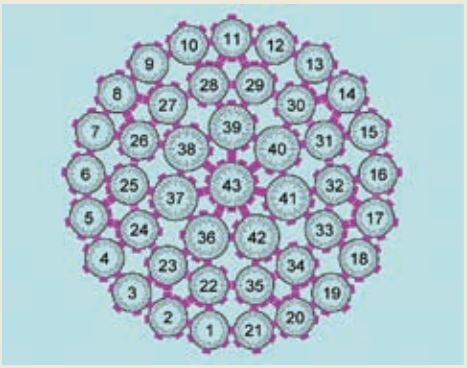
b) Douglas Point 19-el bundle

c) CANDU-BLW bundle



d) Various CANDU bundle designs

e) CANFLEX 43-element bundle

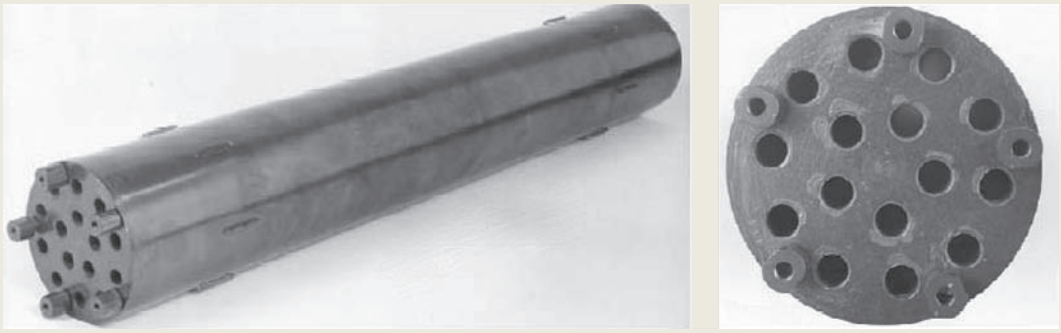


f): Cross-section of CANFLEX bundle at button plane

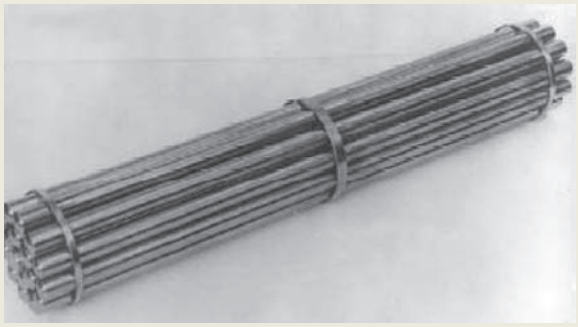
Figure 2: Designs for current and previous CANDU reactor fuel bundles

beyond the capabilities of subchannel codes. The ideal approach to test any proposed CHF enhancement techniques requires a full scale bundle experiment using electrically heated fuel-bundle-simulators in water-cooled loops. Since full scale testing in a water-cooled bundle is a very expensive proposition, many ad hoc experiments have also been performed in Freon-cooled bundles at a fraction of the cost of an equivalent water-cooled test. Although CHF Freon testing is an excellent approach for simulating the CHF behavior of water-cooled test sections, and has been widely used for separate effect studies, final confirmatory tests in water would still be required.

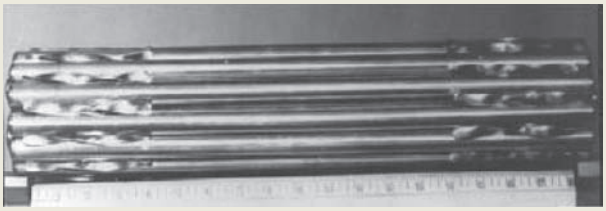
Various methods for enhancing the CHF power in CANDU fuel bundles will de discussed in the following sections. They include bundle subdivision, reducing hydraulic resistance, enhancing CHF by turbulence promotion, CHF redefinition, and reducing uncertainties in experiments and modeling.



a) Tube-in-shell design – 1960

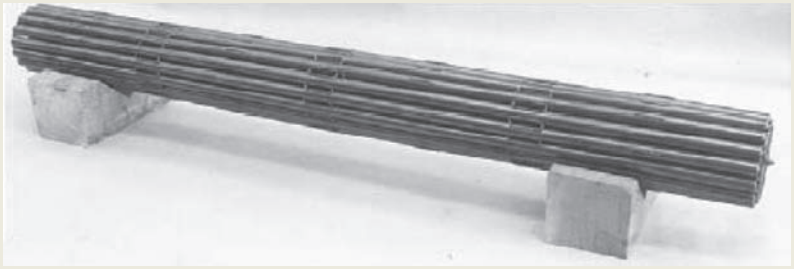


b) Belly band fuel design – 1960



c) Twisted-tape 19-element bundle design – 1962

d) Early BRUCE booster rod design



e) Double length bundle design

Figure 3: Abandoned fuel designs

2. Fuel Bundle Evolution

The design of CANDU fuel bundles has evolved from the early design of NPD's 7-rod bundle to the current 43-element bundle. Many of the basic design parameters have remained unchanged: (i) string of 50 cm long segmented bundles, (ii) located in horizontal pressure tubes, (iii) design allows for on-line refueling, and (iv) fuel elements are kept together by endplates.

The bundle evolution has passed through the following phases:

- NPD: 7- and 19-rod bundles, 8 cm ID pressure tube,
- Douglas Point: 19-rod bundle, 8 cm ID pressure tube,
- Pickering: 28- and 37-rod bundle, 10 cm ID pressure tube,
- CANDU-BLW (G-1): 18-rod bundle, 10 cm ID pressure tube,
- BRUCE, CANDU-6 reactors: 37-rod bundle, 10 cm ID pressure tube,
- ACR - CANFLEX 43-rod bundle, 10 cm ID pressure tube.

Figure 2 shows photographs of the various bundles designs used in CANDU reactors. In order to increase the channel power and still maintain an adequate margin to CHF, the more recent fuel bundles became more subdivided (larger number of rods, increased surface area) resulting in higher powers while maintaining the ele-

ment rating to acceptable levels. There is a practical limit to bundle subdivision as too much subdivision would lead to a bundle of small-diameter elements, prone to element bowing and with large enthalpy and flow imbalances among the subchannels.

Other bundle designs have also been considered in the past — Figure 3 shows several photographs of prototype bundles that were built at CRL but that were not considered sufficiently promising for implementation. Many of these early enhancement studies were performed during the 1960s in support of the CANDU-BLW-250, also known as the G-1 reactor. This reactor was built at the Gentilly site for Hydro-Quebec in the late 1960s and operated with boiling light water coolant. Some of these abandoned designs had interesting features such as:

- Tube-in-shell design. This design is a more radical departure from the conventional bundle design. This fuel design allows for cooling by means of multiple holes inside a large Zircaloy-clad UO2 cylinder. Bearing pads were placed on the outside of the bundle to separate it from the pressure tube and to provide additional cooling. Note that the CHF in the holes is generally higher than in the external annulus between the fuel and the pressure tube because of the curvature effect (e.g. see Doerffer et al., 1997): convex surfaces have a considerably lower CHF than concave surfaces for saturated boiling conditions.
- Belly band of pressure tube stripping rings designs. The intent of these designs was to redirect the colder water from the pressure tube wall towards the bundle where it was most needed (Moeck et al., 1964; Pon, 1968; Wikhammer et al., 1965).
- Twisted tapes in the larger subchannels, that could redirect the flow to the smaller subchannels where it was most needed.

3. Optimize Bundle Core

The ideal fuel core would avoid CHF-prone areas in the core, i.e. CHF occurrence would occur simultaneously across the core and along the bundle string. This is not practical but the principle of an ideal fuel core can be applied in the core design and to the refuelling schemes of a reactor. They include (i) having a maximum heat flux towards the inlet where the CHF margin is the highest, (ii) optimize the fuel bundle design by minimizing the enthalpy imbalance for the most common radial flux distribution, and (iii) reshuffling the fuel and/or orificing certain channels that receive a lower flux.

4. Reduced Hydraulic Resistance

Figure 1 showed that increasing the flow rate (lifting up the top curve) can have a large impact on the critical channel power. In an existing reactor, having a fixed pump curve, the only option for increasing the flow rate is by decreasing the hydraulic resistance of the various components in the flow path. One of the largest contributors to the fuel channel pressure drop is the bundle junction (~ 30%), see Figure 4. The junction pressure drop can vary significantly – for a maximum bundle misalignment the junction pressure drop is about 50%. This suggests two ways of reducing the hydraulic resistance and hence increasing the flow: (i) by using

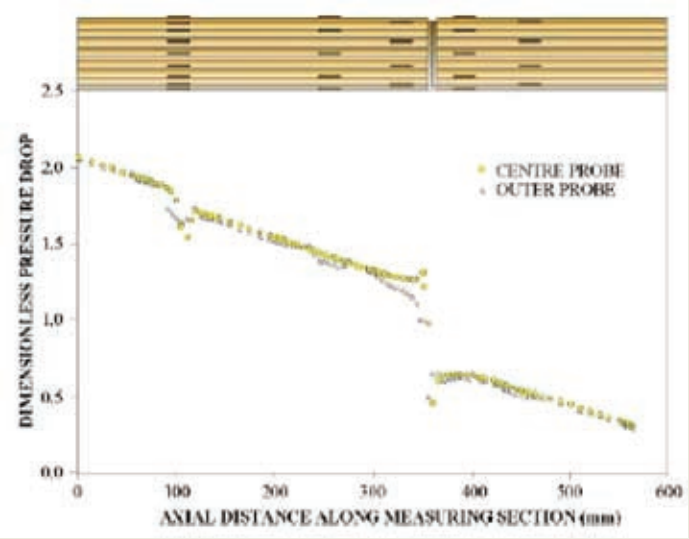


Figure 4: Pressure distribution along a bundle

double length bundles and (ii) by aligning adjacent bundles.

The first option can be achieved by using double length bundles – Figure 3e showed a photograph of a prototype double length bundle that was constructed at CRL around 1970. The second option was explored about 15 years ago and a patent was obtained for interlocking or wavy endplates (Groeneveld et al., 2002). The intent was that since bundles always move in pairs through the fuel channel of the CANDU-6 reactor, having a pair of bundles that are always aligned would reduce the channel hydraulic resistance by 15-20% and could increase the CCP by 1.5-3%.

