CANADIAN NUCLEAR SOCIETY

Bulletin

DE LA SOCIÉTÉ NUCLÉAIRE CANADIENNE

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- **Special Supplement on the NRU Isotope Crisis**
- **Pinawa – 12 years Later**
- **Manhattan Project Redux**
- **World Nuclear University**

Safety Culture – Learning from Sunrise Propane

The massive explosion and fire at Toronto's Sunrise Propane recently is a stark illustration of the wide-ranging consequences to public safety, and also to the entire industry when that industry lacks an effective safety culture. This incident has ignited new debate on the effectiveness of self-regulation to protect the public, and highlighted an apparent lack of safety awareness and disregard for the hazards that some propane companies manage. According to the Technical Standards and Safety Authority, two prior safety violations occurred at the same Sunrise facility, one being a so-called "truck-to-truck" transfer in 2006. In a media release the TSSA stated that another "truck-to-truck" transfer had taken place just before the explosion (which may have caused it). In follow-up audits, the TSSA found other safety violations in other propane companies and suspended the licences of six major facilities pending proof of training and certification. Later, the TSSA revoked the licences for the three Sunrise Propane facilities, citing a "lack of safety culture".

Five years ago in Newton, NJ, a similar explosion and fire occurred at Able Energy caused by an illegal truck-to-truck transfer of propane. According to the US Occupational Safety and Health Administration, Able Energy had prior and numerous fines levied for illegal truck-to-truck transfers and several other safety violations (including driving away with the transfer hose still attached). It was a common and apparently concealed practice at Able because it saved time from driving the tanker trucks to a properly licensed propane transfer facility farther away. In the case of Sunrise, the cease and desist order was ignored - according to the TSSA, such illegal truck-to-truck transfers were a "frequent and common" practice up to and including the blast in Toronto.

A poor safety record in one organisation taints all others by association, including the majority of propane companies that take safety seriously. We know all to well that a nuclear accident, even in a foreign country, can have a devastating effect on the rest of our industry, which is why the World Association of Nuclear Operators has promulgated an industry-wide safety culture as a collective responsibility to "watch out for each other".

Interestingly, the TSSA stated that truck-to-truck transfer is not prohibited by the national propane code. If that is so (and I tried to check but got only mumblegal jumblegal and references to a hard to obtain "Propane Code Adoption Document"), then there may be a more fundamental problem. When truckers cross jurisdictions, the legality of truck-to-truck transfer may be confusing and could be regarded as a technicality rather than a safety issue. Furthermore, since the TSSA is funded by the same companies it regulates, enforcement could be viewed as a conflict of interest, resulting in more leniency with no accountability through an elected government minister.

Perhaps it was a mistake to delegate regulatory services from the government to a privately held TSSA. Perhaps there is a need for high-hazard industries to be regulated at the federal level, similar to aviation and nuclear. A federal agency would also ensure consistency across the provinces to avoid any confusion about the legality of certain operations. A national focus with sharing of experiences (no learning from Able Energy?) would help foster a more effective safety culture, which is apparently lacking in some high-hazard industries.

In This Issue

My editorial in the June 2008 edition of the Bulletin, "***New Build – Have We Got the Right Stuff?***" prompted a lot of response. I was wrong in my statement that production of pressure tubes has been problematic lately due to loss of skilled craftspeople during the past 20 years with no new build. Quite the contrary, according to **George Legate**, president of Nu-Tech Precision Metals Inc. (see Letter to Editor). I apologise for the mistake and welcome the encouraging news from Nu-Tech. **Neil Alexander** of the Organization of CANDU Industries also responded by submitting a review of the Canadian nuclear industry's readiness for the renaissance in his article "Canada Has the Right Stuff – and then some". It answers my editorial question in the affirmative.

There is a special supplement in this edition of the Bulletin about the extended shutdown of the NRU reactor and the isotope crisis. **Drs. Morrison and Meneley** co-authored the paper and have expressed their views on "**Balancing the Risks**", calling for changes in government processes to improve safety regulation.

Twelve years ago AECL announced it would be closing the Whiteshell Laboratories. The town of **Pinawa**, Manitoba was primarily a "one-horse" town populated almost entirely of Whiteshell employees and their families. **Len Simpson**, who provides a very interesting and readable account of the events up to the present, reviews the impact of the announcement on the town. It appears the "**Secret of Pinawa**" has been discovered!

Canada was involved in the Manhattan Project during World War II, and many have argued without proof that there was no Canadian uranium in the atomic weapons used against Japan to successfully terminate the war in August, 1945. In the **History** section, **Jim Arsenault** presents quantitative evidence to support the conclusion that no Canadian uranium was in the bombs dropped on Japan.

We are honoured to have reports from **Bill Garland** (facilitator) and **Jason Wight** (attendee) of the World Nuclear University Summer Institute. We also have the regular General News and CNS News including an interesting biography of CNS President, **Jim Harvie**, written by our publisher, **Fred Boyd**. And last but never least, **Jeremy Whitlock's** "second best" **Endpoint** of Olympic proportion.

As editor, I try to include a variety of articles including reviews, technical papers, history, opinions, membership news and other items of interest. As always, your comments, suggestions and **contributions** are welcome!

Dear Editor,

In June's Editorial *New Build – Have We Got the Right Stuff?*, you take the premise that Canada's nuclear supply chain has been inactive for 20 years and as such is floundering to supply acceptable product. I was dismayed when you cited the manufacture of pressure tubes as your prime example of this inadequacy. Specifically you stated **"the supply of replacement tubes has been problematic. This is not new technology, but after 20 years without orders, the knowledge and skill inherent in the craftspeople that machine and manufacture pressure tubes has diminished and it is taking longer and costing more to produce pressure tubes with the required quality"**. You also stated that **"there are problems to be resolved with the production of advanced (ACR) pressure tubes, which have more stringent material specifications than compared to the current CANDU"**.

I do not know where you obtained your information and I am somewhat surprised you would make such statements without verifying their validity. Since 1958, Nu-Tech Precision Metals, located in Arnprior, Ontario, has produced every pressure tube for every CANDU reactor everywhere. I would like to address your comments with the facts:

1. You claim that prior to the Bruce A re-tube which was placed with Nu-Tech in late 2005 that Nu-Tech (and other companies in AECL's supply chain) have for the past 20 years been idle. In fact Nu-Tech has produced about 4000 pressure tubes in the period of 1985 to 2005. Projects included the Pickering A refurbishment, the original Bruce A re-tube, Wolsong 2,3 and 4 and Quinshan 1 and 2. There has been no loss of skill as you report in your Editorial. The same "craftsmen" that worked here in the 70's and 80's are working here today. Many will be retiring over the next several years but we have a competent group of young Canadians who now have the experience of manufacturing a few thousand pressure tubes to carry on supplying to future projects.
2. In 2005, faced with requirements for an unprecedented volume of pressure tubes being required over a short period of time Nu-Tech invested several million dollars in expanding our capacity. Tubes for the Bruce A re-tube were supplied at 2 ½ times the build rate and were completed on time and about a year ahead of the date required on site. We went on to build and complete pressure tubes for the Point Lepreau re-tube which were also completed exactly when promised. We are currently completing the pressure tubes for the Wolsong 1 re-tube and those will be supplied on time as well. In terms then, of a pressure tube taking longer to produce, in fact the production time is the same, and our capacity to build is about 3 to 4 times what was possible in 1985.
3. Concerning quality, I can report that over the course of the past 3 years our operations have been continuously audited and source surveyed (at a frequency of about twice per month) by AECL, OPG, Bruce Power, NB Power, KHNP, the TSSA and the CNSC. There are no quality issues. Further, the quality of today's pressure tube far exceeds that of a circa 1985 tube (as it should). A few examples include the use of quad melted raw material vs. double melted, hydrogen levels that have been driven to a few ppm, the exacting control over the tube extrusion and cold drawing process (to control microstructure and strength to minimize in-reactor creep) and laser dimensioning.
4. Concerning cost, our selling price is established before contracts are placed. After manufacturing pressure tubes for 50 years we have a very good (exact) grasp of what the manufacturing costs are. The statement of pressure tubes costing more to produce than what was planned or agreed upon is ridiculous.
5. Finally Nu-Tech has produced three production runs of ACR pressure tubes. These tubes are made to a Technical Spec that is virtually identical to that used for today's CANDU 6 tubes. There are no technical issues with the production of ACR tubes and Nu-Tech has indicated to AECL that it is in a production ready status. Two reactor sets of ACR tubes would require about 14 months to construct, posing no challenges what so ever.

Nu-Tech is but one example of the AECL/ Team Candu supply chain. Contrary to the premise of your article and perhaps the situation faced by other reactor manufacturers, AECL has been building reactors over the past 25 years and it's supply chain has been manufacturing reactor parts. I would hope upon reviewing this information and verifying its accuracy you will publish a retraction.

George Legate, President
Nu-Tech Precision Metals Inc.

Re: The response of Terry Jamieson VP CNSC in the CNS Bulletin issue of June 2008, to the Bill Schneider article entitled "What would warrant selection of CANDU?" of the March 2008 Bulletin

Dear Editor,

I would like to strongly commend Terry Jamieson and his colleagues at CNSC for what, to me, appear to be very strong and appropriate organizational measures and operating process changes for dealing with the challenges brought into focus by recent difficulties.

Mr Jamieson's response in the Bulletin Issue of June 2008, which describes those organizational and process changes, is recommended reading for all in the industry.

Commendation is particularly due regarding:

- the measures identified to deal with the responsibilities and challenges of both on-going regulatory work and new-build; and the re-structuring, resource build-up, project management measures implemented to make that all happen
- the establishment of process and time-lines for new-build reviews – all in addition to on-going responsibilities regarding existing plant operations
- also for harnessing the focus brought by the difficulties of the past months to bring new management mechanisms and new resources to bear on the huge challenges ahead – truly a case of turning an intractable situation into an excellent out-come
- and for using these Bulletin discussions as a vehicle for bringing your excellent story to the attention of those of us who may not otherwise be current on the advancements that have been made.

Again - excellent work.

Bill Schneider

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~ Cover Photo ~

Aerial view of the Town of Pinawa taken in the '90's before ACEL's downsizing of its Whiteshell Laboratories.

– Photograph courtesy of the Pinawa Community Development Corporation

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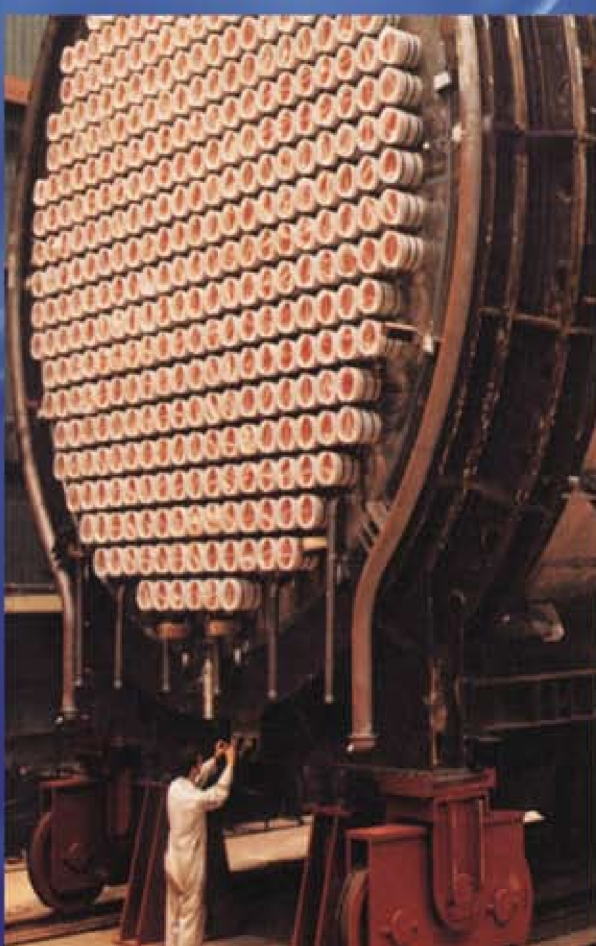


Canada has the right stuff – and then some

by Dr. Neil Alexander, President of the Organization of CANDU Industries.

As countries around the globe embrace nuclear power as the preferred source of greenhouse gas-free electricity, Canada's homegrown nuclear industry is poised to reap the benefits.

World-wide demand for nuclear power is increasing as countries around the world consider nuclear as an attractive option for new sources of green-house-gas free electric power. Estimates of the number of new plants being planned vary but start at over a hundred. This compares with the trickle of new builds that have taken place over the last decade.

Imagine this as a wave of opportunity that is developing out in the ocean. The world is populated by organisations that have spotted that wave and are waiting eagerly like surfers for that wave to arrive. Just like surfers we have been watching the wave for sometime asking ourselves whether it is real or not but there is now no doubt that it is there as we can already feel the swell. And just like surfers it will be the organisations that pick up momentum in advance of the wave that will gain the benefit of the exciting and highly profitable ride to the beach. Those that do not have momentum run the risk that they will do nothing more than watch the wave go past.

Canadian companies stand a better chance than most of gaining that momentum. Our homegrown reactors, the CANDUs are built largely of components designed and manufactured in Canada and CANDUs have been built consistently during what has been a calm time for the industry. Additionally our renaissance started early with a few trial ripples such as the Pickering restarts, the Bruce Power refurbishments and restarts and the planning of the refurbishments for Lepreau and Gentilly. Even the Canadian geology is on our side as we have some of the largest and richest deposits of uranium in the world. Few other countries stand to benefit as much from the renaissance.

The question is how important is the momentum that we have and how much advantage will it give to Canada. The answer is clear that the advantage is huge.

For much of my childhood I watched a black and white TV, at sixteen I bought my first calculator, in university I read a New Scientist article in which they talked about the invention of Charged-Coupled Devices (CCDs) that would make digital photography possible but where they concluded that it would be impossible to produce enough memory to allow their popular use! Even I now use the Internet, though in my formative years not even science fiction writers had conceived of anything like it. I mention this because it is easy to forget how much the world has changed.

The first reactors were built with the technology of their time and to the standards of a time when the consequences of an off-design event had never been experienced. The designs, specifications and expectations reflected the era. Because no one had built reactors before they were built by companies that were transferring skills from other sectors and this was acceptable because there was no other choice. Barriers to entry in to the business were low and there was no demand for previous nuclear industry experience, at least not from anyone expecting to get their project finished.

Over the years the fundamentals of nuclear physics have obviously not changed but almost everything else has. We live now in an era where fabrication technology allows reproducible precision while inspection technology allows us to confirm that precision. I was privileged to visit Laker Energy Products a few weeks ago and watched their inspection tools patiently monitoring every dimension of every component and carefully logging it for future reference. There was no room for human error and no component that did not meet the demanding tolerances would make it through the test. With the ability to build to these very stringent standards and a capability to confirm they are being met the nuclear regulators rightly insist that not only do we do just that but that we prove that we have done it.