5. CHF-Enhancement from Bundle Appendages

During the 1980s CANDU owners became concerned with ageing effects (pressure tube creep, fouling) since this would shift the CHF curve of Figure 1 to the left. The resulting eroding margins to CHF would derate the older reactors. Hence a vigorous

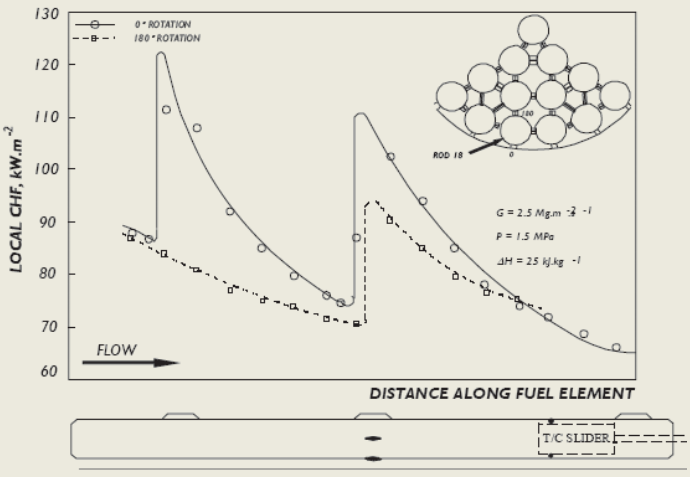


Figure 5: Effect of flow obstacles on local CHF

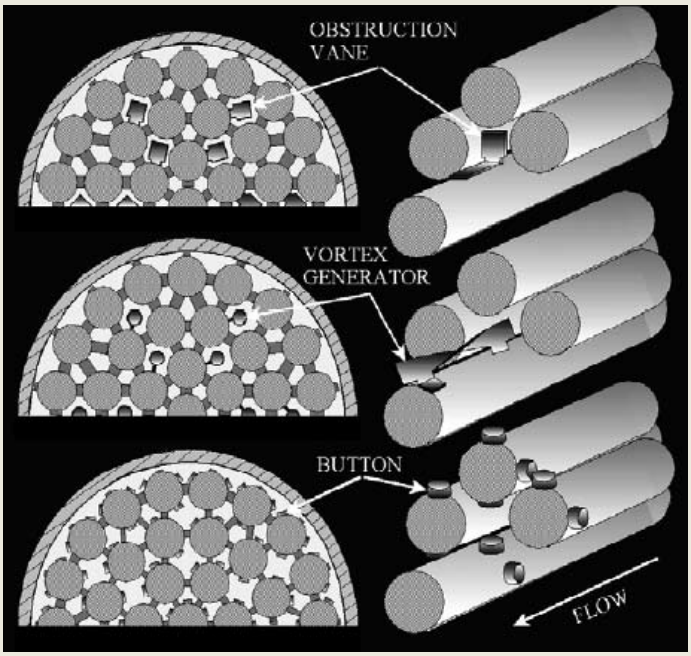


Figure 6: Bundles with various CHF-enchancing appendages

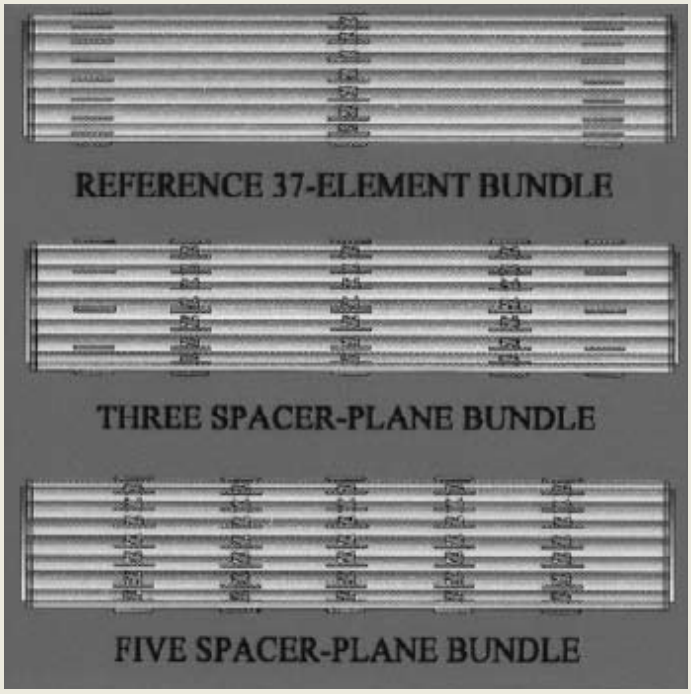


Figure 7: Bundles with several spacer planes

CHF enhancement program was started by the CANDU Owners Group (COG). To properly understand and quantify the CHF enhancement in bundles required a special experimental technique. Such a technique, the sliding thermocouple probe technique was invented at Chalk River (Schenk and Groeneveld, 1990) and allowed us to understand and quantify the impact of the various CHF enhancement methodologies. The sliding thermocouple technique consists of a ceramic thermocouple carrier containing two spring-loaded thermocouples and located inside the heater rods of CANDU fuel bundle simulators. These probes have the following unique features: (i) they can move axially inside the heater rods, (ii) they can be rotated 360°, (iii) they are capable of detecting the first occurrence of CHF anywhere along a bundle, and (iv) they can measure the 2-D post-CHF temperature distribution on any of the heater rods. By moving these probes across spacer planes, the impact of the spacers location on the local CHF can be determined — see Figure 5. Sliding thermocouples are currently used in all CHF tests on CANDU fuel bundle simulators. Using this CHF detection methodology – the most advanced in the world – thermalhydraulic experiments were performed on bundles equipped with CHF-enhancing rod-spacing devices, turbulence-promoting appendages, or flow deflectors e.g. see Figure 6-8. The impact of the various CHF enhancement techniques on the CCP power was thus determined. The CHF-enhancing appendages resulted in a higher hydraulic resistance which by itself had a negative effect on CCP as can be seen in Figure 1. However the CHF curve moved to the right due to the CHF enhancement and this more than compensated for the flow reduction effect. The impact on CHF (constant inlet subcooling) and pressure drop is shown in Table 1. The magnitude of the CHF enhancement in obstacle-equipped geometries depends primarily on

- Geometric parameters (e.g. flow blockage ratio, shape of leading and trailing edge, location of blockage in subchan-

Table 1: Comparison of CHF enhancement techniques in bundles

	% Increase In CHF (Range)	% Increase In CHF (Avg)	% Increase In ΔP
2 Addt'l Bearing Pad Planes	1.7 to 10.6	3.0	2
2 Addt'l Spacer & Bearing Pad Planes	5 to 21	3.1	15
4 Addt'l Spacer & Bearing Pad Planes	9 to 20	14.1	24
2 Planes of Vortex Generators	-7 to 8	0.6	5
2 Planes of Flow Obstruction Vanes	-6 to 9	0.8	27
Grid Spacers 1/3 and 2/3 bundle length position (no spacers)	10 to 25	15.5	99
Grid Spacers Mid-plane and Endplate Position (no split spacers)	-2 to 7	1	103
2 Button Planes	10 to 20	15	9

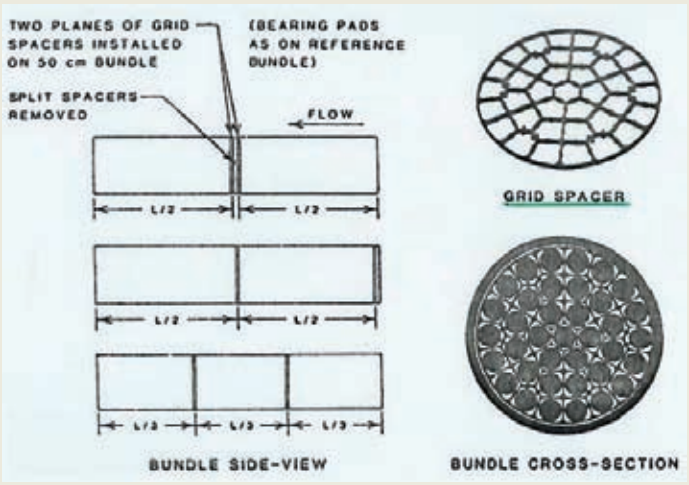


Figure 8: Bundle equipped with gridspacers

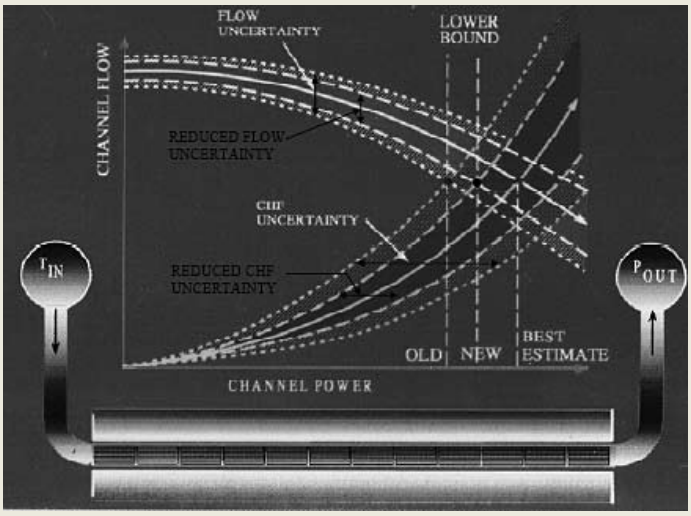


Figure 9: Effect of reduced uncertainty on CCP

nel cross section , distribution of flow blockages across the bundle, axial pitch of blockage), and,

- Flow conditions (e.g. quality, mass flux).

In general the maximum increase in CHF enhancement is for flow blockages that are well distributed across the bundle, minimally interfere with the liquid film flow on the heated surface, provide a large increase in turbulence (blunt leading and trailing edge), and have a small axial pitch. The enhancement is also largest at high qualities and high mass flow rates. Equations for CHF enhancement have been proposed and are summarized by Groeneveld et al.(1980, 2001). They are generally of the form of $CHF/CHF_0 = \{b+exp[-aLsp/D]\}$ where a and b depend on flow conditions and the geometry of the spacer, Lsp is the distance to the nearest upstream flow obstacle and CHF_0 is the CHF in the absence of any CHF-enhancing flow obstacle. The exponentially decaying impact of distance from the spacer place can be clearly seen in Figure 5.

CANFLEX bundle: Around 1985 it was decided to attempt to raise the CANDU channel power for current or future reactors using a bundle different from the reference 37-el CANDU fuel design. The 43-element bundle was eventually selected as the candidate fuel. The next step was to optimize the bundle appendages of the CANFLEX bundle from a CHF point of view. Several shapes of turbulence promoting buttons were tested for their CHF-enhancing potential – first in tubes and trefoils and eventually in a full-scale 4-element bundle string in Freon, culminating in full-scale bundle tests in the water-cooled test facility at Stern Laboratories.

The patented design that was eventually selected, consists of two planes of round buttons where the buttons are placed strategically at various locations across the bundle (Sollychin et al., 2002; see also Figure 2f). As can be seen from Table 1, this design corresponds to the optimum CHF accompanied by a nominal increase in hydraulic resistance.

6. Redefining CHF as the Onset of Dry Sheath (ODS)

The current power limiting criteria for C-6 reactors is based on the onset of intermittent dryout (OID). At conditions of

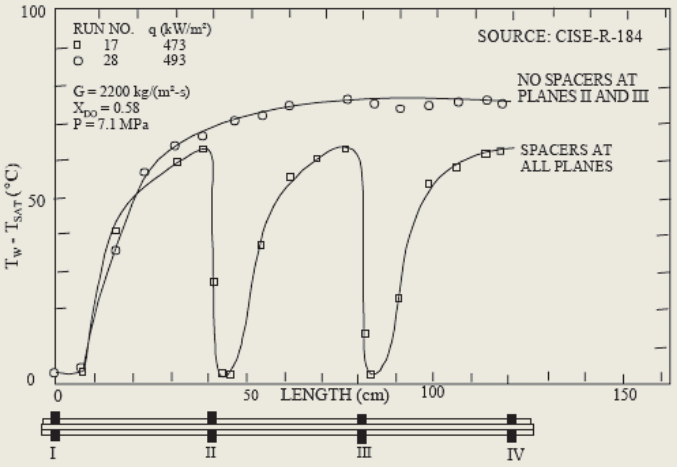


Figure10: Effect of spacer planes on post-CHF temperature

interest in CANDU reactors, OID corresponds to the first occurrence of small temperature spikes on the thermocouple charts observed during bundle CHF tests. These spikes represents the first deviation from nucleate boiling and the start of the transition boiling regime. This is in contrast with PWR's where a sharp temperature rise is usually associated with the CHF point (due to different flow conditions and CHF mechanisms) and results in film boiling occurrence.

Since the OID is of no practical significance, a phenomenologically more correct definition of CHF has been introduced (Groeneveld, 1986). It is referred to as the onset of dry sheath (ODS) and corresponds to the point where the sheath temperature reaches 374°C (representing a theoretical limit to the minimum film boiling temperature). This temperature is selected because rewetting of the sheath is no longer possible at temperatures beyond this point. Based on an analysis of the water CHF and post CHF data obtained on 37-rod bundles, it appears that the dryout power can be increased between 1.5 and 5% due to redefining the CHF in terms of ODS instead of OID.

7. Reduce Uncertainties

Figure 9 shows that the uncertainties in reactor flow and CHF power play a significant role in determining the margin to CHF. The probability that CHF cannot occur must be at least 95%, and this implies that the difference between the best-estimate critical power and the 95% lower-bound critical power can be significant. The margin between these two values can be reduced by (i) performing more accurate CHF experiments, (ii) more accurate determination of bundle friction factors and k-factors, and (iii) performing more realistic experiments such that the extrapolation of test results from fuel bundle simulators to actual fuel channels does not introduce significant additional uncertainties. Figure 9 shows schematically how a reduction in experimental and other uncertainties can increase the 95% lower bound critical power value significantly.

8. Impact On Post-CHF Heat Transfer

Rod spacing devices strongly affect the heat transfer as has been demonstrated in many single phase heat transfer studies, e.g. Yao et al. (1982). Studies of the effect of spacers or flow obstructions on the post-CHF heat transfer coefficient are less common. Era (1967) investigated the effect of spacers on post-CHF heat transfer in an annular geometry. His results show (Figure 10) that spacers often results in preferential rewetting sites just downstream of the spacer and lower the maximum surface temperature – due to the reduction in vapor superheat at the spacer locations and the increased turbulence level. Zahlan (2008) and Zhang (1997) performed post-CHF studies in tubular geometries equipped with flow obstacles and found similar preferential rewetting sites just downstream of the obstacle. Zahlan also noted that if the heat flux was sufficiently high, no rewetting would take place but the local heat transfer just downstream of the spacer would be significantly enhanced because of the extra turbulence and this would lower the local vapor superheat.

Leung et al. (2003) has investigated the post-CHF behavior of a 37-rod bundle equipped with simulated bundle junctions and spacer planes. His results are again similar to those Era and Zahlan: rewetting downstream of the flow obstructions (spacers, bundle junctions) and the highest temperatures just before the flow obstructions. To spread the dryout area across and along the complete bundle requires a large overpower – typically the local heat flux needs to be increased by over 100%.

The mechanisms of post-CHF heat transfer enhancement by rod spacing devices has been discussed by Groeneveld and Youssef (1980) and Zahlan and Groeneveld (2008).

9. Conclusions And Final Remarks

Rod spacing devices can have strong effects on CHF. Very large increases in CHF (over 200%) have been observed with properly designed rod spacing devices.

The largest increase in CHF is usually observed at high flow, high quality, short axial distance between rod spacing devices and large flow obstruction. Attachment of mixing vanes or short vortex generator can further increase the CHF.

Rod spacing devices can increase the hydraulic resistance considerably. This increase in hydraulic resistance should not only be based on the flow blockage factor but should include the effect of spacer length and shape of the spacer's leading and trailing edge.

Post-CHF heat transfer is increased by rod spacing devices. This increase is most pronounced in the area just downstream of a spacer where rewetting frequently originates.

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GENERAL news

(Selected by Fred Boyd)

Bruce Power looks at Nanticoke site

In late October 2008, the Canadian Nuclear Safety Commission reported that it had received an application from Bruce Power for a licence to prepare a site for a proposed new nuclear power plant at the existing Nanticoke coal-fired plant in the Haldimand-Norfolk region on the shores of Lake Erie in southwestern Ontario.

The submission mentioned that two nuclear power units are proposed with a generating capacity of between 2,200 and 3,200 MWe.

The CNSC stated that it will review the project description for adequacy then will initiate an environmental assessment process under the Canadian Environmental Assessment Act. Following the precedent of applications for new units at the Bruce and Darlington sites there would probably be a joint review panel between the CNSC and the Canadian Environmental Assessment Agency.

The Minister of Energy and Infrastructure, George Smitherman, issued a statement, on October 31, that the Government of Ontario had not encouraged or solicited a proposal to build a nuclear station in the Haldimand-Norfolk region. The statement added that the Ontario Government is not looking to build new nuclear facilities at Nanticoke and that the proposal from a private company was speculative.

Deadline for Ontario Bids Extended

In early November, Infrastructure Ontario announced that it was extending the deadline for final bid proposals for two new nuclear power units to be built at the Darlington site of Ontario Power Generation until "spring 2009". The previous deadline was 31 December 2008.

The reason appears to be the unwillingness of the potential vendors to accept the total financial risk. In the announcement Infrastructure Ontario stated, "the extension would allow respondents more time to assess appropriate risk-sharing and pricing terms".

The announcement stated that the preferred vendor could be announced in the spring but the timing would be flexible "to ensure the best deal for Ontario ratepayers".

Originally, in early 2008, the Ontario Ministry of Energy invited four vendors to participate in the first phase of the proposal process. They were: Areva; Atomic Energy of Canada Limited; GE-Hitachi Nuclear Energy; and Westinghouse-Toshiba. GE-Hitachi withdrew from the exercise in the spring of 2008. There was a media report that Westinghouse-Toshiba had recently also withdrawn but that was denied.

Infrastructure Ontario states that it is using an innovative approach based on pre-established commercial terms, including lifetime power cost; ability to meet a pre-determined schedule; and the level of investment in Ontario.

Infrastructure Ontario is a provincial crown corporation. It was formed in 2006 by merging the Ontario Strategic Infrastructure Financing Authority ("OSIFA"), a corporation incorporated under the Corporations Act (Ontario) and Ontario Infrastructure Projects Corporation, a corporation incorporated under the Business Corporations Act (Ontario). Its official name is ***Ontario Infrastructure Projects Corporation (OIPC)****.*

NWMO Siting Process on DVD

During the fall of 2008 the Nuclear Waste Management Organization has been conducting discussions and inviting comments on the design of a process for selecting a site for a repository for used fuel from Canada's nuclear power plants.

This is part of the Adaptive Phased Management approach proposed by NWMO in 2006 and approved by the federal government in June 2007. NWMO has stated that it is committed to working with interested and potentially affected citizens and organizations and is seeking an informed and willing community to host the centralized repository.

It has prepared a document titled *Moving Forward Together* that is available on a DVD. The DVD can be ordered, without cost, by calling 1-866-249-6966 or e-mail to: *contactus@nwmo.ca*

Technical Review Group

The NWMO has also appointed an Independent Technical Review Group ITRG) to provide unbiased reports on NWMO's technical program. The members are:

Allan Hooper, chair, chief scientific advisor to the UK Nuclear Decommissioning Authority Radioactive Waste Management Directorate:

Kay Album, site manager for the Swedish Nuclear Fuel and Waste Management Company;

Lawrence Johnson, senior scientist and research coordinator at the Swiss National Cooperative for the Disposal of

Radioactive Waste, a native of Canada and formerly at the AECL Whiteshell Laboratories;

Derek Marin, professor in the Department of Civil and environmental Engineering, University of Alberta, former senior advisor to the Director of the Canadian Nuclear Fuel Waste Management Program.

Bruce to Milton Transmission Line Approved

In early fall 2008 the Ontario Energy Board approved the application of Hydro One to construct approximately 180 kilometres of a double-circuit 500 Kilovolt ("kV") electricity transmission line extending from the Bruce Power Facility in Incardinate Township to Hydro One's Milton Switching Station in the town of Milton, northwest of Toronto.