Market entry costs to the nuclear industry are now very high. The ability to design, construct and inspect to the very high standard means that nuclear businesses are typically highly specialized. More importantly purchasers of "Nuclear" equipment

L3 MAPPS has used its CANDU simulator experience to become a supplier of similar systems to BWRs and PWRs throughout North America, Europe and the Far East.

Photo courtesy of L3 MAAPS.

want to use people with demonstrable experience. Demonstrable experience provides maximum assurance of success and success is the industries' only acceptable outcome. In other words if you are already in the nuclear industry you have a considerable advantage over those that might want to enter.

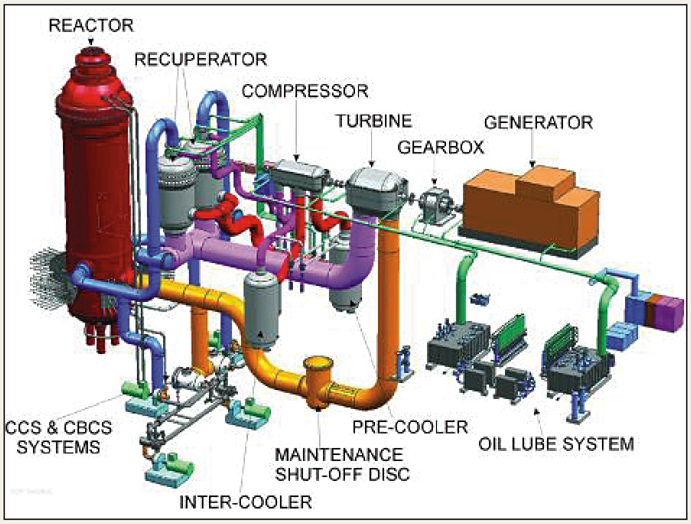
The CANDU construction and refurbishment program has kept our Canadian supply chain in a state of constant development. Fabrication equipment has been upgraded, QA plans put in place and exercised routinely and most importantly it has provided Canadian companies with ongoing experience. Our Supply Chain is already over the barrier to entry and it has demonstrable experience. This readiness provides a great boost to AECL as it gives assurance that the Canadian supply chain can and will deliver on an order for an ACR.

But that is only the start of the opportunity for the Canadian Industry. The skills needed to design, fabricate and inspect a CANDU component are largely the same as for a BWR or PWR and the experience of Canadian companies is welcomed by an industry where many of the original suppliers have become rusty or simply do not exist anymore. L3 MAPPS for example have parlayed the experience they developed in CANDU simulators and control systems to become a supplier of similar systems to BWRs and PWRs throughout North America, Europe and the Far East. Meanwhile SNC Lavalin used their expertise in reactor construction, developed under the name Canatom, and combined it with the international experience of their other divisions to secure their role in the South African Pebble Bed reactor. Bruce Power's success in operating the Bruce reactors has led them into involvement in a bid for a Build-Own-Operate opportunity in Turkey. I could go on and on with a long list of similar examples of where the Canadian nuclear experience is creating international opportunity for Canada and is boosting Canadian companies to world leading positions. In fact, indulge me, I will go on. Candesco are using their Canadian regulatory experience in Argentina, while Babcock and Wilcox, fresh from the production of Steam Generators at Bruce Power, are using their facility in Cambridge to produce steam generators for First Energy in the US and their service expertise to inspect Steam Generators throughout the US. OK I think you probably get the point.

All of these activities bring direct financial, job opportunity and Intellectual Property benefits to Canada as well as improving the prestige of Canada on the world stage. These benefits are in addition to the more conspicuous direct benefit of say a CANDU reactor sale and the existing uranium production and isotope supply businesses of the Canadian companies Cameco and MDS Nordion.

Looking at the CANDU figures alone the potential economic impact for Canada to the year 2030 ranges from $15 billion to $34 billion in GDP growth and up to 419,000 person-years of employment. That makes Canada's nuclear industry an indispensable contributor to our economy and a leading player in the global nuclear power sector. To put this into context for every CANDU exported, Ontario will gain the equivalent number of direct jobs as an automotive plant during the five-year construction phase. That's 2,000 jobs each year for five years. I stress again that these figures are the direct jobs.

We are all working hard to ensure politicians at all levels understand the importance to Canada of its nuclear industry and to ensure that it gets appropriate attention and support. But we cannot just wait for our politicians to do things for us. That wave is out there. It is coming towards us. Our supply chain is in better shape than almost any other in the world. Now is the time to follow the example of L3 MAPPS, SNC Lavalin, Bruce Power and the others to embrace the full magnitude of the oncoming opportunity and enjoy that long profitable ride to the full. I for one am looking forward to the day when we sit on the shore congratulating ourselves on the fact that we put in the effort and investment at the right time while we watch our international competitors limp lamely home.



SNC Lavalin Nuclear has used its CANDU experience in the development of the South African Pebble Bed Modular Reactor. Shown is a sketch of the main components of the PBMR.
Photo Courtesy of PBMR.

***Ed Note: Pebble Bed Modular Reactor (Pty) Limited (PBMR)** was established in 1999 with the intention to develop and market small-scale, high-temperature reactors both locally and internationally. The Pebble Bed Modular Reactor is a Generation IV high temperature gas reactor (HTR), using helium as the coolant.*

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Pinawa, Twelve Years Later

by Len Simpson

Ed. Note: *Len Simpson is a CNS Member from Pinawa, Manitoba and Director of Reactor Safety Research (Retired) at AECL's Whiteshell Laboratories near Pinawa, and also former Mayor of Pinawa.*

Whiteshell To Close!

"*Pinawa waits for the worst!*" This was one of the many front page headlines in the Winnipeg Free Press during the month of November, 1995. What followed were weeks of confusion, panic, demonstrations, and denials by AECL that a decision to close Whiteshell had been made. However, when the dust finally settled, it was confirmed that AECL would be discontinuing support for the Nuclear Waste Management Program, and moving Reactor Safety Research, and other core programs supporting the CANDU product, to Chalk River. This began a long period of anxiety, rumours and false anticipations.

The History

Pinawa was established in 1963 as a bedroom community for the employees of AECL's second research laboratory, named the Whiteshell Nuclear Research Establishment (WNRE). The Labs were located on the east shore of the Winnipeg River about 100 Km north east of Winnipeg. Pinawa was located 12 Km to the east of the lab at the end of a highway. While the location was fantastic in terms of the natural beauty and recreation potential, it was off the beaten track and visitors rarely came to town unless they had business there. Pinawa's isolation was not a concern since AECL's vision was that it would grow to a population of 5000 with the anticipated expansion of the lab (one early model of the site showed four reactors, WR1 to WR4). The community actually grew to a population of about 2200 and WNRE did thrive while developing the organic-cooled reactor, studying other reactor concepts and researching reactor safety issues. Because of the early success of the Pickering reactors, AECL's interest in the organic-cooled concept waned, but emerging concerns about spent fuel disposal spawned the Nuclear Waste Management Program (NWMP). By the mid-nineties, the NWMP and the Reactor Safety Research Program were the main programs at the site, employing over 1000 employees. However there were clouds on the horizon. In 1995, because the nuclear industry was out of favour with the Liberal government of the time, AECL was instructed to cut back. A decision was made that AECL would consolidate core R&D (supporting CANDU) at Chalk River and attempt to commercialize the remaining programs, including the NWMP, at Whiteshell.

Until this time, Pinawa had been a true company town. There was only one general store a drug store and a bank. A special school district was established, to ensure that the AECL employees would have control over the educational choices of their children, and a Local Government District (LGD) was established that dealt with municipal needs of the community. AECL provided the capital infrastructure of the LGD, including schools, a municipal office, a shopping mall, a community centre, a nine-hole golf course and a well-equipped town yard. In later years, AECL also provided a hockey rink and an outdoor swimming pool. The operation of the town was covered by municipal taxes and a large grant-in-lieu from AECL. Obviously, it was a very comfortable life, especially for those raising families. Winnipeg was only 90 minutes away if one wished to partake of the cultural events or visit shops. Little thought was given, either by the Pinawa citizens or AECL, to diversify the economy of the town. Initially, nearly all employees rented houses from AECL, but in the seventies employees were encouraged by AECL to buy their homes. With home ownership residents began to improve their properties. In spite of that the market prices stayed low relative to the surrounding communities. Because Pinawa was still seen as an AECL town, there was not much interest in moving there, unless you worked for AECL or one of the few town businesses.

Early Events

In February 1996 the federal government set up the Whiteshell Task Force under the chairmanship of Peter Siemens, a successful Manitoba businessman, to recommend ways to commercialize the site. In July, the task force report was submitted to natural Resources Canada (now NRCan) recommending the establishment of an authority to proceed with commercialization. Finally, after another six months, the federal and provincial governments created the Economic Development Authority of Whiteshell (EDAW) under the directorship of Peter Siemens, whose mandate was to find new tenants for the site and employment for laid-off AECL employees. A loan fund of $20 million was established to help entrepreneurs start new businesses in town, and in April 1997 NRCan invited a consortium led by British Nuclear Fuels Ltd. (BNFL), to negotiate taking over the site, bringing in their own businesses, and taking over the Nuclear Waste Management Program (NWMP). A Senior Vice President from BNFL was sent to work in Pinawa for as long as it took to come to an agreement with AECL to transfer facilities.

Deer roam freely in Pinawa.

In 1998, a federal fund of $3.5 million was established, to be distributed to Pinawa and the surrounding communities to help start new projects that would provide jobs. This was known as the Community Adjustment Fund (CAF) and was administered by a committee made up of local reeves and mayors, a representative from the Pinawa Community Development Corporation (PCDC), Peter Siemens of the EDAW and a representative from the Western Economic Diversification Office.

The three years from 1996 to 1998 were filled with confusion and mixed messages. AECL was anxious to commence downsizing, but layoffs were frozen by NRCan pending possible commercialization. While members of the core programs were under pressure to complete research for licensing CANDU reactors, the NWMP employees were neglected by the executive, and their programs had been cut. Some staff in both programs began leaving AECL for jobs abroad or in other industries. Also, some members of the core program who did not want to transfer to Chalk River were talking to Peter Siemens about privatizing their programs at Whiteshell, and also to BNFL about joining their project. There was considerable conflict between Siemens and AECL because of this. At least one division director forbade his staff to talk to EDAW and BNFL, an instruction that was mostly ignored.

In April 1998, frustrated by an inability to engage AECL in serious negotiations, the BNFL group pulled out. By November 1998, AECL announced they were proceeding to close the site and move core programs to Chalk River.

Because of the relatively low expectation of selling one's house at a reasonable price, AECL launched a program that would pay the difference between an employee's selling price and the assessed value. This applied to those employees being transferred to Chalk River or those laid off and moving out of town. During this period, property values in Pinawa crashed.

Many people declined the offer to move to Chalk River and took a lay-off or retirement package. Moving to Chalk River was not welcomed by many as Chalk River's prospects for surviving the political climate were not thought to be much better than Pinawa's, and real estate there was two to three times the cost in Pinawa. Some of the best and brightest moved to the USA or Europe if they were young enough to restart their career. My position as Director of Reactor Safety Research was moved to Chalk River and I was offered a retirement package if I declined to go. It was an offer I couldn't refuse. Most of those of my age took the same path. Some started new businesses, some consulted, some took courses and started new endeavours and some just retired. No one wanted to leave this paradise called Pinawa. Of those called to Chalk River less than 50% accepted the transfer.

The Mysterious Israelis

The $20 million EDAW loan was established to help entrepreneurs start businesses in Pinawa but whenever government funding is available, all sorts of people turn up including what Peter Siemens referred to as bottom feeders. One day, a group claiming to represent an Israeli development company dropped into Peter's office. They had a plan to make Pinawa the "*only five diamond resort between Toronto and Lake Louise*", starting with the AECL staff hotel. In a town meeting they flabbergasted the citizens with their grandiose plan. Peter Siemens put them in touch with AECL and negotiations began to sell the staff hotel, the Pinawa marina area and several parcels of land in town. The staff hotel was offered to the town first, but the council of the time turned this down as the maintenance would have been a huge financial burden. AECL sold the property for one dollar to this group even though, two weeks earlier, information from Israel suggested this group was misrepresenting themselves.

It soon became clear that they had no money of their own to invest, apart from a Scotiabank loan based on their business plan, which was subsequently rejected by EDAW. They managed to run the staff hotel for only a few months before going into receivership in the spring of 1999. By then I was Mayor of Pinawa, and one day a few months after the receivership, we were visited in the Council office by two investigators from the Israeli government, who were searching for Israeli government funds that had been released to the same group during a project in Israel. We assured them that they had brought no funds to Pinawa and we spent the rest of the day sharing stories of our incredible experiences with these people.

Council Takes Action

In October 1998 there was an election for Pinawa Council. I was elected mayor and three new councillors were elected along with one member of the previous council. The election turnout was about 80%, extremely high for a municipal election. The people of Pinawa wanted action. I immediately met with Darrin Praznik, our MLA, to discuss AECL's announcement to close Whiteshell. We decided to form a Leader's Group, consisting of four provincial ministers and the reeves and mayors of the communities affected by AECL's action. We met monthly to develop a unified approach to deal with AECL's decision and wrote a report on the impacts to the communities, including economic effect, the environment, and the fact that Manitoba

would no longer be receiving its fair share of federal research dollars. Darrin and several municipal leaders took the Leader's Report to Ottawa and met with several ministries, AECL and the Auditor General's Office. We expressed our concerns about the delays in commercialization of Whiteshell, and also the emerging inadequate decommissioning plans which were being prepared for the site. The Leader's Group united about seven local municipalities to a common cause. The group lives on, now expanded to include all of the northeast Manitoba municipalities, working together on economic issues and sharing resources.

Up until the municipal election in December 1998, the high level discussions that affected our future were carried out by EDAW, the federal government, AECL and the various companies that were interested in the site. The new council, supported by the general population, were determined to get more involved in our future. In a community workshop, we established that Pinawa needed to lessen our strong dependence on AECL and to do this, the community had to grow. We decided not to wait for outcomes that may arise from EDAW's efforts to bring new businesses to the AECL site, but to act in areas where we had total control. We recognized that Pinawa was already becoming a popular place for retirees, and many people from Winnipeg were purchasing Pinawa houses as recreational properties. However a complete town needs young working families and we decided to focus on attracting new businesses to our town.