The transmission line will run adjacent to the existing transmission corridor (500 kV or 230 kV) and is expected to be in service by Year 2011.

Hydro One stated that the project is required to meet the increased need for transmission capacity associated with the development of wind power in the Bruce area and the return to service of nuclear units at the Bruce Nuclear Generating Station.

The OEB decided that the project would be in the public interest in regard to its impact on price, reliability and quality of electricity service to consumers. As well, the Board found that the economic benefits of the transmission line would exceed its estimated costs of $635 million.

The Board's approval is subject to a number of conditions. Most notable is the Minister of the Environment's approval of the Environmental Assessment.

IAEA Revises Event Scale

The International Atomic Energy Agency has revised the *International Nuclear Event Scale* used to quickly categorize the severity of an event at a nuclear facility.

The scale was introduced in 1990 for nuclear power plants and extended in 2001 to include accidents involving the transport of radioactive materials. Additional guidance on its use was issued in 2006.

Although the scale remains basically as before a revised user manual will be published in early 2009. Areas that have been developed include details of doses to individuals, the transportation of fissile material, events involving damage to nuclear fuel and consistency of terminology.

Like the scales used to describe earthquakes, each of the INES seven levels is designed to be ten times more severe than the one before. There are three levels of "no safety significance; three described as "incident"; and four of "accident".

The selection of a level for a given event is based on three parameters: whether people or the environment are affected; whether any of the barriers to the release of radiation have been lost; and, whether any of the layers of safety systems are lost.

EDF buys British Energy

In the early fall of 2008 it was announced that British Energy, the owner of the nuclear power plants in the UK, had accepted a takeover bid from Electricité de France (EDF) the national electricity generation and transmission of France.

The UK minister for business said EDF intended to build four new nuclear units in Britain with the first to start up in 2017.

EDF has been in the UK for a decade and employs 13,000 people in its subsidiary EDF Energy.

The take over is not expected to be completed until mid 2009.

L-3 MAPPS to Provide Simulator for AREVA Test Facility

L-3 MAPPS has been awarded a contract by AREVA NP GmbH to provide an EPR Engineering Simulator and on-site support for one year to AREVA's test facility in Erlangen, Germany.

The EPR Engineering Simulator will be based on the EPR full scope simulator that L-3 MAPPS is currently developing for the Olkiluoto 3 nuclear plant under construction in Finland. It will primarily serve as a Verifications & Validation Tool for AREVA's Teleperm XS safety systems Distributed Control System and the Siemens Teleperm X.

L-3 MAPPS, located in Montreal, is a subsidiary of L-3 Communications. It was formerly part of CAE. It has three decades of experience in supplying plant computer systems for CANDU units in Canada and abroad and for simulators for different types of nuclear plants around the world.

Public Review of Bruce New Build EA Begun

In mid 2008 the Canadian Nuclear Safety Commission and the Canadian Environmental Assessment Agency announced the establishment of a Joint Review Panel to review both the Environmental Impact Statement and the application for a Licence to Prepare a Site filed by Bruce Power for its proposed two new nuclear units at the Bruce site.

In November the Joint Review Panel announced the start of a six-month public review period.

The Panel has issued instructions for the public review process. Comments may be submitted any time during the six-month period. At the close of the public comment period, if the

Panel feels that all information requests have been satisfied, it will schedule and announce the start of public hearings.

Written comments will be accepted until 4 May 2009. They should be sent to either: Jennifer Clark, Canadian Environmental Assessment Agency; e-mail: Bruce.Review@ceaa-acee.gc.ca or Kelly McGee, Canadian Nuclear Safety Commission e-mail: JRP-Bruce-CEC@cnsc-ccsn.gc.ca

AREVA to supply SEU to Cameco

Cameco Corporation has awarded an 11 year contract to AREVA for the supply of Slightly Enriched Uranium and Blended Dysprosium Uranium powder. These powder products will be used to fabricate Low Void Reactivity Fuel (LVRF) for the Bruce A reactors.

Discussions have reportedly gone on since 2005 on this arrangement. AREVA's fuel fabrication facility in Richland, Washington, will supply the material for the Bruce A reactors beginning in 2010 and continuing through 2021. The contract provides for two optional five-year extensions.

The scope of the contract includes the design, construction and qualification of a dedicated BDU blending system using processes conceptually designed by Cameco, qualification of a modified SEU blending system and the production and transportation of powder to Cameco's fuel facility in Port Hope, Ontario.

Nuclear Safety Solutions re-brands

Nuclear Safety Solutions (NSS) Ltd. was formed in 2002 from the "spin-off" of the Nuclear Safety Analysis Division (NSAD) of Ontario Power Generation. That separation of NSAD was to ensure that both OPG and Bruce Power had unbiased access to the service of the group and to provide an opportunity for it to grow.

The success of NSS and its original British parent company NNC attracted the attention of the large international engineering services company AMEC. AMEC purchased NNC and NSS in 2006. That acquisition enabled NSS to venture into larger and wider nuclear and other services while maintaining and growing its core nuclear safety capability.

In the fall of 2008 the company decided to "re-brand" its name to **AMEC NSS Limited.**

Walter Thompson, vice-president commercial operations, who announced the change, emphasized that it will definitely not diminish or alter the services or relationships established as NSS.

OECD-NEA issues 50 year forecast

The Nuclear Energy Agency of the Organisation for Economic Cooperation and Development has produced a major report titled, *Nuclear Energy Outlook*, which provides projections to 2050 of growth scenarios and potential implications on the future of nuclear energy in OECD countries.

It finds that the security of energy from nuclear power is more reliable that that from oil or gas. In addition, the high energy density of uranium lessens the amount of transportation vulnerable to disruption and eases storing.

In its most optimistic scenario the report predicts 1400 nuclear power reactors could be in service by 2050. However this would require building over 50 units per year from 2030 to 2050.

AREVA and Northrop Grumman to build plant for heavy components

AREVA NP, based in the USA, and Northrop Grumman have agreed to jointly build a plant, to construct heavy components for nuclear plants, beside a plant currently owned by Northrop Grumman at Newport News in Virginia, USA. A new company will be formed, called Areva Newport News.

The plant, estimated to cost $360 million, will be dedicated to building heavy components such as PWR reactor vessels and steam generators. Anne Lauvergon, chair of the Board of Areva, said that, along with Areva's plant at Chalon/Saint-Marcel in France, the new plant will provide the capacity to build the many new nuclear reactors that Areva expects to build over the coming years.

Consortium formed for Cernavoda 3 and 4

Seven European companies have agreed to establish a jointly owned company – to be named EnergoNuclear SA – in March 2009, to construct, commission and operate two new units at the Cernavoda site in Romania.

Romania's state-owned Nuclearelectrica SA will hold 51% of the new company. Other partners come from Belgium, Czech Republic, Germany, Italy and Spain.

The project will be conducted in two stages. The pre-project phase, of about 18 months, will involve development of technical and commercial specifications, calls for bids, etc. The project stage is expected to take six years at a cost of about $5 billion.

There are now two CANDU 600 units operating at the Cernavoda site. The consortium has agreed that Cernavoda 3 and 4 would also be CANDUs, similar to unit 2.

John Luxat named to AECL Board

John Luxat, currently professor at McMaster University and NSERC Industrial Research chair in Nuclear Safety Analysis, has been named to the Board of Directors of Atomic Energy of Canada Limited.

He was formerly vice President of Technical Methods Inc. and a Director of Nuclear Safety Solutions Limited. Earlier he had been manager of

Nuclear Safety Technology at Ontario Power Generation. In the summer of 2008 he was appointed to the Nuclear Power Expert Panel established by the Alberta government to provide advice on the possible building of nuclear power plants in that province.

Luxat was a founding member of the University Network of Exellence in Nuclear Engineering (UNENE). He has been an active member of the Canadian Nuclear Society for over 20 years including being president in 2005-2006.

The other members of the AECL Board are: Glenna Carr, CEO, Carr, Gordon Ltd. (chair); Marcel Aubut, lawyer, Heenan Blaikie; Richard Boudreault, CEO Exploration Orbite Inc.; Peter Currie, Director, Canadian Tire Corp.; Richard Dicerni, Deputy Minister, Industry Canada; Cassie Doyle, Deputy Minister, Natural Resources Canada; Claude Lajeanesse, CEO, Aerospace Industries Association of Canada; Hugh McDiarmid, CEO, AECL; Carol Perry, Commissioner, Ontario Securities Commission; Gordon Shaw, Corporate Secretary, Aeolis Wind Power Corp.; Stella Thompson, Governance Consultant; Barbara Trenhom, Professor, University of New Brunswick.

Cameco suspends UF_6 production until fall 2009

At the end of November 2008, Cameco Corporation announced that it had suspended production of uranium hexaflouride at its Port Hope, Ontario conversion facility until the second half of 2009.

Cameco said that a dispute with its sole supplier of hydrofluoric acid (HF), used for the production of uranium hexaflouride, remained unresolved and it had nearly exhausted its inventory of HF. It is seeking other suppliers. Although it has suspended the conversion operation it still anticipates meeting UF_6 deliveries during the first half of 2009.

Cameco had voluntarily suspended operation of the UF_6 plant in mid 2007 when it was discovered that some chemicals and uranium had leaked through the floor into the groundwater. It was determined that none had travelled beyond the plant boundary. Production resumed in October 2008 at a reduced rate because of the lack of HF.

Cameco ships all of its UF_6 abroad for use in enrichment plants.

Cameco was also hit in November by a biased program on CTV's W-5 program, which presented a very one-sided picture of the supposed contamination of Port Hope, generated by a small number of very vocal opponents of the plant. The town's mayor issued a strong rebuttal and there were a large number of letters from Port Hope citizens supporting the company.

Pressure tubes removed from Bruce 1 in record time

(Extracted from a report By Rob Liddle of Bruce Power.)

As November 2008 ended, the Bruce A retube team from Atomic Energy of Canada Limited had cause to celebrate, after completing the removal of pressure tubes from Unit 1 reactor in just two-thirds of the time it took to do the job in Unit 2.

Cut free earlier, the pressure tubes were pushed and pulled, one at a time, into metal transfer cans, inserted from the east end of the reactor. The cans, when clear of the reactor, were picked up by a Retube Tool Carrier (RTC) and swung around to align with a hydraulic press. Everything was done by remote control.

The pressure tubes are still highly radioactive despite the fact that the unit was shut down in 1997. The longer-lived radionuclides such as cobalt-60 and niobium-94 still remain.

Access to the removal area was restricted during the high-hazard process due to the high radiation fields from the removed components. The tools were controlled from a Retube Control Centre outside the reactor vault. Four separate crews worked 12-hour shifts around the clock, supported by the project's radiation protection team.

Fed into the press from the transfer cans in small increments, the pressure tubes were crushed and chopped into small, flat pieces, approximately five centimetres square. Waste containers were staged beneath the press to catch the remnants as they were released from a chute. The whole process was monitored by cameras and sensors.

Each waste container holds 24 to 25 pressure tubes. With heavy lids welded in place, they are shipped on site to the Western Waste Management Facility.

In Unit 2, pressure tube removal took 86 days. The team completed the removal in Unit 1 in just 59 days.

In Unit 2 there was problem with a red oxide dust in the reactor. It clogged the tool heads and increased contamination levels. That did not exist in Unit 1.

Work is underway to set up equipment and tools that will release the inserts that fasten the ends of the calandria tubes to the reactor's inboard tubesheets. Once the inserts are removed, the team can begin the final stage of the disassembly work: calandria tube removal.

Midwest mine project postponed

Areva Resources Canada, Denison Mines Corp. and OURD Canada Co., partners in the Midwest uranium mine in northern Saskatchewan, announced at the end of November 2008 that they have decided to postpone the project. Denison representatives said the decision was due to "current economic climate,

delays and uncertainties associated with the regulatory approval process, the increasing capital and operating costs and the current market for uranium".

The Midwest partners will complete the environmental assessment, which was begun in December 2005, and will complete the engineering.

The Midwest project is about 15 km west of the McLean Lake operation. The deposit was discovered in 1978. It would be an open pit operation by draining part of the South McMahon Lake. The ore will be transported over a dedicated road to the McLean Lake mill. The mine is expected to produce over 16,000 tonnes of U_3O_8.

AECL - China Agreement to explore use of spent LWR fuel

In early November 2008, Atomic Energy of Canada Limited (AECL) formalized an advanced nuclear fuel development agreement with China's Third Qinshan Nuclear Power Co. (TQNPC), China North Nuclear Fuel Corporation and Nuclear Power Institute of China.

The agreement is to jointly develop the technology for the use of uranium recovered from the spent fuel of light water reactors in China to be used in the CANDU reactors at Qinshan. The planned development program will involve scientists and engineers from Canada and China but will be conducted in China.

AECL's President & Chief Executive Officer Hugh MacDiarmid, visiting Beijing with a delegation of Canadian premiers and business leaders, noted that this demonstration project has the potential to make a major contribution to reducing China's dependence on imported nuclear fuel resources as it complements China's light water reactors, which produce the bulk of its nuclear power. We plan to follow this agreement with a similar program to demonstrate the CANDU reactor's capability to use China's abundant thorium resources." This agreement followed TQNPC's 5th anniversary ceremony celebrating the completion of the Qinshan Phase III CANDU nuclear power plant. Hailed by China's President Hu Jintao as a "model for Canada-China cooperation" and the largest infrastructure project ever undertaken between Canada and China, the Qinshan Phase III nuclear power plant incorporates two 728 MWe CANDU 6® PHWR reactors designed by AECL and built in cooperation with TQNPC.

Mr. MacDiarmid noted that thorium has been identified as possibly China's largest potential energy resource. "Demonstration of the use of thorium in CANDU reactors will mark a significant step towards China's quest for energy sustainability," he said.

The AECL media release made no mention of the DUPIC program still being pursued in Korea.

USNRC and DoE plan licensing of HTGC reactor

The US Nuclear Regulatory Commission and the Department of Energy have proposed a licensing plan for a high temperature gas cooled reactor to be built at the Idaho National Laboratory.

This design is described as a "next generation nuclear plant". It would provide high-temperature steam of up to 950 C, which could be, used for a range of industrial purposes, such as fertilizer production, shale oil recovery and hydrogen production.

The plan was prepared to explain to congress how NRC and the potential builders would cooperate in the licensing of the new design. It is acknowledged that some areas would require regulatory development such as guides, review plans, codes and standards. NRC expects to take five years to develop the plan.

Bruce Power presents study of nuclear in Saskatchewan

In lat November 2008 Bruce Power released its study of the feasibility of building nuclear power plants in Saskatchewan. This study was part of an initiative called *Saskatchewan 2020*.

The study concluded that a region spanning from Lloydminister to Prince Albert would be the most viable location for a nuclear power plant. Three reactor designs were considered: AECL's ACR 1000, Westinghouse's APR 1000, and Areva's EPR.

Bruce Power will now work with SaskPower, the provincial utility, to investigate a number of topics, including future power demand and improvements to the province's electrical grid. It will also start considering suitable sites within the area identified and begin meeting with community and aboriginal groups.

CNSC asks for Comprehensive EA for Cameco Port Hope plan

Following a hearing on November 6, 2008, the Canadian Nuclear Safety Commission has decided to recommend to the Minister of the Environment that the environmental assessment of Cameco Corporation's proposed Vision 2010 plan for the redevelopment of its Port Hope facilities be continued as a comprehensive study. Assuming the Minister of the Environment accepts this recommendation this means that the environmental assessment will go to a Panel review.

Over the past year Cameco experienced underground leaks from its uranium hexaflouride (UF_6) plant. These were resolved and production resumed briefly in the fall of 2008.

As a result of that problem and others stemming from the long history of the facility (dating back to the 1930s) the company developed a comprehensive program to address other subsurface contamination resulting from those earlier years. This multi-year program, known as Vision 2010, will include removing up to 150,000 cubic metres of contaminated soil, building materials and stored historic waste.

A site-wide environmental investigation identified subsurface contamination, mainly from operations that pre-date Cameco.

"General News" is compiled by Fred Boyd from generally open sources.


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Alex Hoyle

Alex Hoyle, a member of the original team that designed NPD, the prototype of the CANDU design of nuclear power reactors, died in Peterborough, Ontario on November 8, 2008.

Alex was born in Scotland in 1927 and graduated in chemical engineering from the Royal Technical College in Glasgow in 1947. He subsequently immigrated to Canada and worked at the Chalk River Nuclear Laboratories. In 1955 he was recruited as one of the small initial team assembled to design the Nuclear Power Demonstration plant.

Atomic Energy of Canada Limited, Ontario Hydro, and Canadian General Electric had joined to design and build this prototype plant with the detailed design being conducted at CGE's facility in Peterborough. He remained with CGE working on the design of the nuclear plant in Pakistan, the WR-1 research reactor at AECL's Whiteshell Laboratory and other projects until his retirement.

A photograph of the original NPD design team in mid 1955. Alex Hoyle is at the third desk of the left row, shown speaking with John Foster, the head of the team.

INNOVATIVE SOLUTIONS

The team at **L-3 MAPPS** comprises the world's largest, most experienced group of simulation engineers, all dedicated to designing, developing and building simulators focused on quality and simulation fidelity. The creative synergy and collaborative spirit between the simulation engineers generates new ideas and bold concepts that put L-3 MAPPS simulators way ahead of the competition. The company's superior products and responsive service reflect the company's maturity and commitment to power plant simulation – now and in the future.

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L3 LEADING.

From the President

My recent duties as President of the Canadian Nuclear Society have mainly involved attendance and participation at a variety of Canadian and international conferences and meetings at which your Council considered it important that the Society be represented.

In October I traveled to Aomori, Japan, to participate in the 16th Pacific Basin Nuclear Conference. This conference was very well attended, and featured papers from a wide range of countries, including several from Canada. I acted as co-chair of a Plenary session on Activities of Asia-Pacific Countries, in particular Indonesia, Thailand, and Vietnam. In conjunction with the conference, I participated on behalf of the CNS and the CNA in a meeting of the Pacific Nuclear Council.

In November I attended the American Nuclear Society Winter Meeting in Reno, Nevada, another conference with large attendance and many multiple parallel sessions. At the request of the ANS and the International Nuclear Societies Council (INSC), I presented a summary of the session which I had chaired in Aomori during a panel session on Nuclear Energy Prospects for Developing Nations. I also attended meetings of the International Committee of the ANS and the INSC during my stay in Reno.

In addition to these activities, I took the opportunity to look in on the events which the CNS has organized during the past few weeks, and which are reported on elsewhere in this issue of the Bulletin. First, we had the 10th International Conference on CANDU Fuel, which was held in Ottawa in early October. This successful conference attracted about 150 attendees, and was clearly a great success. This was followed by the Symposium on Simulation Methods in Nuclear Engineering, also held in Ottawa at the beginning of November, and also a successful technical event. Finally, the 8th CNS International Conference on CANDU Maintenance took place in Toronto in mid-November. This conference continues to get bigger and more successful each time it is held, and the current work of refurbishment of our reactors makes it particularly relevant.

The CNS is very fortunate to have many willing volunteers who work very hard to put these events together. Having been involved in the organization of our recent Annual Conferences, I am well aware of the amount of detailed organization which is required in order to make our Conferences and Symposia successful, and the teams which have organized these three events deserve our heartfelt gratitude.

One of my roles as President of the Society is to participate as an ex-officio member of the Board of the Canadian Nuclear Association. At its meeting in early October, I was encouraged by the interest of Board members in the CNS membership, and by their willingness to assist in making the benefits of CNS membership known to their staff. I am pursuing this opportunity in the hope that it will help us to expand our membership, particularly in parts of our industry where we have not attracted many members.

Fred Boyd and a number of our colleagues are continuing to work on preparations for a special meeting of our Extended Council and other important stakeholders to take a broad look at our Society, what we do, and where we are headed in the future. I am particularly enthusiastic about this initiative because it will give us the opportunity to get input from a wide range of our members in setting the future direction of our Society. I am hopeful that Fred's efforts will encourage our Branch, Division, and Committee representatives to make a big effort to attend this session.