EDAW had assisted in helping a number of small businesses spin out of AECL. The loan fund was helpful in a few cases, but several entrepreneurs found it very bureaucratic. The PCDC purchased the vacant elementary school to accommodate new businesses and renamed it the Lewis Centre. Darrin Praznik placed the North Eastman Health Authority's head office in the centre and they are still the major tenant occupying about half the building. Other occupants include Eco Matters, now employing about a dozen people formerly in the NWMP, Granite Internet, which has grown into an internet service provider for the Eastman region and other small businesses. Eco Matters has a world-wide business providing advice to nuclear agencies in Sweden, France, the UK and Canada, investigating disposal of greenhouse gases for Canadian oil and coal industries, and modeling agricultural impacts across Canada. Space was rented at the AECL site for Acsion Industries, which offers irradiation services and composite materials for specialized uses. This is a spin-off from AECL'S Radiation Applications Branch. One of their products is a fibre-composite panel cured by radiation for Air Canada. They are also developing a course in radiation safety with the University of Winnipeg. Channel Technologies, another spun-out business, offers hardware for monitoring spent fuel bays in nuclear reactors to prevent nuclear proliferation, and does software development for AECL.

It was clear from day one that AECL's original plan to close the site and leave it with a skeleton staff, deferring major decommissioning for decades was unacceptable, a position shared by the Manitoba government. We also felt that the Whiteshell site was a valuable resource and every effort should be made to bring in another federal program, as they had done in similar situations elsewhere. With the establishment of the Leader's Group, we had built a strong relationship with the Province and maintained this when Gary Doer's NDP government won power in September, 1999. Following our first visit to Ottawa with Darin Praznik, I continued to lobby Ottawa on an annual basis, taking advantage of the annual CNA conference each year in Ottawa to meet with federal ministers, the nuclear regulator and AECL executives. We reminded the federal government at every opportunity that they had an obligation to leave Pinawa in a stable condition. We never approached them empty handed, but came with detailed proposals for locating anticipated new federal programs to the site. One of these suggested programs was a centre for climate change studies, where we had developed a concept with a Winnipeg consulting firm using funds from both the federal government and the province. While well received by government bureaucrats, our study now appears to be gathering dust somewhere on a shelf in Ottawa.

Decommissioning was a serious issue. Shortly after becoming Mayor, EDAW identified decommissioning as a potential new industry for Whiteshell to develop. Up until then it appeared that AECL viewed decommissioning as cursory decontamination and mothballing a facility until proper disposal facilities were built to take care of the decommissioning wastes. It apparently was not part of their mission to provide such facilities so we went after NRCan to provide them. Even though NRCan's motto at the time was "polluter pays", there was an extended period of buck passing over who had the financial responsibility.

As I was visiting Paris in the spring of 1999, I invited Peter Siemens and the Assistant Deputy Minister of Manitoba Environment (Dave Wotton) to meet me in the UK and visit several sites where they could witness serious decommissioning in progress. Our first stop was the UK Atomic Energy Authority site at Harwell near Oxford. We saw an entire building of hot cells undergoing full dismantling, and active laboratory buildings being decontaminated so they could be released from the nuclear license. Through their privatization project, they were successfully attracting new businesses to the site and commercializing some of their old ones. This was basically what we were trying to do in Pinawa, but so far with little success. We saw similar things happening in Winfrith, the site of the Steam Generating Heavy Water Reactor, where they proudly showed us their

New housing projects underway in Pinawa.

spent-fuel bay that was now so clean that they actually served a lunch there when the decommissioning job was complete. Our final visit was to Sellafield, in the English Lake District, where we visited the British national site for low level waste disposal (Drigg), and toured the recently completed Thorpe reprocessing plant. Thorpe was an impressive sight, especially its cleanliness, but even more amazing was the simultaneous decommissioning of surrounding buildings, some clearly badly contaminated. Our visits made us realize the value of a site licensed for nuclear activities. They didn't just discard a site when they had no use for it, but were ready to bring in new nuclear activities to a community that is comfortable with the nuclear business.

At Harwell we were greeted by the UKAEA Chief Executive, Dr John McKeown, who met with us for an hour and drove us to lunch later that day. We were treated to well-prepared presentations by senior people at all three sites. Dr. McKeown explained to us the importance of maintaining good relations with the local population, and stated that he personally spent one or two days a month in the communities explaining UKAEA activities to the local citizens. At this time, AECL senior executives showed little interest in communicating with the Pinawa residents. Being a politician also allowed me easy access to government ministers on my trips to Ottawa and Winnipeg, and also to talk to other community leaders in Eastern Manitoba.

We returned to Pinawa envious of what other countries were doing and frustrated with our own nuclear industry. Dave Wotton and I each wrote trip reports. Soon after, when AECL presented its Decommissioning plan to the Canadian Nuclear Regulator in November 2002, we both made power point presentations protesting the plan to defer decommissioning. We stressed the safety issue of deferring decommissioning and losing the expertise of workers familiar with the site, and the moral issue of deferring the decommissioning costs to future generations.

About the same time, I was invited to make a presentation at an OECD Nuclear Energy Agency workshop in Ottawa. The theme of the workshop was the relationship between the nuclear industry and the communities hosting that industry. Most countries boasted of strong industry relationships with their local communities but, at that time, AECL was clearly bound to get out of Pinawa as cheaply and as quickly as possible. I said some unkind things about our treatment by AECL and the federal government and was later reprimanded by one of AECL's public affairs staff for criticizing AECL in an international forum. However, I had no choice. I was no longer an AECL employee but was there speaking for the people of Pinawa, and I was expressing their views on the conference theme.

Later, I began to notice subtle changes in AECL's attitude to decommissioning and changes to AECL's relationship with the town. The Liberal government in Ottawa still had not responded to our many proposals, but in the summer of 2006 following a change in federal government, the new minister of NRCan, Gary Lunn, announced a five year budget of over $500 million to address Canada's nuclear legacies. One quarter of that money was targeted for Whiteshell decommissioning. AECL now employs about 300 persons in Pinawa and expects to be continuously decommissioning for the next 20 or more years. We will never know exactly how much our lobbying led to this decision, but we had certainly stayed in the face of the federal government, and with the Conservatives coming to power we made sure our new MP, Vic Toews, was well aware of our situation.

Demise Of The EDAW

In March of 1999 Peter Siemens resigned as Executive Director of EDAW. His relations with AECL were never good, primarily because there was a conflict of interest between AECL's strategy and the goals of EDAW. AECL's first goal, apparently, was to prevent any new occupant at Whiteshell from using the nuclear facilities in competition with them. They had also removed most of the equipment from the site that could have been used even by non-threatening businesses such as mechanical testing. After several attempts to get something going at the site, Peter finally had had enough and resigned. He was replaced by Pat Haney, another Winnipeg businessman. The focus by then was on the creation of an employee-owned business formed out of the Waste Management group, or what was left of it. With a consultant from Ottawa and assistance from AECL, a business plan was developed for spinning out the NWMP. Then in the summer of 2001, AECL decided that the NWMP would stay with AECL and become part of their new Waste Management and Decommissioning program. The board of Directors of the EDAW all resigned in protest and the EDAW was dissolved. Bob van Adel had become CEO of AECL in February of 2001, had cleaned house and installed a completely new executive except for Dave Torgerson and Gary Kugler.

With the end of EDAW, Pinawa's future became totally in our control and in hindsight that was a good thing. It put us in direct communication with AECL (we were never included in meetings between AECL and EDAW even though it was us they were talking about). Things began to improve after that. At a meeting between Council and Bob van Adel we agreed to put the past behind us and move forward. When our community centre needed a new heating system and roof, Dave Torgerson, who was then in charge of the research sites, contributed $800 thousand. The Economic Development Committee of Council merged with the PCDC and, following some strategic planning sessions, set out to market the community as a good place to live and work. Success was slow but steady. Real estate values increased. The first $100 thousand house sale occurred and a year later one sold for over $300,000. Today the market is mostly between $150 and $250 thousand. At the time of AECL's assistance plan, they were selling for $40 to $70 thousand. Every year sees an increase in building permit purchases, not just for new houses, but also for property improvements as people see the value of their property rise.

For years, people wishing to move to Pinawa had to buy one of the few houses on the market or build. Builders were reluctant to come to Pinawa because of the boom in Winnipeg. To address the shortage of houses for sale, PCDC recently formed the Pinawa Housing Corporation to provide new houses for sale. The first one, a ready-to- move (RTM) house, was sold two weeks after delivery to site. Two more are now under construction using a local contractor and labour. We now also have a Pinawa entrepreneur who just brought in three RTM's and has already sold two. Potential residents do not want the headache of building, but will readily buy a new house already in place. Thus by building houses ourselves we are meeting a demand.

Over a decade ago, Rick Backer built an RV campsite just west of town on the Winnipeg River. It quickly became popular with nearly all the sites becoming seasonal. It now increases our summertime population by about 400 and brings more business to our modernized deli-supermarket, now known as the Solo Store, and other local businesses. Several campsite residents have purchased lots or houses in Pinawa or are building new homes. Having camped here they now want to live here year round. We have other residents moving here from across Canada and even Europe.

After the bankruptcy of the former Kelsey House, the building and some waterfront property was purchased from the receiver (for real money) by an eastern Manitoba company and turned into the Wilderness Edge Resort. It specializes in organizing retreats for a variety of groups, including church groups, provincial cabinet meetings, companies and government organizations. They are now operating close to capacity and are considering expansion, plus a sixty unit luxury condo complex. The Kelsey House experience with the Israelis taught us one golden rule. Never sell property for a dollar based on promises from a developer!

Our world-wide public relations campaign to attract home-based entrepreneurs is slowly starting to bear fruit. We advertise Pinawa as a safe environment in an area of natural beauty with all the necessary amenities of a large urban center, including two providers of high-speed internet. Our website "Pinawa.com" is the centre of our marketing campaign and was developed with the help of funding from the community Adjustment Fund.

AECL continues to be a vital part of our community. They are hiring again and expect to be decommissioning the Whiteshell site for at least the next twenty years. The relationship between the company and the town is solid again, but we are no longer seen as being a company town. AECL is once again participating in town events such as the Pinawa parade and sponsoring our website. It remains our goal to diversify further and grow to lessen our dependence on a single company. We believe that having a site that is licensed for nuclear activities and situated on a transmission line corridor to Winnipeg is a real asset, especially with the nuclear renaissance in progress and the interest in Western Canada in going nuclear. For the past three years or so we have been meeting with Manitoba Hydro and the Provincial Government to get them to consider a nuclear power plant at the Whiteshell site, instead of relying on northern rivers with their need for billion dollar transmission lines to the markets of Winnipeg, Western Canada and the northern states. We feel we are beginning to make some progress here.

The suspension bridge was the first section of the Trans Canada Trail built in Manitoba and crosses the Pinawa Channel. The channel was originally named "Pinnowok, an aboriginal word meaning "calm waters", and was used by French fur traders as a safe bypass of the rapids on the Winnipeg River.

Pinawa – The Secret Discovered

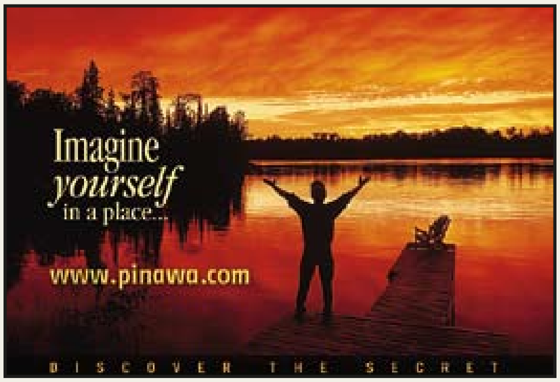
It has been an incredible experience to live in Pinawa during the past decade. The early years were frustrating but with the strong support of the Filmon and Doer provincial governments we survived that period and learned many lessons. The EDAW concept seemed like a good idea at the time, but required the cooperation of two levels of government (at least two ministries on the federal side) and AECL, and the goals were not always focused on the same outcome. Accessing the loan fund was incredibly complex and negotiations were difficult. The absence of the town from the top-level meetings left us unable to bring our desires directly to the table. The demise of the EDAW left the council fully in control of our future and we took control with a passion.

Built by volunteers, the Pinawa Heritage Sundial has become a famous landmark for visitors.

Our community's greatest asset is its volunteers. Early on they designed and built the Pinawa Suspension Bridge across the Pinawa Channel. It was part of the Pinawa section of the Trans Canada Trail, the first section to be completed in Manitoba. At the town centre, they designed and erected the Pinawa Heritage Sundial, which has become our most familiar landmark and is a must-see for visitors to Pinawa. They also organize our annual events such as the Manitoba Loppet, the Pinawa Triathlon, Art in the Garden and the Pinawa Birthday Celebrations, all of which attract outside visitors and participants.

The one government program that was very useful was the Community Adjustment Fund. The $3.5 million was controlled by a committee of local council members and overseen by Western Economic Diversification. About half of the money came to Pinawa projects with the rest going to nearby communities that were also affected by AECL's downsize. Projects funded in Pinawa included the purchase of the Lewis School and converting it to a business centre, a business incubator program, several economic development initiatives, and a grant for the Pinawa Housing Corporation for pre-apprentice training during their building projects. The CAF committee worked together and disagreement was very rare even though several different communities were involved.

What was once seen as a company town located at the end of a 12 Km road is changed forever. In 1998 we took over the AECL highway signs and developed the slogan "Discover the Secret". We now have a growing and diverse population, and an expanding business community. The future looks bright. We have recently changed our slogan to "Imagine Yourself in a Place". The *secret* has been discovered and Pinawa is on the map.



Manhattan Project Redux: Canada and the First Atomic Weapons

by James E. Arsenault, P.Eng.

Ed. Note: There has been a lot of controversy regarding Canada's involvement in the development of the atomic bombs that ended WWII. Many have claimed that there was no Canadian uranium used in the two atomic bombs dropped on Japan but until now, no one has been able to prove it. Jim Arsenault provides here quantitative evidence that demonstrates that it is very unlikely that Canadian uranium was used in those bombs. Jim is a CNS member and frequent contributor to historical reviews of the Canadian nuclear industry.

1. Introduction

Only three nuclear weapons produced by the Manhattan Project (MP) were used during World War II: Trinity Test, New Mexico on 16 July 1945, Hiroshima, Japan, on 6 August 1945, and Nagasaki, Japan, on 9 August 1945.

Several sources and authors, including EM&RL (1967), Stacey (1970), Sanger (1981), and Buckley (2000), have written that it is unlikely that any Canadian uranium was used in the atomic weapons that ended WW II. These sources offer no detailed justification for their conclusion, nevertheless, after analysis of data contained in numerous sources, this article reaches a similar conclusion.