Branch News

Alberta – Duane Pendergast

Duane Bratt's study of nuclear power in Alberta and Saskatchewan titled "Prairie Atoms: The Opportunities and Challenges of Nuclear Power in Alberta and Saskatchewan"was released on September 11. It was prepared as part of the Canada West Foundation's "Going for Gold" series and can be found under the "Publications" sub-menu of the foundations website (http://www.cwf.ca). Duane also prepared a summary published as an op-ed in many papers across the country including the Regina Leader-Post, Red Deer Advocate, and the Hamilton Spectator.

Bill Olsen prepared a talk for the Peace River Rotary Club and delivered it on September 29. Several people (including the mayor of Peace River) have asked for copies of the talk and it was reported in the local paper. Bill's talk has been recommended for the Peace River Chamber of Commerce and the Grimshaw Rotary Club.

Cosmos Voutsinos spoke to the Lethbridge Lions Club on October 7. His talk, titled, "Why There is a Renaissance in Nuclear Power" was delivered to about 80 people who raised many cogent questions and were receptive to the possibility of nuclear power in Alberta.

Duane Bratt was engaged in debates with Gordon Edwards at the request of the Saskatchewan Branch on Monday October 20. He reports that it was an interesting experience debating Gordon four times in one day, in a hostile environment. The last debate was in front of about 500 people, with 75-90% being staunch anti-nukes. (N*ote: Hopefully that is the entire cadre of anti-nuclears in Saskatchewan*)

CNS sponsored a Petroleum Alliance of Canada (PTAC) forum held in Calgary on October 21, 22. It focused on technology development related to the reduction of greenhouse gas emissions from oil production and was attended by 110 people. Cosmos Voutsinos, David McColl and Duane Pendergast were in attendance with Cosmos giving a lunchtime talk. He urged potential users of nuclear energy to specify their needs so the nuclear industry could respond with proposals. CNS was identified as the sponsor of the lunch. Our participation was well received and it is encouraging that PTAC has already initiated an oil industry cooperative study of nuclear. PTAC has commissioned a study of nuclear energy focused on small reactors for heat and hydrogen production. PTAC has requested that we help identify expertise capable of reviewing the report from their consultant.

Chalk River – by Blair Bromley for Ragnar Dworschak

- On Monday, October 20, 2008, the Chalk River Branch held its AGM. A review of the events and activities held during 2007/2008 were discussed, along with a financial report, and elections for a new executive. **Several new members of the executive were elected, including Ragnar Dworschak (Branch Chair), Yolanda Dworschak (treasurer), Geoff Edwards (program coordinator), and Alex Rauket (education and outreach chair).** Outgoing chair Blair Bromley expressed his thanks and appreciation to all executive members and volunteers, including Uditha Senaratne, Morgan Brown, Nihan Onder, Chris Canniff, Jintong Li, Marcel Heming, Bryan White, Syed Zaidi, and Jeremy Whitlock.
- On Monday, October 20, 2008, following the AGM, a seminar was held with guest speaker Professor John Campbell (University of Canterbury, New Zealand) who gave a presentation on the life and accomplishments of Nobel Prize winning physicist Earnest Rutherford who had done some of his ground-breaking research at McGill University. About 30 people were in attendance.
- On Monday, October 20, 2008, members Bryan White and Peter Lang, who are part of the Education and Communication Committee (ECC), performed a test run of a workshop for senior science teachers on using Naturally Occurring Radioactive Material in their classes. This was done for the heads of science departments in Renfrew County. The same workshop will be repeated at the upcoming STAO Conference in Toronto and at the ATA Science Council Conference in Calgary in mid-November.
- On Thursday, September 25, Professor Peter Ottensmeyer (University of Toronto), gave a talk on the Subduction for Permanent Disposal of Long-Lived Highly Radioactive Nuclear Wastes. Over 30 people were in attendance.

The Chalk River Branch is planning the following activities for the remainder of 2008 and starting into 2009:

- **Continue with scholastic award for graduating high school students in Renfrew County.**

  We will plan to continue targeting three local high schools with two prizes of $125 each per student, per school. The scholastic award will be based on the highest combined grades in physics, chemistry and calculus. If necessary, changes to the award amounts or criteria can be made.
- **Hold joint events with NA-YGN and WiN**

  We are in communication with Ruth Allen (Kinectrics), Pauline Watson (AMEC), June Connell (NB Power), and Bernice Lanigan (NB Power) about trying to find a speaker for 2008/2009.
- **Sponsorship of Science Fair, Poster Contests and High School Scholarship Award Competitions**

  We intend to continue our sponsorship and support of the Renfrew County Science Fair, and our poster contest for Grade 7/8 students. We are transforming the essay contest for high school students into a scholarship application with two awards ($1,500, $1,000) and targeting Grade 12 students entering university or community college in the fall of 2009. Notices have just been sent out to the high schools, with a target deadline of March 31, 2009. Alex Rauket is leading the effort on these activities.

Golden Horseshoe – Dave Novog

The GHB hosted one talk in October related to GEN IV reactor designs. On October 9, 2008 Dr. David LeBlanc gave an excellent talk on Molten Salt Reactor Designs entitled "A New Beginning for an Old Idea". The talk was attended by faculty and about 20 graduate students and there were lively discussions (going well beyond the allotted time). The GHB would like to thank Dr. LeBlanc for his talk, as it was excellent exposure to the molten salt design. In the coming months we will have additional talks on CFD applications as well as feeder inspection methods and processes.

New Brunswick – Mark McIntyre

At the November Brian Shanks discussed new innovations in Emergency Planning.

A speaker from NWMO has been invited to talk about that group's progress on waste storage.

Ottawa – Mike Taylor

On 21 October, the Ottawa Branch held its second meeting of the season with a lively talk by Dr. John Campbell, retired professor from the University of Canterbury, Christchurch, New Zealand and author of a book on the life of Lord Rutherford, on

"Earnest Rutherford and the Nobel Prize". It was also interesting to discover that John Campbell is a firewalker.

On November 20, Terry Jamieson, Vice President, Technical Support Branch, Canadian Nuclear Safety Commission, outlined the CNSC approach to nuclear power plant licensing. Several Regulatory Documents have recently been issued. He commented that CNSC is moving towards a "risk informed" approach. With many of the audience former members of the regulatory organization there was an active discussion period.

The Branch executive has been enlarged. It now has nine members: Chair: Mike Taylor; Secretary: Ted Thexton; Treasurer: Fred Boyd; Program: Ron Thomas; Web master: Satyen Baindur; Members-at-Large: Ian Grant, Jim Harvie, Ralph Green, Dumitru Serghiuta, Ted Thexton.

A full schedule of speakers for the first four months of 2009 is being finalized.

Pickering – Marc Paiment

It has been decided to close the Branch.

Quebec – Michel Saint-Denis

Michel Saint-Denis is the new Branch Chair.

Sheridan Park – Adriaan Buijs

In October we had a seminar by Prof. John Percy, from the University of Toronto, Mississauga campus, with the title *"Celebrating the Golden Ages of Astronomy"*. He gave an interesting introduction to the current state of knowledge in astronomy. Many in the audience were surprised to learn of the significant role that Canada plays in this field.

Toronto Branch – Joshua Guin

CNS Toronto Branch has nothing to report currently. However, we have a new Webmaster who will be updating the CNS Toronto Branch website regularly. A few new committee members have been recruited. The current initiative is to revitalize the Toronto branch and have monthly seminars starting in December, if not the new year (as it depends on conference room availability).

New Members

We would like to welcome the following new members, who have joined the CNS in the last few months, up to 2008 November 30.

Ahmad Al-Dabbagh, UOIT
Georgi Cvetanov Aldev, Ryerson University
Mafamiya Beleshi, Laurentian University
Paula Buerger, AECL
Eric Cantin, Ceradyne Canada ULC
Kathie Cronier, AECL
Gregory Cully, Laurentian University
Rolf Eberl, Special Electronics & Designs Inc.
Geoffrey Edwards, AECL
Andrew Fitchett, Candesco Corporation
Hossam Elsayed Gabbar, UOIT, FESNS
Jean-Claude Gohard, CNSC
Dé Groeneveld
Mohinder Singh Grover, AECL
Susanna Harding, Apantec, LLC
Cameron Howe
David Hummel, McMaster University
George Jack
Quinton Jacobs, AMEC NSS Limited

Nous aimerions accueillir chaudement les nouveaux membres suivants, qui ont fait adhésion à la SNC ces derniers mois, jusqu'au 30 novembre 2008.

Madeleine Jennings, Algonquin College Pembroke
Jagjit (Jeet) Khosla
Sherry Lynn Laroche, AECL
Hoikei Leung, Student
Ting-Ting Lu, University of Toronto
Roy Martin, Technical Standards and Safety Authority
Dominic Mendoza, UOIT
Ashley Milner, UOIT
Jim Moretti, Ecole Polytechnique de Montréal
Tasfia Zabeen Preeti, Nuclear Eng. Student
Kevin Reyes, UOIT
Sam Sadeghi, AECL
Mohammed Basha Shaik, OPG, IM&CS-HTED
David A. Snopek, GE Hitachi Nuclear Energy Canada Inc.
Matt van Wieringen, UOIT
Paddy Walker, OMNI Technologies Corporation
David White, Plan Energy
Benjamin Xu, AMEC NSS
Michael Zrizanc, NWMO

Membership Note

As of this writing, it is time to renew your CNS membership to take advantage of the low early-bird-renewal fees.

You can now conveniently and securely renew on-line and receive your receipt immediately! It is a very fast and convenient process. Just log on to https://www.signupmaster.com/cns-membership and follow the very easy steps. Be an early-bird and don't delay. Renew now!

A feature of the on-line renewal is that the renewal fee will be increased from the early-bird discounted fee to the regular fee on 2009 January 1, so it is in your interest to renew early.

If you are signed up for automatic renewal, the CNS Office will do the work for you each year in good time, so you will never miss the discounted early-bird renewal rate, without lifting a finger ! **If you are not yet signed up for automatic renewal, but would like to take advantage of this convenient service, please get in touch with the CNS office at 416-977-7620 or cns-snc@on.aibn.com.**

Also, remember to always keep your individual CNS ID number handy. You will need it to identify yourself as a CNS member when registering for a CNS Conference or Course, to receive the member rate! Your ID number is shown on your annual CNS membership card. You may like to keep this in your wallet. The CNS ID number is now also shown on certificates to new members.

Ben Rouben
Chair, Membership Committee

Note d'adhésion

Au moment où j'écris ces lignes, il est déjà temps de renouveler votre adhésion à la SNC et de bénéficier des frais de renouvellement « précoce ».

Vous pouvez maintenant facilement et en toute sécurité renouveler en ligne et vous recevrez votre reçu immédiatement ! C'est vraiment très facile et rapide. Branchez-vous au https://www.signupmaster.com/cns-membership et suivez les instructions. Renouvelez dès maintenant !

Le renouvellement en ligne changera les frais de renouvellement précoce aux frais standard le 1er janviear 2009 ; c'est donc dans votre propre intérêt de renouveler tôt !

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Ben Rouben
président du comité d'adhésion

2nd Canadian Climate Change Technology Conference

12-15 May 2009

Hamilton, Ontario

CLIMATE CHANGE … DEAL WITH IT!

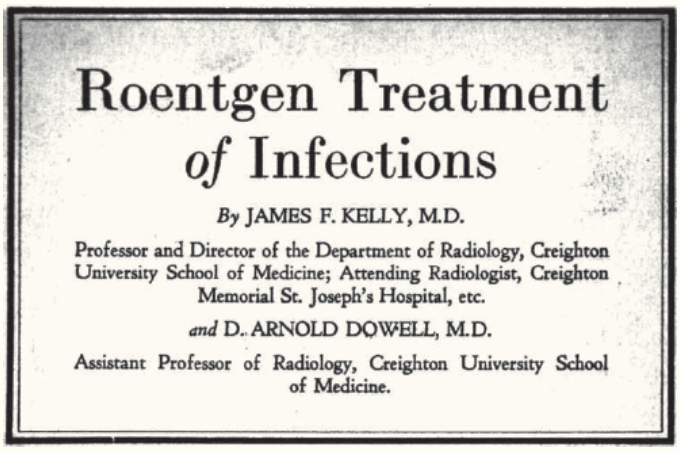
The 2nd Climate Change Technology Conference (CCTC 2009) is a Canadian and international forum for engineers, scientists, policy advisors, industry and other stakeholders to share and exchange new information and ideas for dealing with climate change and global warming. It also provides an opportunity for participants to keep abreast of emerging techniques and technologies for the mitigation of, and adaptation to, the impacts of climate change.

The CCTC2009 is organized by the Engineering Institute of Canada (EIC) and nine of its member societies.

The conference will be held on the campus of McMaster University in Hamilton.

Conference topic categories are: **Impacts; Monitoring; Modeling; Mitigation; Adaptation; Biorefining; Education; Standards; Policy and Regulation.**

For further information go to website: www.cctc2009.ca



Roentgen Treatment *of* Infections

By JAMES F. KELLY, M.D.

Professor and Director of the Department of Radiology, Creighton University School of Medicine; Attending Radiologist, Creighton Memorial St. Joseph's Hospital, etc.

and D. ARNOLD DOWELL, M.D.

Assistant Professor of Radiology, Creighton University School of Medicine.

I carried out research on nuclear fission through the 1960s, measuring neutrons and gamma rays. In the early 1970s, I manufactured and sold x-ray, gamma ray and neutron detectors, before being employed to design and procure nuclear instrumentation systems for many CANDU reactors. Over the years, I read many articles on health concerns regarding low doses of radiation, but did not see any convincing evidence to substantiate such concerns. In 1995, at the ANS Winter Meeting in San Francisco, I heard Dr. Myron Pollycove's remarkable lecture celebrating the centennial of Roentgen's discovery of x-rays. He outlined the history of the use of x-rays in medicine. I had heard about the diagnostic applications, but was very surprised to learn about the stimulatory effects of low radiation doses that had been used by many physicians in the first half of the twentieth century to treat and cure cancer and a variety of infections. Especially interesting were the x-ray treatments to cure deadly gas gangrene infections.

On my return, I searched a U of T library and found remarkable papers in early volumes of Radiology by physicians Kelly and Dowell (Cuttler 2002). Recently, at Amazon.com, I located a copy of their book, Roentgen Treatment of Infections, Year Book Publishers, Chicago 1942 (the year of my birth). This was the first time that I read a 432-page medical textbook from cover to cover. Part I (three chapters) on X-Ray Physics and Fundamentals is interesting, but somewhat primitive in light of current knowledge. However, it explains how the dosage was determined, produced and administered for the local treatments. The dose fractions ranged from about 50 to 100 roentgens (r), depending on the specific case. The total dose for the infections ranged from about 300 to 900 r. A smaller dose, as low as 200 r, was given to children or to processes which were seen early and resolved after two or three small doses. The other five parts (19 chapters) cover: General Considerations, Clinical—Gas Bacillus Infection, Clinical—Abdominal Infections, Clinical—Miscellaneous Infections, and Contraindications to X-Ray Therapy; Review of the Literature. Each of the six parts has an extensive bibliography of books and other scientific publications, starting from the early 1900s. There is also a list of the 135 physicians (or hospitals) who contributed the hundreds of case studies that are reported in this book.

The antibiotic penicillin was discovered in 1928 and employed during World War II. It made a major difference in the number of deaths and amputations caused by infected wounds among Allied forces. Availability was severely limited, however, by the difficulty of manufacturing large quantities of penicillin and by the rapid renal clearance of the drug, necessitating frequent dosing. Improvements were made and methods were developed to mass produce and distribute it after WWII. Many other very powerful antibiotics have been developed since then to deal with infections, and physicians found these miracle pills and serums to be very convenient. The application of x-rays, which had always been met by much skepticism because its mechanism of action was not understood, was discontinued.

The essential role of the patient's biological defences in preventing and curing infections and in the subsequent healing process should not be ignored. As this book demonstrates, stimulation of these defences and the regeneration with the proper radiation therapy can make a dramatic difference in the outcome for infections by many pathogens. Consider MRSA, which has evolved to become resistant to a large group of antibiotics (the beta-lactams). It should be noted that a gas gangrene infection, if not treated promptly, would incubate and then progress at an alarming rate, damaging the circulatory systems. Treatment with an antibiotic at this stage would be futile because it would not be transported to the infected areas; however, a beam of x-rays on the infected areas would penetrate and stimulate the patients own defences. In view of the renewed interest in low-dose radiation effects, it would be very appropriate to study this application again and optimize this form of treatment.

Appendix (Text appearing on the jacket of the book)

This is *a book that deserves consideration,* not only by radiologists, but also by surgeons and all others concerned with reducing the mortality from gas gangrene and peritonitis. Practitioners, teachers and students of radiology will welcome it as the first complete American textbook on the x-ray treatment of infections, covering the third great field (malignancies and dermatology being the others) where roentgen therapy is effective. It contains all the scientific, clinical and bibliographic material appropriate to a standard textbook—procedures in thorough detail, supporting evidence of their efficacity, and critical review of the literature.

Internists and general physicians will find it an authoritative guide, based on nearly two decades of clinical experience and investigation, to the application of this modality to twenty-seven types of infections. Its subject is that form of treatment which requires only the usual low-voltage x-ray apparatus and only small doses of rays—hence that field of radiologic therapy in which the fully informed physician can work safely and effectively.

To the military and industrial surgeon charged with responsibility for the welfare of the fighting forces and of the factory-workers

1 Methicillin-resistant Staphylococcus aureus

who supply them, this monograph will be especially timely. The authors were the originators of the mobile therapy unit for prompt prophylaxis and bedside treatment of cases of gas gangrene resulting from all sorts of fractures, crushing injuries, penetrating wounds, etc.; and the reader will be immediately impressed with the possibilities which this form of management offers for minimizing the sequelae of such accidents and for restoring patients to normal activity with a minimum of hospitalization.

Pediatricians, gynecologists, ophthalmologists and oto-laryngologists are other who will find helpful information within these covers. In fact, since infection knows no medical boundaries, and since the text is thoroughly comprehensive, there is no type of physician or surgeon to whom the book won't be both thought-provoking and valuable.

The late Dr. Willis F. Manges is known to have remarked, years ago, that modern radiology owes its gratitude to Dr. Kelly for having first demonstrated the success of roentgen in controlling gas bacillus infection, since that was the first non-self-limiting infection on which this modality was used effectively. The present work not only presents the method, but also submits the evidence of its results. This consists of 439 carefully analyzed cases, many of them reported in full and supported by graphic evidence of the diagnosis and the results of treatment, as well as analyzed in tables and graphs. Likewise, there are 51 cases of peritonitis. The authors "pull no punches" (on themselves, as well as others!) in presenting their evidence of the benefits of roentgen therapy in controlling infectious processes; but every reader will appreciate their honesty and sincerity.

On Nov. 15, 1941, the British Medical Journal published an editorial on Pendergrass and Hodes' recent report on x-ray treatment of inflammations. The editorial said that the "modest claims" of these American radiologists "should inspire confidence, and when in addition their paper is supported by a bibliography of nearly 200 references, by no means confined to radiological literature, it is rather surprising that skepticism should persist." The present book calls for a general and scrupulously scientific evaluation of the therapy which the conservative British journal thus endorses.

Cuttler JM. 2002. Disinfecting Wounds with Radiation. Proceedings of the Twenty Third Annual Conference of the Canadian Nuclear Society. Toronto

PUBLICATION

Nuclear Energy And Health
And the Benefits of Low-Dose Radiation Hormesis

Jerry M. Cuttler: Cuttler & Associates Inc., Mississauga, ON, Canada
Myron Pollycove: School of Medicine, University of California San Francisco, San Francisco, CA

*[**Ed. Note:** This paper is a Dose-Response Journal publication, supported by The American Council on Science and Health. The abstract is presented here. The full paper can be viewed on the websites listed below.]*

Abstract

Energy needs worldwide are expected to increase for the foreseeable future, but fuel supplies are limited. Nuclear reactors could supply much of the energy demand in a safe, sustainable manner were it not for fear of potential releases of radioactivity. Such releases would likely deliver a low dose or dose rate of radiation, within the range of naturally occurring radiation, to which life is already accustomed. The key areas of concern are discussed. Studies of actual health effects, especially thyroid cancers, following exposures are assessed. Radiation hormesis is explained, pointing out that beneficial effects are expected following a low dose or dose rate because protective responses against stresses are stimulated. The notions that no amount of radiation is small enough to be harmless and that a nuclear accident could kill hundreds of thousands are challenged in light of experience: more than a century with radiation and six decades with reactors. If nuclear energy is to play a significant role in meeting future needs, regulatory authorities must examine the scientific evidence and communicate the real health effects of nuclear radiation. Negative images and implications of health risks derived by unscientific extrapolations of harmful effects of high doses must be dispelled.