2. The Manhattan Project

"The Manhattan Project was officially established on 13 August, 1942, to develop and construct an operable atomic bomb for military use." (Norris, 2002). The Project was organized by the United States Army Corps of Engineers with a nominal head office in New York City, to manage the Manhattan Engineer District (MED). The production of the weapon was to be based on research and development programs underway in U.S. university and government laboratories. About one year later, on 19 August 1943, the U.K. and Canada were formally brought into the Project via the Quebec Agreement (Eggleston, 1966). Initially, each nation operated their own programs with only limited collaboration, however, after the Agreement the programs were guided by the Combined Policy Committee (CPC), of which Canada was a member.

Regardless of the Agreement, a Canadian company, Eldorado Gold Mines Limited, had for several years supplied refined uranium materials to the nuclear research and development programs of the U.S., the U.K. and Canada.

3. Early Canadian Uranium Mining and Refining Activities

Pitchblende, which is the mineral that has the highest naturally occurring concentrations of radium and uranium, was discovered in 1930 along the shores of Great Bear Lake (GBL) in the Northwest Territories. The discovery was staked for the Eldorado Gold Mines Limited which began underground operations in 1932, and by 1933 the mine was brought into production. A refinery was built at Port Hope, Ontario, to extract radium from the ore shipped from the mine (Griffith, 1967). As a result of radium market disruption caused by WW II, the mine was shut down in 1940 and was allowed to fill with water. However, the war effort subsequently caused a strategic need for uranium in atomic weapons development, so the company was requested to reopen the mine in the spring of 1942 and production resumed.

On 27 January 1944, for reasons of security, the Canadian government acquired the shares of the renamed Eldorado Mining and Refining Limited, and transferred them to a Crown company of the same name and the officers of the company became public servants (Griffith, 1967). Since that time the company was reorganized as Eldorado Mining and Refining (1944) Limited, Eldorado Nuclear Limited, Eldorado Resources Limited and later it was amalgamated into present-day Cameco Corporation, the largest producer of uranium in the world.

4. Fissile Material

The active material from which the weapons were constructed was derived from radioactive uranium (U-235) and plutonium (Pu-239) metals. These materials are called fissile because when their atoms are bombarded with neutrons, they split and release energy and more neutrons. Thus a chain reaction may be initiated at the atomic level which then develops rapidly and produces the huge amount of macroscopic energy associated with atomic weapons. The challenge of weapon design is to generate sufficient destructive energy in a short time before the chain reaction is extinguished, as a result of the fissile material being transformed into non-fissile material. Theoretically only about 15 kg of U-235 or 5 kg of Pu-239 are required to produce weapons with the destructive power achieved in the first atomic weapons (Serber, 1992).

Radioactive U-235 occurs in natural uranium (U-238) at about 0.7% content and it must be increased to weapons grade for use in weapon making. Weapons-grade uranium contains U-235 in the range of 20% to 90% (Regehr & Rosenblum, 1983). Complex engineering issues were associated with the weapons-grade production process. Nevertheless, it was accomplished principally with gaseous diffusion, electromagnetic, and thermal diffusion techniques. After the war, gaseous diffusion became essentially the only means of producing U-235 in the U.S.

Radioactive Pu-239 was produced from the irradiation of natural uranium (U-238) in large, high-powered, water-cooled

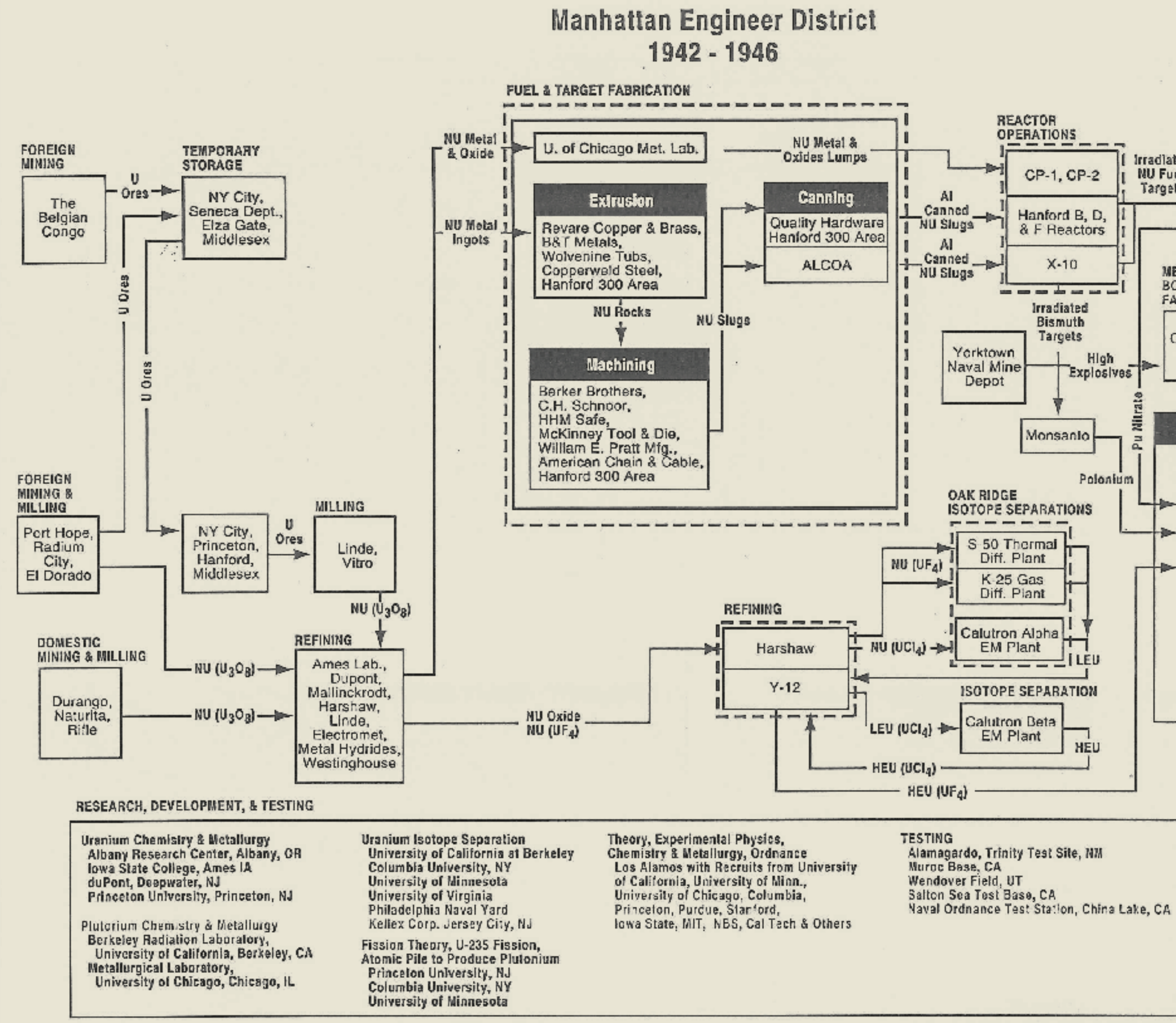


Figure 1 Fissile material processing for the Manhattan Project

graphite pile reactors. In this process, neutrons are slowed sufficiently so that they are, in fact, first absorbed by the uranium atoms. Further nuclear decay reactions result in the production of Pu-239, which is removed by chemical means.

Figure 1 illustrates the rather complicated processes required to produce the necessary fissile material (DOE, 1997).

5. Uranium Oxide Refining

Early in the MP it became clear that the Eldorado refinery at Port Hope was the largest radium and uranium processor in North America. As a result, this facility was fully tasked with manufacturing uranium oxide from Canadian, Belgian Congo and U.S. concentrates for conversion to fissile material in the U.S. Raw material arrived at the refinery in the form of concentrates and was converted into uranium oxide by chemical means. The processing was accomplished by first dissolving the concentrates in acid, then filtering off the insoluble material, carbonate precipitation of other impurities, and caustic precipitation of the uranium, followed by a further upgrading by alternate acid dissolution and ammonia precipitates, and finally a burning or calcination of the common salts to form the 'black oxide'. This material contained about 95% U3O8 (EM&RL, 1967) and eventually the impurities were reduced to less than 1% (Smyth, 1989).

5.1 1942

As noted earlier, the GBL mine was closed in late 1940 and the Port Hope refinery did little uranium refining. The mine was reopened in early 1942 when an order for 60 t (tons) of oxide placed by the U.S. Office of Scientific Research and Development (OSRD) made it economic to do so. This order was completed and was followed by P.O.135 for 350 t. In June the responsibility for weapons development was given to the U.S. Army and it was organized under the MP in September. Slowly it became apparent that the required quantity of oxide for P.O.135 could not be fulfilled from GBL ore. Near the end of the year, after 150 t had been delivered, the refinery began to process high-grade (65% uranium) Belgian Congo ore shipped from stocks in the U.S. The remaining 200 t was transferred to order W-7405-eng-252 (which was originally for 500 t) for a total of 700 t (Kelley, 1945).

Thus Eldorado shipped (60 + 150 =) 210 t of oxide of GBL origin. Eldorado records (PH-1, 1942) show that a total 235.4 t of oxide was produced in 1942 and, therefore, (235.4 - 210.0 =) 25.4 t would have been of Congo origin.

5.2 1943

The production of oxide from high-grade Congo ore continued through almost all the year, with some GBL ore being processed near year-end. Eldorado records (PH-1, 1942) show that the total amount of Congo oxide from high-grade ore shipped at the end of the year was 1216.9 t and, as noted above, 25.4 t was shipped in the previous year. Therefore (1216.9 - 25.4 =) 1191.5 t of Congo oxide was shipped in the year.

Eldorado records (PH-1, 1942) show that a total of 373.5 t of oxide from GBL ore was produced by year-end. As noted above, 210.0 t of GBL oxide was shipped in the previous year and, therefore, (373.5 - 210.0 =) 163.5 t of GBL oxide was shipped in 1943.

5.3 1944

During 1944, 594.6 t of oxide was produced but only a fraction of this was shipped and much of it was from the Congo.

Throughout the entire year GBL and Congo ore was blended for processing, because the uranium content was similar for both types of ore. Of the resulting C-55 oxide, 152.9 t was shipped and it would not be possible to physically separate the oxides by origin in the blended mixture. However, for bookkeeping purposes it is possible to separate them on the basis of ore mix percentage. The ore from GBL averaged 27.09% uranium and the Congo ore averaged 21.07%. Thus the GBL content in the blend would be (27.09 / (27.09 + 21.07 =) 56.25%. Thus the 152.9 t of C-55 oxide of necessity would consist of (0.56 x 152.9 =) 85.6 t of GBL oxide and (152.9 - 85.6 =) 67.3 t of Congo oxide.

Eldorado records (PH-2, 1944) show that two other types of Congo ore also were refined during 1944 and the respective oxides shipped consisted of 38.8 t each of 82-K and 80-K oxide.

5.4 1945

An Eldorado planning schedule (French, 1944) shows that 322.4 t of GBL and 65.3 t of Congo oxide was scheduled to be produced, however, information is not available on the amount actually shipped.

5.5 Summary

The results of the discussion above are captured in Table 1, with the shipments summarized by year and with the GBL and Belgian Congo oxide segregated.

In summary, the refinery processed GBL ore throughout 1942 and a small amount of high-grade Congo ore near the end of the year. Throughout 1943 the refinery processed mostly high-grade ore from the Congo, and some GBL ore at year-end. Throughout

Table 1
Shipments of oxide (in tons) from Eldorado for the Manhattan Project

Year	Oxide specification	GBL origin	Congo origin	Shipments	Remarks
1942	Unknown	60.0			OSRD order
	MD-1-308	150.0			P.O.135
	82-K		25.4		Produced near year-end
	Total	210.0	25.4	235.4	235.4 t produced
1943	82-K		1191.5		
	K-35	163.5			Produced near year-end
	Total	163.5	1191.5	1355.0	1355.0 t produced
1944	C-55	85.6	67.3		Blended oxide
	82-K		38.8		
	80-K		38.8		
	Total	85.6	144.9	230.5	594.6 t produced
1945	12M		65.3		Planned production
	K-35	322.4			Planned production
	Total	322.4	65.3	387.7	Shipment assumed

1944 GBL and low-grade Congo ore was blended and processed but only a third of the oxide was shipped. Also there were batches of low-grade Congo ore processed individually. Early in 1945 blending ceased and, thereafter, only GBL ore was processed.

6. Utilization of GBL Oxide by the Manhattan Project

From the data in Table 1, it is possible to assess acquisition of GBL oxide by the MP. In carrying out this exercise it is important to be aware that by the end of 1943 the oxide accumulated from all three sources (GBL, Belgian Congo, and U.S.) was more than sufficient to fulfill the weapon-making plans of the MP (see section 8). It is also interesting to note that there was a deliberate policy to first utilize foreign oxide (Jones, 1985) which coincides with documentation that most of the oxide shipped in 1943/1944 was refined from Congo ore. These considerations probably explain why the shipments from the refinery apparently were curtailed in 1944 and were restricted to Congo oxide only.

In 1942, 210.0 t of GBL oxide was shipped and most of this would have been used early in the MP research and development program (see section 7). In 1943, 163.5 t of GBL oxide was shipped but only after 1191.5 t of Congo oxide had been shipped. As already noted, by the end of 1943 the oxide accumulated from all three sources was sufficient to fulfill the weapon-making plans of the MP. It is unlikely that any of this GBL oxide was used to produce fissile material. In 1944 very little GBL oxide (85.6 t) was shipped to the MP and it would have been at the end of a long pipeline already filled with oxide from the Congo and the U.S. Therefore, it is unlikely that any of this oxide was used to produce fissile material. The oxide produced in 1945 would have been delivered too late for use in weapons because the fissile material production cycle is estimated to take about six months.

It appears that only the GBL oxide shipped in 1942 (210.0 t) had the potential to be utilized for the production of fissile material by the MP. This is examined in more detail in sections 7 and 8.

7. MP Research and Development

Initially, the MP was engaged in extensive R&D conducted in government and university laboratories. Eventually, it transitioned to a production environment and finally to deployment in the form of atomic weapons. Although oxide used in the project came from three sources, GBL was first in the pipeline throughout 1942, followed by Belgian Congo oxide in 1943/1944.

The first major research milestone took place at the University of Chicago in December 1942 when the reactor known as CP-1 went critical. It was constructed from 41.9 t of uranium oxide and 6.2 t of uranium metal originating from GBL oxide (Smith, 1989; Rhodes, 1986). The metal was converted in the U.S. from Eldorado oxide. In 1943, CP-1 was moved and slightly expanded to become CP-2 (Glasstone, 1950; Hewlett and Anderson, 1962). It is assumed that this would require 10% of additional material, i.e., 4.2 t oxide and 0.6 t metal, all derived from GBL oxide. Note that uranium metal can be expressed in terms of oxide using the ratio of their atomic weights, i.e., 0.848.