Full Paper can be viewed at: The CNS hyperlink: http://www.cns-snc.ca/media/MemberArticles/NuclearEnergy&HealthDec2008.pdf

The EFN Hyperlink: http://www.ecolo.org/documents/documents_in_english/low-dose-health-CUTTLER-08.pdf

30th Annual Conference of the Canadian Nuclear Society and 33rd Annual CNS/CNA Student Conference

Calgary TELUS Convention Centre
Calgary, Alberta, Canada
2009 May 31 - June 03
Conference Hotel: the Fairmont Palliser Hotel, Calgary

"New Nuclear Frontiers"

Call for Papers

The 30th Annual Conference of the Canadian Nuclear Society and the 33rd Annual CNS/CNA Student Conference will be held in Calgary, Alberta, Canada, 2009 May 31 - June 03 at the Calgary TELUS Convention Centre. The Conference hotel will be the Fairmont Palliser Hotel, 133 9th Ave SW, Calgary.

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

- Invited speakers in **Plenary sessions** will address broad industrial and commercial developments in the field.
- Speakers in **Technical sessions** will present papers on their work related to nuclear technology. **This call for papers is to solicit papers in Technical sessions** covering, but not limited to the following **Technical Topics**:

- Reactor and Radiation Physics
- Thermal Hydraulics
- Safety and Licensing
- Process Systems
- Chemistry and Materials
- Instrumentation and Control
- Operation and Maintenance
- Oil Sands Applications
- Mining and Fuel Manufacturing
- Advanced Reactors and Applications
- Environment and Waste Management
- Nuclear Components and Manufacturing
- Plant Life Management and Refurbishment
- Medical Isotope Production and Applications
- Radiation Detection, Radiation Protection and Health Physics
- Education and Public Outreach
- Codes and Standards

Important Dates

- Deadline for submission of full papers: **2009 February 01**
- Notification of paper acceptance: 2009 March 15
- Deadline for submission of final papers: 2009 April 15

Guidelines for Full Papers

Papers should present facts that are new and significant, or represent a state-of-the-art review. They should include enough information for a clear presentation of the topic. Proper reference should be made to related published information. The name(s), affiliation(s), and contact information of the author(s) should appear below the title of the paper. A short abstract of 50-100 words must be placed at the beginning of the paper. A length of ~10 pages with an electronic file size of less than 5 MB is suggested for a typical paper.

Paper Submission Procedure

Submissions of full papers should be made electronically, preferably in MS Word format, through the Annual Conference electronic submission system at:
https://www.softconf.com/s08/CNS2009Technical

For questions about papers and technical program, please contact
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Atomic Energy of Canada Limited
e-mail: cns2009@aecl.ca
Tel: 905-823-9060 ext 33335
Information regarding paper template, copyright of papers, publication methods can be found at
http://www.cns-snc.ca/conf2009.html
General inquiries regarding the Conference may be addressed to
Denise Rouben, CNS Office Manager
e-mail: cns-snc@on.aibn.com
Tel: 416-977-7620

CALENDAR

2009

Jan 14-16 — **Spent Fuel Management Seminar XXVI**
Washington D.C.
website: www.inmm.org/events

Feb. 25-27 — **CNA Nuclear Industry Conference and Tradeshow**
Ottawa, ON
website: www.cna.ca

Mar 30-Apr 3 — **International Symposium on Nuclear Security**
Vienna, Austria
IAEA
fax +43 1 26007

Apr 5-9 — **6th American Nuclear Society International Topical Meeting on Nuclear Plant Instrumentation, Controls, and Human Machine Interface Technology**
Knoxville, TN, USA –
website: http://www.ans.org/meetings

Apr 12-15 — **Advances in Nuclear Fuel Management IV**
Hilton Head Island, SC, USA
website: http://www.anfm2009.org

May 3-7 — **M&C Topical: 2009 International Conference on Advances in Mathematics, Computational Methods, and Reactor Physics**
Saratoga Springs, NY, USA
website: http://www.ans.org/meetings

May 10-14 — **2009 International Congress on Advances in Nuclear Power Plants (ICAPP 09)**
Tokyo, Japan
website: http://www.icapp09.org

May 12-15 — **EIC Climate Change Technology Conference**
McMaster University
Hamilton, Ontario
e-mail: jacksond@mcmaster.ca

May 31-June 2 — **30th Annual CNS Conference & 33rd CNS/CNA Student Conference**
Calgary, Alberta
website: www.cns-snc.ca

June 14-18 — **American Nuclear Society Annual Meeting**
Atlanta, Georgia
website: www.ans.org

July 12-17 — **Twelfth Quadrennial International Conference on Fracture (ICF12)**
Ottawa, Ontario
website: http://www.icf12.com

Aug 9-14 — **SMiRT 20 Conference Int'l Assoc. for Sturctural Mechanics in Reactor Technology**
Espoo, Finland
website: iasmirt.org

Nov. ?? — **6th CNS International Steam Generator Conference**
Toronto, Ontario
website: www.cns-snc.ca

2010

May 9-14 — **PHYSOR 2010, "Advances in Reactor Physics to Power the Nuclear Renaissance"**
Pittsburgh, PA, USA
website: http://www.physor2010.org

May 30-June 2 — **31st Annual Conference of the Canadian Nuclear Society and 34th CNS/CNA Student Conference**
Montréal, Québec
website: www.cns-snc.ca

June 13-17 — **ANS Annual Meeting**
San Diego, CA, USA
http://www.ans.org/meetings

Oct 3-10 — **International Conference on Water Chemistry of Nuclear Reactor Systems (NPC 2010)**
Québec City, QC;
(organized by CNS)
website: http://www.cns-snc.ca

Wind is from Venus; Nuclear is from Mars

by Jeremy Whitlock

Hello Nuclear Power. Do come in. We haven't seen you around here for some time.

Yes. I've been busy.

Indeed. And busier times to come, no? We've certainly heard your name spoken in many quarters lately.

Well… You shouldn't believe all you hear. But yes, it does look like we'll be expanding soon.

About time I dare say? So the public is finally coming around?

Not really. I don't think they like me any more. But perhaps they hate me less.

And you can live with that?

I'm ecstatic.

So tell me: what brings you here today?

It's just that … well … I wish I could understand. I mean, I wish I knew what I could do to …

Yes?

…to be like Wind Power. Nobody's afraid of Wind Power.

Don't be silly. Wind Power is a great guy, but he can never do what you do.

Really? Then why is Ontario talking about having more Wind Power and less of me?

Ontario's a fool. Ontario hasn't known what it's been doing for thirty years. It can't blow its nose without having a personal crisis.

Thirteen million people are all fools? They want more Wind Power.

No … they like the idea of Wind Power. Trust me, they don't want more wind power.

They want clean power. They want reliable power. They want safe power. They want affordable power.

But doesn't this describe…

It describes you and your friends. Fossil, Nuclear, Hydro, Wind. All working together, happily and mutually supportive. But mostly you.

That's not what I'm hearing.

You're hearing crap. Look, people feel more control over Wind Power, okay? It seems simple to them. They understand it. It's a turbine on a stick for crying out loud. It can't be added in chunks greater than 50 MW or so. So Wind Power in any one location seems small.

Yeah, but 50 MW…

…is nothing. Yes I know. And more importantly Wind Power never lets on too widely how much energy it actually produces, or with what level of predictability.

I could be like that.

You don't have to. You produce about as much as any machine can. It's just that you're …

Yes?

…you're a little … inaccessible. You're a whole bunch of science and megawatts, all packed into very big buildings with very, very big concrete walls.

Reassuring and strong…?

Hm, no I'm thinking scary and ugly.

You're right. I'm pathetic. Oh what's the use…

Please. There's lots of room for the strong, silent type. Look: you enable Wind Power. You empower it. You validate it. Without you there is no Wind Power. Wind Power needs a strong grid to absorb its … vicissitudes.

I'm the wind beneath its blades?

Wonderful. I'm crying. You've got me crying. You're the man.

I want to be the Everyman.

Not going to happen.

But I do worry about this Climate Change thing. I see lots of people, even anti-nukes, saying I can save the world.

Please, people know about as much about Climate Change as Ontario knows about energy planning. You want a real, tangible benefit? Let's talk about replacing Nanticoke with clean, baseload power. Let's talk about supplying reactive load in Southwestern Ontario.

You're saying I'm reactionary???

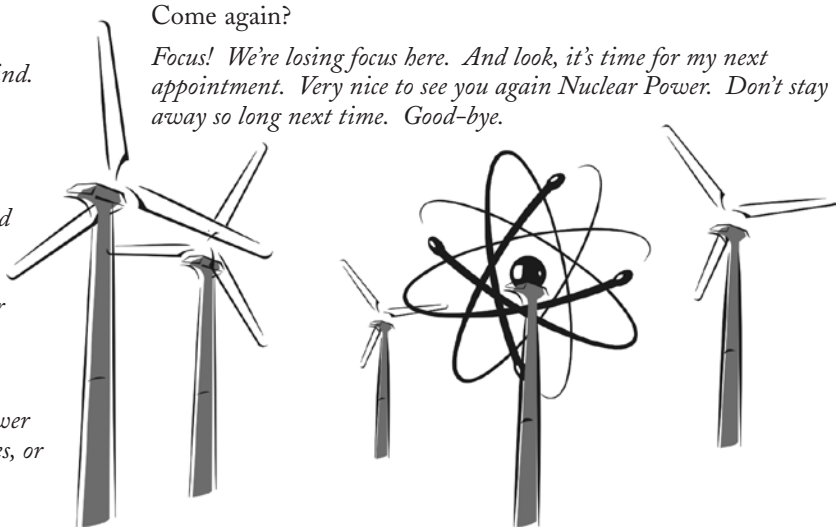
Reactive! Reactive power. You have the power dude.

Reactive power?

Yes. It's imaginary.

Come again?

Focus! We're losing focus here. And look, it's time for my next appointment. Very nice to see you again Nuclear Power. Don't stay away so long next time. Good-bye.



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