The second significant research milestone took place at Oak Ridge, Tennessee, when the X-10 reactor (1 MW, air-cooled, using uranium metal and graphite) went critical near the end of 1943. This reactor supplied small quantities of Pu-239 for experimentation throughout 1944, until Pu-239 became available in large quantities from the production reactors at Hanford, Washington. Assuming an average loading of 36 t of uranium metal and a throughput of 1/3 t per day, yields a consumption of (36 + (1/3 x 365) =) 157.7 t. (Hewlett and Anderson, 1962). Essentially all of this uranium would be supplied from Eldorado oxide as it was the first through the pipeline. Little or no Pu-239 from the X-10 reactor would have ended up in an atomic weapon and, even if it did, it would have been used in the Trinity Test.

There were three other research reactors which all went critical in 1944. By that time all of the GBL oxide would have entered the R&D program. These reactors were H-305 (Hewlett and Duncan, 1969), CP-3 (Dahl, 1999), and Water Boiler (Hewlett and Duncan, 1969).

In addition to the above research reactor programs, mostly associated with production of Pu-239, there were three others involved with U-235 production from natural uranium, i.e., thermal (S-50), gaseous diffusion (K-25) and electromagnetic (Y-12). All had associated pilot plants constructed. A nominal amount of 5.0 t of oxide is allocated for the S-50, K-25 and Y-12 pilot plants. Production plants based on these methods eventually provided the sought-after U-235. However, early in the MP emphasis was on Pu-239 because it appeared to offer a clearer practical path to fissile material, even though the manufacturing process consumes much larger amounts of oxide compared to the other three methods. Natural uranium contains 0.7% of

Table 2
Oxide utilization (in tons) for early R&D in the Manhattan Project

Reactor	Date	Oxide	Metal	Total oxide	Remarks
CP-1	Dec.42	41.9	6.2		World's first operating reactor
CP-2	Mar.43	4.2	0.6		CP-1 rebuilt, CP-2 slightly larger
X-10	Nov.43		157.7		Pu-239 pilot plant
S-50, K-25, Y-12	42/43	5.0			U-235 pilot plants
Total used		51.1	164.4	245.4	Metal converted to oxide
GBL oxide				210.0	Produced in 1942

U-235 so that one ton of oxide contains (2000 x 0.848 x 0.07 =) 119 lbs (54.0 kg) of U-235, which is enough fissile material for the manufacture of several atomic weapons. As the early projects faced difficult technical problems only small amounts of U-235 were produced for laboratory experiments.

The above discussion is captured in Table 2, which shows the amounts of uranium metal and oxide used by the early MP R&D projects.

Table 2 shows that the amount of oxide consumed early on by the MP R&D projects was about 245.4 t. The amount of GBL oxide available was 210 t and it would, therefore, have been consumed completely in the R&D program so that little (if any) GBL uranium ended up in the MP production program which provided fissile material. Any oxide deficit would have been made up by oxide from the Belgian Congo and/or the U.S.

8. MP Production Program

The goal of the production program was to provide sufficient fissile material to produce atomic weapons. For Pu-239 this was accomplished at Hanford by three large reactors and for U-235 at Oak Ridge by a chain of plants using different separation methods.

The three 250-MW reactors (B, D, F) at Hanford were of the uranium metal, graphite, water-cooled type and were each designed to produce 0.25 kg of Pu-239 daily when loaded with 200 t of uranium. The Pu-239 was subsequently removed from the metal by chemical means. Most of the fissile material used in the MP weapons was produced by the B reactor, with an unknown amount supplied by the D reactor; the F reactor was kept on standby. The reactors started to deliver production quantities in late 1944 and there was time before the end of the war for the B reactor to consume about two metal loads and one load each for the others. The total metal used would, therefore, be 800 t or (800 / 0.848 =) 943.4 t of oxide (Groves, 1962; Hewlett and Anderson, 1962).

The chain of plants used for U-235 separation were S-50 (thermal diffusion), K-25 (gaseous diffusion), and Y-12 (electromagnetic) with one plant feeding another in that order (Nichols, 1987). The gaseous diffusion plant was designed to produce 1.0 kg per day using uranium hexaflouride gas and it is estimated that about 125 t of oxide would be required to run the plant for six months, which is the period of interest (Hewlett and Anderson, 1962). Because the production is serial, 125 t would be consumed in the entire production process.

Thus the entire production program would have required a total of (943.4 + 125 =) 1068.4 t of oxide, which is less than all the oxide produced by Eldorado at the end of 1943. There would be additional oxide available from vanadium ore mined in the U.S.

9. Conclusion

The Allies were successful in terminating WW II on V-J day, 14 August 1945, after the use of two atomic weapons against Japan. Thus the mandate of the MP was fulfilled. Because of the close association of Canada with the MP, there has always been a concern that Canadian uranium was present in those weapons. The above analysis shows that this is highly unlikely as the GBL uranium available to the MP was most probably consumed entirely by the R&D program and, therefore, none was available for the weapon production program.

However, it must be stated that the fissile material in the Nagasaki weapon was almost certainly derived from oxide processed by Eldorado (Bernstein, 2001) which would have been mostly of Belgian Congo origin. The same is probably true for the Hiroshima weapon. It is also possible that there was some uranium of U.S. origin in both of these weapons.

It was not until 19 July 1946 that Eldorado finally delivered the last of the 700-t order for GBL oxide, under order W-7405-eng-252, long after it was placed in 1943 (Ross, 1946).

10. Acknowledgments

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Implementation of a Comprehensive Program to Deal with Canada's Nuclear Legacy Liabilities: A Progress Report

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Abstract

In 2006, the Government of Canada adopted a long-term strategy to deal with the nuclear legacy liabilities that have resulted from 60 years of nuclear research and development in Canada. These liabilities are largely located at Atomic Energy of Canada Limited's (AECL) sites and consist of shutdown research buildings, prototype and research reactors, a variety of buried and stored wastes, and contaminated lands. Implementation of the program is being coordinated with on-going operations. Key accomplishments during the first two years of a five-year funded program will be presented, highlighting the progress in addressing health, safety and environmental priorities and in laying the groundwork for the upcoming phases of the strategy.

1. Introduction

The Government of Canada's nuclear legacy liabilities have resulted from 60 years of nuclear research and development (R&D) carried out on behalf of Canada by the National Research Council (1944 to 1952) and Atomic Energy of Canada Limited (AECL, 1952 to present). These liabilities are largely located at AECL sites and consist of shutdown research buildings, prototype and research reactors, a variety of buried and stored wastes, and contaminated lands. The shutdown buildings and contaminated lands need to be safely decommissioned to meet federal regulatory requirements, and long-term solutions need to be developed and implemented for management of the wastes. More than half of the liabilities are the result of Cold War activities during the 1940's, 1950's and early 1960's. The remaining liabilities stem from R&D related to medical isotopes and nuclear reactor technology, as well as national science programs.

About 70 percent of the liabilities are located at AECL's Chalk River Laboratories (CRL) in Ontario, and a further 20 percent are located at AECL's Whiteshell Laboratories (WL) in Manitoba. The remaining 10 percent relate largely to three shutdown prototype reactors in Ontario and Quebec, which were key to the developmental stage of Canada's CANDU®[3] reactor technology.

The inventory of legacy waste includes spent fuel, high-level, intermediate-level and low-level solid and liquid radioactive wastes, and wastes (largely contaminated soils) from site clean-up work across Canada. In many cases, due to past practices of limited waste conditioning and characterization, unique and potentially costly solutions will be required to recover, handle and process the wastes.

In 2006, the Government of Canada adopted a new long-term strategy to deal with the nuclear legacy liabilities over a 70-year period, at an estimated cost of $6.8B (2005 Canadian dollars). The objective of the Nuclear Legacy Liabilities Program (NLLP) is to safely and cost-effectively reduce the nuclear legacy liabilities, and associated risks, based on sound waste management and environmental principles. The program was initiated in 2006 April with a 5-year, $520 million plan, and is being implemented through a Memorandum of Understanding (MOU) between Natural Resources Canada (NRCan) and AECL. Under the MOU, NRCan is responsible for policy direction and oversight, including control of funding, and AECL is responsible for managing the NLLP and executing the work. A Performance Measurement Strategy is in place to assess program performance against the objectives and goals for the 5-year plan.

2. Five-Year Implementation Plan

AECL had been performing decommissioning activities on its sites since the early 1990's, but the slow rate of progress, and the increasing requirements, as structures continued to age and remediation needs were identified, meant that a more structured approach, and increased levels of funding, would be required. The long-term strategy was initiated in 2006 with a 5-year startup phase that focuses on:

- addressing immediate health, safety, and environmental (HSE) priorities;
- accelerating the decommissioning of shutdown buildings; and
- laying the groundwork for subsequent phases of the strategy,

while continuing necessary care and maintenance activities to maintain the liabilities in a safe state until they can be fully addressed in subsequent phases of the program.

The five-year implementation plan was developed to be consistent with the regulatory commitments and priorities embodied in the CRL Comprehensive Preliminary Decommissioning Plan (CPDP) [1] and the WL Comprehensive Study Report (CSR) [2].

Implicit in developing the long-term strategy and the five-year plan were the following considerations:

- The need to comply with regulatory requirements, which include, for example, Canadian Nuclear Safety Commission

1 Atomic Energy of Canada Limited, Chalk River, Ontario and Pinawa, Manitoba

2 Natural Resources Canada, 580 Booth Street, Ottawa, Ontario

3 CANDU is a registered trademark of Atomic Energy of Canada Ltd. (AECL)

(CNSC) licenses, the Nuclear Safety and Control Act (NSCA), the Canadian Environmental Assessment Act (CEAA), and the Fisheries Act. This would include commitments on reporting results from environmental monitoring programs, maintaining CNSC license commitments, and meeting the requirements of existing AECL Nuclear Compliance Programs (Environmental Protection, Radiation Protection, Occupational Safety and Health, Security, etc.).

- The need to address immediate HSE priorities while maintaining flexibility to manage emerging issues. A significant portion of the liability in the NLLP resides with wastes that were buried and stored over the last six decades at the CRL. These wastes include both liquid and solid wastes that do not meet present day standards for their management. During the 5-year start-up phase, significant priority is being placed on addressing the liquid wastes. Liquid wastes are a high priority because of the risk they pose from a leak potential.
- The need to assess, early in the strategy, wastes which require recovery versus those that can remain in situ. In particular, large volumes of very low-level radioactive wastes had been buried at CRL. If they require recovery, processing and long-term management, facilities would need to be sized accordingly.
- The generally long timeframes (5-10 years) associated with the definition of requirements, design, licensing, construction and commissioning of new facilities required to process, characterize and store the wastes from building decommissioning and waste recoveries, required that these activities be initiated early in the strategy. The NLLP facilitated several of these "enabling" facilities to be initiated in parallel.

In addition to detailed milestones associated with the objectives given above, high-level program outcomes have been established. These include achieving reductions in uncertainties, risks and liabilities, improved on-site safety and environmental conditions and, increased stakeholder awareness and understanding. The longer-term strategy (beyond the approved 5-year plan) is also being refined and further developed, incorporating the lessons learned from implementation of this first 5-year part of the strategy, changing priorities and other pertinent information from this program and other relevant international programs.

A Joint NRCan – AECL Oversight Committee, chaired by NRCan, plans, reports and delivers the 5-year plan. NRCan represents the interests of the Federal Government, providing policy direction, overseeing implementation, ensuring value for money, transparency and accountability, and providing for public consultations to inform the further development of the long-term strategy. AECL identifies priorities, develops annual plans, implements the work and reports on approved activities. As part of its responsibilities, AECL ensures regulatory compliance and safety, and holds and administers licences, facilities, lands, materials and other asset responsibilities, related to the nuclear legacy liabilities.

Recognizing its importance, and to ensure a sound basis for decision-making on future phases of the strategy, public consultations are an important component of the 5-year start-up phase. Consultations will be conducted in local communities, in parallel with the waste management and decommissioning work being conducted. Consultation plans, and tools, focused on the integrated program, are being developed to inform the public on the long-term strategy and next steps.

3. Progress to Date

3.1 Chalk River Laboratories

3.1.1 Waste Management – Enabling Facilities

In order to execute the program strategy, a number of new facilities are needed to allow the decommissioning activities themselves to proceed. These "enabling facilities" include those needed for waste characterization, processing, conditioning, treatment, packaging and storage— for both existing waste already in storage and waste produced as a result of the decommissioning and remediation activities.

Projects associated with the design and construction of two major enabling facilities are underway to address *immediate health, safety and environmental (HSE) priorities* and reduce risks at AECL's Chalk River Laboratories site. These enabling facilities will provide modern replacement storage facilities, and meet current-day standards for high-hazard wastes currently stored in facilities close to the end of their useful life.

The Liquid Waste Transfer and Storage (LWTS) Project involves the design, licensing, construction and commissioning of a new liquid waste storage facility for approximately 300,000 litres of legacy liquid waste, which includes high-level radioactive waste from medical isotope production and fuel reprocessing experiments. These liquids are currently stored in 21 tanks built in the 1940's, 1950's and 1960's. The Project scope is divided into two major engineered systems: a Waste Storage System (WSS), and a Retrieval and Transfer (R&T) System. Conceptual design activities, and an Environmental Assessment Screening Report, have been completed. The design of the WSS will be completed in early 2008. Related activities include preparing the existing tanks for the transfer process, addressing tank specific details on access for liquid, and sludge recovery and tank rinsing.

The Fuel Packaging and Storage (FPS) Project involves the design, licensing, construction and commissioning of a facility to store used research reactor fuel, and the associated fuel drying and repackaging equipment and operations. The facility is designed to store the older, experimental fuels from approximately 100 tile holes (existing structures used to store all used research reactor fuel at CRL) with the most problematic and degraded fuel and storage conditions.

The Environmental Assessment Study Report was completed and submitted to the CNSC in 2006, and the detailed design of the storage system and transfer equipment is well underway. A safety analysis is being prepared to support the licence-to-construct application. Field investigations continue to be carried out on the tile holes to support future transfer operations. Remediation activities, such as tile hole dewatering, weather shields and seal maintenance continue for the oldest tile holes with failed seals, to ensure the safety of the stored fuel until it can be transferred.

In terms of *laying the groundwork for subsequent phases of the strategy*, a key accomplishment of the program has been the construction of the Waste Analysis Facility (WAF). The WAF will play a major role in the effective segregation of building decommissioning and remediation materials into radioactive and non-radioactive waste streams. The WAF, a large warehouse-like structure designed to receive the wide variety of expected decommissioning wastes, provides confirmation that 'likely clean' waste, designated as ready for clearance as non-radioactive waste, is below the acceptable waste release limits and safe to leave AECL property.

3.1.2 Decommissioning of Shutdown Buildings

Over the past two decades, AECL undertook a modest program of removing redundant, unoccupied buildings, as funding allowed.

During this time, it continued to monitor, maintain and repair shutdown buildings as their hazards and risks required. The costs to ensure that these buildings remain in a safe and compliant state, long after their useful life cycle, and until they are demolished, can be substantial. The older, wood-framed buildings can also present substantial risks, particularly those used in the 1940's – 1950's for programs related to fuel reprocessing.

At the time of initiating the NLLP, twenty buildings were in various stages of decommissioning. Work is in progress to transfer an additional 27 buildings from active use to decommissioning over the five-year NLLP program, as AECL implements its site renewal program to move staff and equipment to newer facilities. There is a formal transfer process of an active, in-use building to decommissioning, involving safe shutdown, preparation for storage-with-surveillance, dismantling or demolition, and then completion of the decommissioning process, either returning the building or the site for reuse.

Within the past two years, two major buildings were demolished: one the former "plant hospital" and the other a 12,000 m^2 radioisotope laboratory building in use since the late 1940's (see Figure 1). Demolition can produce a large amount of construction materials as waste. Building and equipment surveys, and treatment of some materials to remove the contamination, resulted in significant quantities of waste cleared for recycling and reuse, or sent to local landfills. These activities help to minimize the quantity of waste requiring long-term management within the radioactive waste management areas on site.

Current decommissioning activities include the removal of a large radioactive liquid storage tank and a section of the National Research Experimental (NRX) reactor fuel pond superstructure.

Before **After**

Figure 1: Photos showing Building 107 Radiochemical Laboratory (before) at the CRL site, and the footprint to be returned for reuse (after) for other site operational activities.

The large storage tank decommissioning work includes the safe shutdown of the tank, which involves the removal of residual material remaining in the tank, and the removal of its liner. A second work program is the decommissioning and removal of two small buildings, and a portion of another, to create a fire-break between old, wooden buildings and the NRX reactor. Activities include the removal of contaminated water from a portion of the NRX reactor fuel bays that contributed to a source of groundwater contamination, and covering of the emptied bays, prior to the actual demolition of the portion of the wooden building.

Surveillance and monitoring of the ~20 buildings in the "storage with surveillance" mode, including the NRX reactor building, also continues to ensure safety and compliance with approved requirements. While these care and maintenance costs, and those associated with site monitoring, are a significant portion of the program costs at all sites, they are essential to ensuring the protection of the health and safety of employees, the public and the environment.

3.1.3 Environmental Remediation

Another component of the program *addressing immediate health, safety, and environmental priorities* is to reduce risks associated with environmental contamination of CRL lands. Over six decades of operation at CRL have left environmental footprints on the wetlands and forests of the 3,700 ha of AECL property, from the original construction campsite, experimental programs and waste burials. Various activities have been undertaken to reduce both risks and liabilities, ranging from recovery of discrete historic waste burials, waste removal and treatment, groundwater treatment, and improved groundwater monitoring. In particular, field activities and analyses have allowed completion of the following:

- Disposal of legacy liquid isotope production wastes. This activity involved the disposal of ~ 2,000 separate containers of mixed liquid wastes (oils and solvents with radioactive contamination) that were being stored on the surface of one of the closed waste management sites. Approximately 70,000 litres were analyzed, re-bulked, and shipped offsite for incineration in the United States.
- Remediation of the Glass Block Test Sites. Fifty-two glass blocks were recovered from two experimental sites and transferred to the secured storage of the CRL's Waste Management Areas. These blocks were part of an experiment dating back to 1958 to study fission product leaching rates into the water table from vitrified fuel reprocessing waste.
- Removal of the Field Scale Lysimeter Test Facility. This was an underground installation used to research radioactive contamination migration from buried waste packages through different buffer materials. The lysimeter waste packages were removed, analyzed and shipped offsite for disposal.
- Recovery of NRX fuel rods from Waste Management Area A. Thirty-three irradiated NRX fuel rods and pieces buried in wooden crates following the NRX accident in 1952 were recovered. The fuel was re-packaged in fuel cans and moved to modern tile holes for storage.

- Remediation of the Solvent Bunkers. These 40-year old concrete bunkers located in one of CRL's waste management areas housed 30 drums containing mixed contaminated waste solutions generated from tank rinses. To date, 24 drums have been fully assessed and disposed of offsite.

(a) (b) (c)

Figure 2: Removal of the Lysimeter Test Facility (a) excavation of the lysimeters (b) waste bales removed, and (c) site remediation following decommissioning activities.

Groundwater treatment systems have been in operation at the CRL site for the past decade, removing radionuclide contaminates such as Sr^{90} from plumes originating from the waste management areas. As part of the NLLP, these systems are being upgraded and design of a fourth groundwater treatment system has been started, to help ensure continued mitigation of potential environmental impacts for the longer-term.

The groundwater monitoring program conducted on the CRL site has been enhanced over the past two years, with an increase from 100 to 160 boreholes, and sampling for non-radiological contaminants as well as radiological contaminants [3]. The enhanced program, in conjunction with other existing environmental monitoring programs on site, will result in improved identification of contaminant plumes, and aid in the development of more effective remediation strategies. The monitoring of environmental performance will also ensure that the detailed strategy for remediating the affected areas of the CRL are carried out in a risk-prioritized manner, and that any changes in performance are reflected in periodic updates of the priority-sequenced activities within the long-term strategy.

Enhanced environmental monitoring and remediation activities have extended to the Ottawa River. The shoreline and river bed sediments downstream of the CRL site are being sampled and analyzed as part of an increased monitoring program. This information is being used to develop strategies to minimize any potential ecological impact on the Ottawa River as a result of early operations of the CRL site.

3.2 Whiteshell Laboratories

Whiteshell Laboratories (WL) is a Nuclear Research and Test Establishment in Eastern Manitoba, operated by AECL since the early 1960s, which is now under decommissioning. WL occupies approximately 7,000 ha of land and employed more than 1000 staff up to the mid1990s. Nuclear operations carried out at WL included a research reactor (WR-1), hot cell facilities, waste management, reactor safety research, nuclear materials research, accelerator technology, biophysics, and industrial radiation applications. In preparation for the execution of the WL Decommissioning Project (WLDP), an environmental assessment was successfully completed at the Comprehensive Study level [2]. In 2002, the Canadian Nuclear Safety Commission issued a decommissioning license for WL - the first decommissioning license issued for a Nuclear Research and Test Establishment in Canada. Decommissioning is now well underway, focusing on decontamination of nuclear facilities, laboratories and associated service systems, removal of redundant non-nuclear buildings and preparation of redundant nuclear buildings for full decommissioning. An aggressive decommissioning strategy is in place, with decommissioning of all site facilities and infrastructure, with the exception of the reactor and the Waste Management Area (WMA), and construction and operation of the enabling facilities to facilitate decommissioning, scheduled to occur in the period leading up to 2024.

The photographs in Figure 3 illustrate the buildings planned for decommissioning and demolition by 2008 and 2015. Red circles signify non-nuclear buildings which will be demolished by end of 2008, the yellow circles identify operating nuclear facilities slated to complete decommissioning and demolition by 2015. Post 2015, decommissioning activities will be focused on WMA upgrades and remediation and planning for WR-1 final decommissioning. Decommissioning the WR-1 reactor, WMA storage structures, and the Shielded and Enabling Facilities, will start in about 2024, with a completion schedule dependant on the availability of approved disposal facilities for the stored wastes.

2008 2015

Figure 3: Photographic illustration highlighting the buildings planned to be decommissioned at the Whiteshell Laboratories by 2008 and 2015.

3.2.1 Decommissioning of Shutdown Buildings and Facilities

A number of redundant buildings and building systems have been decommissioned, or are scheduled for decommissioning, as per Table 1 below. A significant activity is the decommissioning of a major portion of the Building 300 R&D Complex, which comprises, in total, five-hundred and sixty-seven (567) rooms, offices, radioisotope laboratories, hallways, crawl spaces, stairways and penthouses and the Shielded Facilities.

The general work plan being followed for decommissioning the radioisotope laboratories is described as follows:

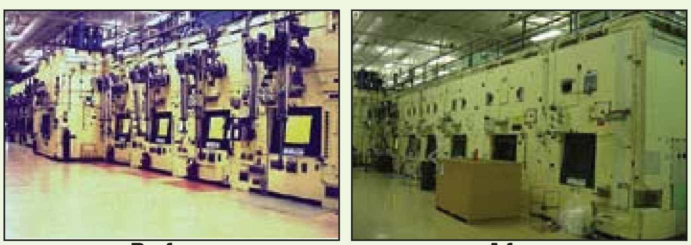
- Operational Shutdown – removal of all loose materials not attached to the building structure;
- Active Drain System Removal – removal of all active drain collection piping from the labs and work areas down to the point they leave the building;

Table 1: List of WL Buildings Currently Under or Scheduled for Near Term (<10 years) Decommissioning.

Building	Description	Footprint Area	Status
500 / 530	Internal Friction Vibration Studies Lab	~ 50 m2 ea.	Removed & site remediated
406	Cafeteria	~ 860 m2	Demolition complete site remediation remains to be done
400	Administration & Engineering	~ 915 m2	Demolition underway
300	Radioisotope Laboratory	~ 4600 m2	Dismantlement / decontamination of internal laboratories underway
300 – Shielded Facilities	Hot / Warm Cells and Associated Support	~ 2500 m2	6 of 13 Hot Cells stripped and out of service, Warm Cells decommissioning underway, decommissioning of selected equipment complete
200	Active Liquid Waste Treatment Centre	~ 420 m2	Currently in operation
411	Decontamination Centre	~ 600 m2	Currently in operation

- Dismantle & Decontaminate – removal of all counters, cabinetry, ceiling tiles, floor tiles and ventilation devices such as fume hoods (not including the ventilation header ducts or fan systems);
- Active Ventilation System – removal of all active exhaust ventilation system components;
- Release Survey – confirmatory radiological survey demonstrating the building shell is free of detectable contamination and ready for demolition;
- Demolition – removal of the now radiologically clean building shell; and
- Site Remediation – remediation of the former building site to make it match with the surrounding natural environment.

Buildings with no history of use of radioactive materials are treated much the same as those with a known radiological history, less the steps to clean up and remove the contaminated materials.



Before **After**

Figure 4: Decommissioning of Hot Cells #6-10 (Before & After) in the WL Shielded Facilities.

A wing of the Building 300 R&D complex is designated as the Shielded Facilities (SF). The SF includes a suite of 12 hot cells, previously used for a variety of fuel and material testing experimental programs. Of these, Cells 1 through 5 will remain operational, particularly for anticipated Waste Management Area remediation activities. Cell 12 has been decommissioned and physically removed. Cells 6 through 11 have been partially decontaminated and external services and manipulators removed (see Figure 4). The hot cells are currently anticipated to be dismantled following WR-1 final decommissioning.

3.2.2 Environmental Assessment Follow-Up Program (EAFP)

During the Environmental Assessment, several areas for follow-up monitoring were identified to verify the validity of the CSR conclusions. These included fitness-for-service assessments for the radioactive and non-radioactive material storage and disposal facilities and environmental monitoring of key areas to verify there is no impact from the decommissioning activities. Under the EAFP for the WLDP, the following activities have been recently carried out. A Fitness-for-Service assessment methodology has been developed for application to the Waste Management Area, lagoon and landfill. In parallel with this initiative, fitness assessments have been carried out on the structural integrity of the Waste Management Area storage bunkers and the lagoon system components. Over one hundred new ground-water monitoring wells were drilled and monitoring instrumentation was installed. Baseline radiological data has been collected and analyzed for assessment of the radiological conditions in river bottom sediments at three target areas on the Winnipeg River. The communication initiative has been continued with Manitoba Stakeholders, as part of the ongoing public consultation program.

3.2.3 Waste Management – Enabling Facilities

As the initial decommissioning activities take place, facilities are being constructed to enable later stages of decommissioning, particularly to deal effectively with the wastes generated from those activities. Enabling facilities include the Waste Handling Facility (WHF), the Waste Clearance Facility (WCF), and new waste storage structures in the existing Waste Management Area based on the Shielded Modular Above Ground Storage (SMAGS) concept used by Ontario Power Generation and CRL. Planning is also underway on waste management improvements for wastes already in storage.

Figure 5 provides a flow sheet that captures the WL waste management strategy. The WHF, which is currently being established, is designed to allow crews to minimize the volume of radiologically contaminated waste generated as part of decommissioning activities, and destined for the Waste Management Area. The WCF, already established in an existing building at WL, is set up to facilitate the clearance monitoring of "likely clean" waste for unrestricted release. Decommissioning wastes are radiologically screened and segregated at the source into "Likely Clean" and "Presumed Active" (contaminated) categories.

Likely Clean waste is monitored for clearance either at the source or at the WCF. Cleared materials are segregated and dispositioned as either recyclable, reusable, landfill or hazardous materials after final confirmation monitoring with a bulk material freight/cargo monitor at the material handling building. Materials identified as contaminated during clearance monitoring are sent to the WHF for processing.

Presumed Active materials are inventoried and sent to the WHF for decontamination, volume reduction, packaging and radiological characterization. Decontaminated materials are sent to the WCF for clearance monitoring. Contaminated materials are sent to the WMA for storage.

Over the next 15 years, material processed by the WCF is estimated to be up to 5000 m^3 per annum. Material processed by the WHF, over the same time period is averaged at approximately 700 m^3 per year.

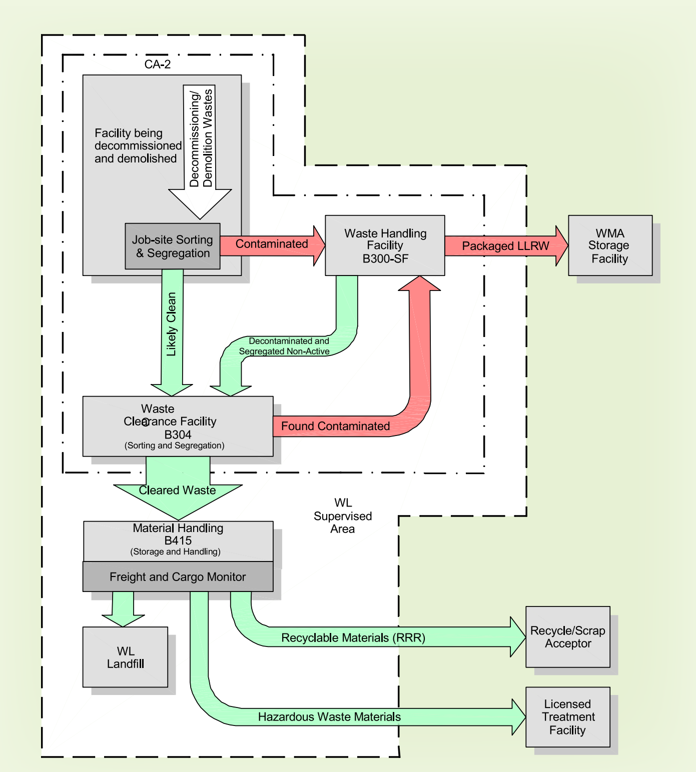


Figure 5: Waste management flow sheet used for decommissioning/demolition wastes at WL.

3.2.4 Underground Research Laboratory (URL) Decommissioning

The NLLP activities at WL include a closure project for the URL, which was used to research and investigate the technical feasibility, techniques and methodologies for deep geological disposal of nuclear wastes. The URL was closed in 2003 and, following removal of experimental equipment was put into a safe shutdown state in 2005 December. With the funding provided through the NLLP, the URL final closure activities commenced, following standard provincial mine closure requirements. For this work, NRCan is conducting a screening-level Environmental Assessment under the CEAA. Closure of the URL surface overburden borehole network was completed in 2006 November, packer system removal and sealing of the underground borehole network is near completion, and surface bedrock borehole packer system removal and sealing operations are planned to commence in 2008. The removal of furnishings and services on the 240 and 420 Levels will be completed in the summer of 2008, prior to commencing removal of furnishings and services from the main shaft in the fall of 2008. Bulkheads will be placed on the main shaft and ventilation raise surface openings by 2010, completing the permanent closure of the URL.

3.3 Prototype Reactors

Storage with surveillance activities associated with three, shutdown prototype reactors are part of the NLLP: the NPD (Nuclear Power Demonstration) and Douglas Point in Ontario, and Gentilly-1 in Quebec. Gentilly-1 was the first facility to be put into a safe shutdown state in the 1980s—the fuel, heavy water and most other hazardous liquids were removed. Similar activities were conducted for Douglas Point and NPD and both reactors placed in the "storage with surveillance" phase in the early 1990s.

The primary activities at the three reactors are regular inspection and monitoring, in accordance with the main purpose of the storage with surveillance phase which is to control hazards. Operating systems such as sump pumps and fire alarm systems are inspected, tested and maintained. Structural components of the facilities are also inspected and maintained. Necessary activities, such as roof repair and updating of remote monitoring systems, are carried out to ensure adequate control of the hazards still inherent in the facilities. As these facilities contain radioactive materials, they are presently licensed by the CNSC as waste management facilities. The storage with surveillance phase is currently envisaged to be ~30 years or longer. A major factor influencing the length of the storage with surveillance phase is the availability of long-term waste management facilities for all of the waste types, including that of the used fuel.

3.4 Laying the Groundwork for Future Phases of the Strategy

The objective "*29th Annual Conference of the Canadian Nuclear Society 32nd CNS/CNA Student Conference* is incorporated into many of the activities discussed above for both the CRL and WL sites, particularly as they relate to the construction of improved waste handling and characterization facilities, and additional waste storage facilities, to deal effectively with the wastes that are generated during building decommissioning and environmental remediation activities and, importantly, those wastes requiring long-term management.

In addition to these activities, a number of studies and design work are being initiated to better define the waste processing, treatment and long-term management facilities necessary to deal with the wide variety of legacy waste types that exist at all AECL sites. These studies will help define the shielded facility requirements for waste handling, the volume reduction and waste immobilization techniques, the extent to which buried wastes can be managed in place over the long-term, and the options for the long-term management of the wastes that need to be recovered and treated. Of note, is the initiation of a feasibility study to evaluate the potential suitability of the CRL site geology for a deep repository for the long-term management of AECL's inventory of low-level and intermediate-level solid radioactive waste. To support this study, existing geological information has been compiled, a monitoring network for micro-seismic activity installed and the first of five planned boreholes drilled to obtain new data on fractures and groundwater salinity with depth (to 900 m) and other geochemical data to assess the local geology.

The next phase of the strategy will be developed based on the results of this current 5-year program, utilizing the results of field activities, design/feasibility studies and program costs and schedules, to identify priorities in concert with risks and begin implementation of those activities focused on providing long-term security of the environment.

4. Summary

The establishment and implementation of the NLLP by the Government of Canada is allowing significant progress to be made on nuclear legacy liabilities. The current 5-year start-up phase is addressing immediate health, safety and environmental priorities, as well as providing the facilities, studies and plans required to advance the program in the following years.

5. References

[1] Dolinar, G.M., "Comprehensive Preliminary Decommissioning Plan for AECL's Chalk River Laboratories", CPDP-01600-PDP-002, 2006 February.

[2] "Whiteshell Laboratories Decommissioning Project - Comprehensive Study Report", Volume 1-3, 2001.

[3] Audet M.C., R. Silke, C.A. Wills, R.W.D. Killey, S.J. Welch and A. Denby, "CRL Groundwater Monitoring Program Annual Report for 2006, AECL Annual Report", 3611-01612-REPT-005, 2007 December.

Steam Generator Replacement At Bruce A: Approach, Results, & Lessons Learned

by W. Tomkiewicz, B. Savage, and J. Smith[1]

*[**Ed Note:** The following paper was presented at the 29th Annual Conference of the Canadian Nuclear Society, Toronto, June 1-4, 2008]*

1. Introduction

Steam generator replacements (SGR) have been performed at nearly 100 nuclear power plants throughout the world. However, the steam generators (SG) replaced at Bruce A, Units 1 and 2, were the first for any CANDU plant. Because of Bruce A's unique reactor containment design and steam generator arrangement, SNC-Lavalin Nuclear faced a number of significant technical challenges for successfully completing the replacement. Bruce A is the only CANDU plant with an arrangement of bulbless steam generators connected to a horizontal, integral steam drum. The steam generators also pass through the containment boundary in the reactor vault ceiling. Because of its unique design, it was determined that previous approaches developed for the replacement of steam generators in Pressurized Water Reactors (PWR) would not be feasible, if used directly. To meet this challenge, a unique approach and methodology was developed for the Bruce A SGR project, which adapted certain PWR technologies specifically for this purpose.

This paper describes the unique approach and methodology for the Bruce A steam generator replacement as developed by SLN. The work at Bruce A was essentially completed when the last steam drum was lifted into position on February 3rd, 2008.

2. Replacing the 16 Steam Generators in Two Bruce A Reactors

The layout and geometry of the Bruce A nuclear reactors is as shown in Figures 1, 2, and 3. There are two sets of steam generators connected to each reactor. Each SG set consists of four lower sections connected to one horizontal steam drum (SD). Each SD is 30 m long, 2.9 m in diameter, and weighs 250 tonnes. Each steam generator lower section is 12 m long, 2.4 m in diameter (narrowing to 1.75 m at its upper end), and weighs 100 tonnes. The fundamental reason for replacing the steam generators is the corrosion of the internal steam generator tubing. Since all the internal tubing is contained in the lower SG sections, those assemblies must be replaced. However, the steam drums are not affected and can be re-used.

The reactors at Bruce A have a unique containment design (see Figure 3). Only the lower part of the reactor building (which houses the reactor, feeder assemblies and PHT piping, the lower

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end of the PHT pumps, the lower end of the steam generators, the pressurizer, and several other vessels that are tied directly to the PHT system) is actually inside the containment structure. The containment itself is connected by underground ducting to the vacuum building, and the reactor re-fuelling machine system. The majority of the steam generators, including blowdown systems, are housed in a "boiler room" that is isolated from the containment by bellows seals and the reactor vault's thick concrete roof. The lower sections of each steam generator pass through the roof of the reactor vault that is 2 m thick.

Between the boiler room and the steam drum enclosure there is another concrete floor with 3 m x 4 m rectangular holes provided for connections from the steam generator to the steam drum. The steam drum itself is contained within the SD enclosure with a roof (0.7 m thick) made of steel and reinforced concrete.

The overall task for this project was to replace the eight steam generators in each of the reactor Units 1 and 2 at the Bruce A plant with like-for-like replacement steam generators, reconnecting them to the steam drums and Primary Heat Transport (PHT) piping, and restoring the plant to "as-found" condition (i.e., returning everything that was removed temporarily to the way it was found).

3. Methodology & Approach

The actual method and approach of how the steam generators would be replaced was the responsibility of the replacement contractor. Several different methods were examined, which included the following possibilities.

1) Taking the steam generators out of the boiler room through holes (to be made) in the 2 m thick side walls of the boiler room;
2) Moving the steam drums, and lifting the steam generator sections by turning them horizontally and removing them through the reactor building North wall;
3) Moving the steam drums, and lifting the steam generators out vertically through the reactor building roof.

Since there was no crane inside the reactor building with the capacity to perform any of the lift methods described above, the replacement of Bruce A's steam generators would require the use of new cranes. For the first two methods, semi-permanent cranes must be set up inside the reactor building. The third method requires either gantry cranes to be mounted on or under the reactor building roof, or a free standing crane positioned on the ground (behind the reactor building) that lowers a hook into the building through the roof to make the vertical lifts.

The concept of a roof-mounted gantry crane system was never developed, as the roof of the reactor building was not specifically designed to support such heavy lifts. Although some temporary supports could be used inside the reactor building, the impact on the schedule would be a significant factor. Also, any structures added within the building and not removed at the end of the project would be subject to additional seismic qualification. These considerations are described in detail in a CNS paper by R.S. Hart (Ref. [1]).

The approved solution involved using a Medium Lift Crane (MLC) positioned on the ground at the North end of the reactor building. This crane (shown in Figures 5 and 6) was capable of making all the required lifts, and could easily reach and lift all the steam generators vertically in and out of their positions. Because of the long reach needed, the lift capacity of this crane was rated at 1800 tons.

Once the crane selection was made, the following logic was used to determine the methodology.

a) To remove the steam generators vertically out through the reactor building roof, the steam drums would be separated (cut) from the steam generators and temporarily moved out of the way. Originally, the steam drums were delivered to site from the manufacturer in two sections that were field welded together. Since they were never lifted before as assembled units, a significant engineering effort was required to assure that the lifts could be executed safely and properly. Many alternatives were considered as to where to place the drums, and how to remove them from the reactor building during the steam generator change-out. The final decision was made to place the drums on elevated saddles (to be designed and constructed) at the inside of the drum enclosures towards the reactor, where the steam drum connections to the replacement steam generators could be machined;
b) To lift out and temporarily relocate the steam drums, the reinforced concrete roof of the steam drum enclosure would be cut into pieces using a special diamond wire cutting process. The cut pieces would then be taken as waste for disposal on site;
c) To remove the steam drums, all connecting piping such as the steam piping, feedwater piping, instrument piping, etc., would be cut, removed, and placed in temporary storage to be re-used later;
d) To remove the steam generators, all connecting piping such as the PHT piping, blow-down system, and instrument piping would be cut. The original seal plate of the bellows seal for each steam generator would then be cut, and replaced by a new seal plate;
e) While the steam generators were still in the reactor building, all open nozzles and man-ways would be sealed with heavy steel covers, as specified for medium term radioactive waste storage. Trunnions would be welded to each steam generator in positions that are comparable to the trunnions supplied with the replacement steam generators. This would permit the same lifting methodology to be used for old steam generator removal and replacement steam generator installation;
f) The generator replacement was performed as follows.
    1) At any steam generator bank, only two SGs were removed at one time. The other two were left in position and remained welded to the PHT piping to stabilize the overall feeder, header, and piping system for that bank of steam generators. Only after the first two steam generators were replaced and welded to the PHT piping, the second two SGs were cut from the inlet and outlet PHT piping;
    2) Pipe restraints were installed at the individual PHT

pipe ends and at other strategic locations in the reactor vault, as determined by modeling and stress analysis in order to limit the movement of individual pipe ends, resulting from residual stresses introduced during the original plant's construction;

3) Given the uncertainty of pipe movement after cutting, the replacement steam generators included unmachined PHT nozzles with a considerable amount of extra material in the area of the pipe weld to allow for fitup to the PHT inlet and outlet piping. After the original SGs were removed, the machining of the open PHT pipe ends was finished. Detailed laser metrology was then performed, and the results (i.e., exact pipe end location and orientation) were used to final machine the nozzles of the replacement SGs on site prior to their installation to ensure an exact fit to the pipe ends;
4) Similarly, the replacement steam generators were supplied with extra material at the upper end, where the smaller diameter SG section would be joined to the steam drum nozzles. It was known from ultrasonic examination that according to the ASME minimum wall criteria, there was little extra material in the SD nozzles beyond the minimum Code requirements. For this reason, the fitup adjustment would be made by machining the top end of the SG. However, first and foremost was the PHT nozzle machining;
5) When installed, the steam generators are supported by pedestals on thermally insulating maronite pads and a trapeze assembly which is suspended from the ceiling of the reactor vault by 4 steel rods. The trapeze assemblies support the combined weight of the SGs and steam drums during operation. To ensure that the trapeze assemblies would not move vertically after the weight was removed, restraints were designed and fitted to the trapeze assemblies, thereby locking their position vertically;
6) The horizontal position of the steam generators and PHT piping was maintained by fitting wooden blocks between the 2 generators that must remain in place at any one time, and the concrete vault ceiling penetration to the boiler room above;
7) The pedestals were removed and replaced by new, custom made pedestals that matched their corresponding replacement steam generator. The original maronite pads contained asbestos, and were replaced by their modern asbestos free equivalent;
8) Extensive surveying was performed before any of the replacement activities using modern laser technology to determine the precise locations of the steam drums, the old steam generators, and the PHT piping. These exact locations established the relationships between the components within a grid coordinate system that was created within the reactor vaults, boiler rooms, and steam drum areas. The replacement steam generators were also surveyed when they arrived on site. The resulting computer model was a 3 dimensional virtual environment, which made it possible for each replacement steam generator to be custom machined outside the reactor building to match all mating PHT piping prior to installation.

g) Pairs of steam generators from each side of the reactor were separated (cut), removed vertically, and transported to Ontario Power Generation's Western Waste Management Facility located within the Bruce site for medium term storage. Measurements of the severed PHT inlet and outlet pipe faces were made to confirm their precise 3 dimensional locations. Following the data processing and analysis, machining instructions were prepared for the PHT pipe ends and matching replacement steam generator nozzles, and the final machining was initiated. The pedestals and pads were removed, their replacements were installed, and the pairs of replacement steam generators were installed. After each generator was gently lowered into place by the MLC, the steam outlet was positioned by the metrology team to match the mating steam drum nozzle and installed bracing, and the PHT pipe welding was started. When the PHT pipe welds were essentially finished, the second pair of steam generators in each bank was replaced following the same procedure;
h) When all the replacement steam generators were installed and the nozzles on the lower side of the drums were final machined, the drums were lifted back on top of the four steam generator banks, and supported temporarily by hydraulic jacks. All four nozzles were perfectly aligned for height, position in the horizontal plane, and orientation to the horizontal plane. Finally, the drum to steam generator welds could be completed;
i) After the drum welds were completed, the concrete roofs of the steam drum enclosures were reconstructed by recreating the steel and reinforcements, and then pouring roughly 220 tonnes of concrete per steam drum. Finally, all the interferences, piping, and insulation were replaced to return the reactor units to "as-found" condition. Both the steam drum enclosures and the reactor building roof (holes) were reconstructed and restored according to the original design. With that, the steam generator assemblies were ready for recommissioning. Full recommissioning and restart will not take place until after the pressure tube replacement and other re-start activities are completed.

4. Results

4.1 Task Completed

As of February, 2008, all of the steam generators at Bruce A reactor Units 1 and 2 are replaced, the drums are repositioned, and the welding is nearing completion. Reconstruction of the drum enclosure roofs is in progress. Pipe replacement, interference replacement, and insulation work will be completed at Unit 2 by June, 2008, and at Unit 1 by September, 2008. This project will be completed with a significant number of first-of-a-kind (FOAK) operations.

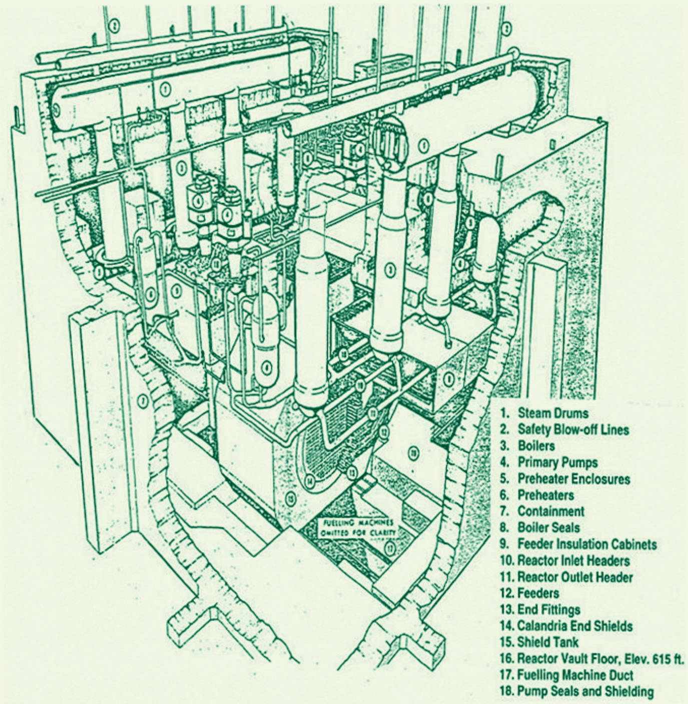


Figure 1, Bruce A Steam Generation Assembly

4.2 Quality

The overall quality record for the project was excellent. A specific Project QA program was established and approved, with compliance confirmed and maintained through audits. Each reactor Unit required a total of 24 major welds.

4.3 Safety

The significant focus on safety throughout the project included daily safety meetings at site, project safety plans, and detailed reviews of any safety incidents. By January of 2008, and with the project nearing completion, over 1 million person-hours of work have been completed on the job without a lost-time injury.

4.4 Radiation Dose

The Bruce A, Unit 2 SGR project set a world record for lowest collective radiation dose in a steam generator replacement job. The collective dose was measured at 41 man-rem (0.41 man-Sv). This can be compared to a previously claimed record of 57 man-rem at Palo Verde (Unit 2) in the U.S. The Palo Verde project involved the replacement of two steam generators. On a radiation dose per steam generator basis, the Bruce A Unit 2 dose of 5.2 man-rem per steam generator was less than one third of the lowest ever collective radiation dose reported for a PWR replacement (ref. [2]). The collective radiation dose from the Unit 1 replacement was 57 man-rem. Although the dose was approximately 40% higher, the radiation fields (mrem/hr) in the critical areas of Unit 1 were almost double those of Unit 2, so the actual results represented better performance by the work crews and ALARA team (ref. [3]).

Figure 2, Computer Model of Steam Generators & Steam Drum

4.5 Alignment & Metrology

Alignment and metrology are crucial aspects of any steam generator replacement project. This is particularly true in the case of Bruce A, as a "12 point alignment" was defined for each steam generator bank. In other words, an extremely accurate alignment was needed from the steam generators to their own pipe connections, and to a common assembly with the steam drum. Laser metrology was used extensively for both the location of terminal points, and as a guide for precise machining to match the terminal points. Every component needed to be aligned correctly to within fractions of a millimeter. As the project moved forward and experience was gained in the metrology systems and methods, the metrology factor contributed significantly to the schedule improvements described above. The reconnection of major equipment consisted of the PHT pipe connections in the reactor containment vault, the pipe trunnion and bellows seal connections in the 'boiler room', and the steam generator to drum welds in the steam drum enclosure. The 12 point alignment combined with the alignment of connections from 3 separate rooms resulted in an alignment and metrology process that was considerably more complex than what is commonly seen in steam generator replacements for light water reactors (i.e., 3 or 4 point alignment, single room).

The 40 heavy lifts completed in total during the SGR project consisted of 4 steam drums removed and relocated, 16 old steam generators removed, and 16 replacement steam generators installed. All terminal points were within the specified alignment tolerances from the outset.

5. Summary

The steam generator replacements at Bruce A Units 1 and 2 have now been completed. The overall results were very satisfactory, including the quality, schedule and safety outcomes, and a world record low collective radiation dose. Areas for possible improvement in future SGR projects have been identified. This initial steam generator replacement for a CANDU reactor will provide good metrics and a point of reference for future projects.

A video will be shown as part of the presentation of this paper.

6. References

[1] Hart, R. S., “Steam Generator Replacement in Bruce A Unit 1 and Unit 2”, Paper presented to CNS International Steam Generator Conference, Nov. 26-29, 2006;

[2] Global RPM Monitor, “Information System on Occupational Exposure, Steam Generator Benchmarking ISOE Database”, Issue: GRPM 01-02, December, 2001;

[3] Khan, Arif*: Personal communication dated April 30, 2008.

*Radiation Protection Manager, AMEC NCL, Bruce A Restart Project.

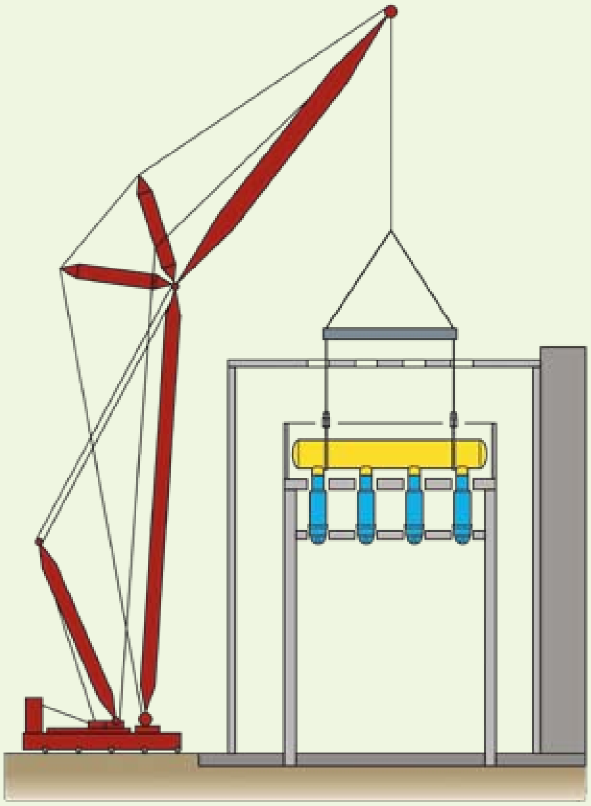


Figure 3, Steam Drum (SD) Repositioning

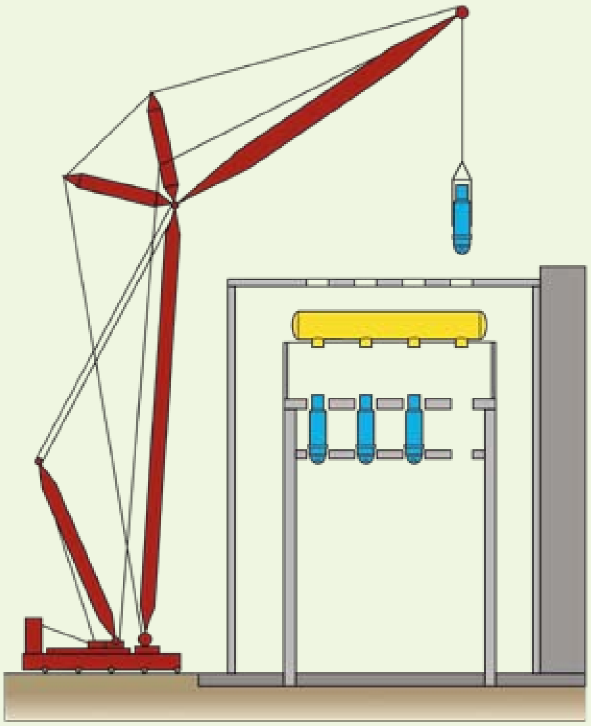


Figure 4, Steam Generator Removal/Replacement

Figure 5, Medium Lift Crane (MLC)

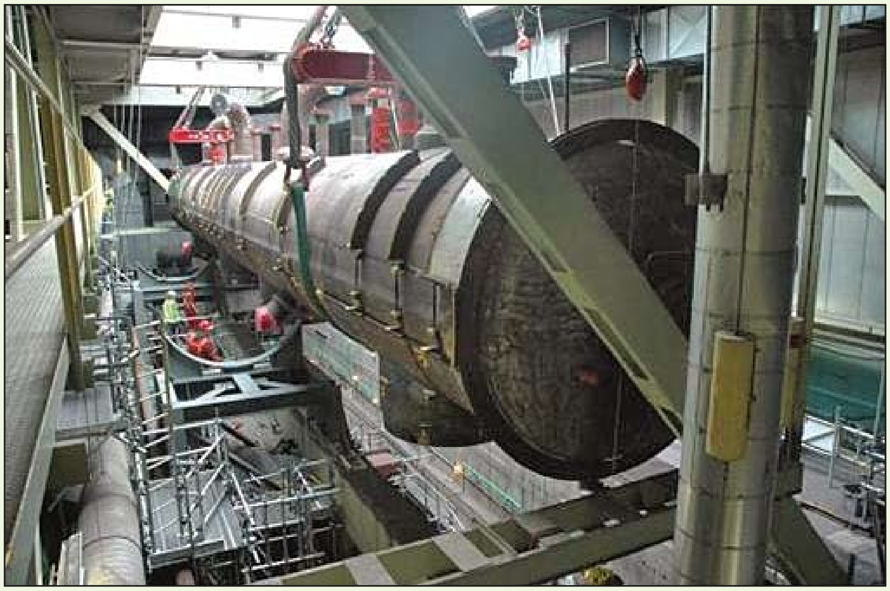


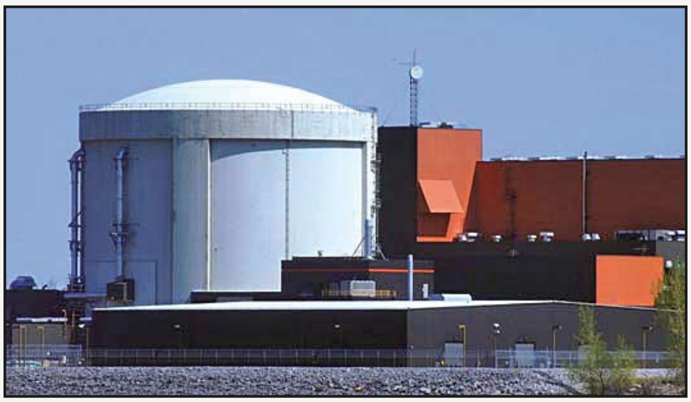
Figure 6, Bruce A Steam Drum

GENERAL news

(Selected by Fred Boyd)

Hydro-Québec to refurbish Gentilly-2

On August 19, 2008, Hydro-Québec announced its decision to invest $1.9 billion to refurbish the Gentilly-2 nuclear generating station in Bécancour. Refurbishing the 675-MW plant will extend its operation until about 2040.



The utility stated that, after conducting many technical, economic and safety-related studies, it had determined that it is justified to continue operating the existing facility. As a reliable, continuous source of energy located near major load centres in the St. Lawrence Valley Gentilly-2 plays an important role in maintaining the stability and reliability of Hydro-Québec's transmission grid. The unit cost of energy generated from 2012 onward will be 7.2¢/kWh. Since it is not subject to vagaries of the weather, Gentilly-2 helps diversify the company's generating portfolio and thus contributes to securing Quebecers' energy supply.

The project has two components:

- refurbishment of Gentilly-2 nuclear generating station, commissioned in 1983, and,
- construction of a solid radioactive waste management facility (SRWMF).

Engineering and procurement for the refurbishment will commence in 2008 and construction work will begin in 2011, with a return-to-service in 2012. Construction activities consist in refurbishing the reactor, the turbo-generator unit, as well as the control and support systems.

Construction work on the SRWMF is divided into four phases. Phase 1, already under way, will meet the plant's immediate operating requirements with the building of storage units for low- and medium-level solid radioactive waste. Phase 2 will provide storage for radioactive waste arising from the refurbishment.

Report blames both AECL and CNSC for isotope crisis

In late July 2008, the Canadian Nuclear Safety Commission and Atomic Energy of Canada Limited released the "lessons learned" report from Talisman International, the consulting company hired jointly to review the factors leading to the isotope crisis of last December. The report identified poor communications as the root of the problem.

The Commission had granted AECL a renewal of the Operating Licence for NRU in 2006 on the understanding that connecting the main heavy water pumps (that provide the flow of heavy water to cool the fuel) to the emergency power supply was a licensee commitment. However, CNSC staff had not included it as a specific licence condition.

In December 2007, on learning that the pumps had not yet been connected, the Commission required the NRU reactor to stay shutdown. That resulted in a serious shortage of the isotope Molybdenum 99 which is used extensively in nuclear medicine diagnostics. Eventually the problem ended in Parliament with the House of Commons holding a special session and subsequently over-ruling the CNSC to allow NRU to operate

The report contains 15 specific recommendations, which CNSC and AECL have accepted. The published report includes the responses from CNSC and AECL. Both organizations have stated that they recognize the need to clarify licence requirements and improve the implementation, tracking and completion of licensing commitments.

The report (with responses) is available in both official languages on both the CNSC and AECL websites.

Subsequently, the CNSC announced the signing of a protocol with AECL regarding licensing activities associated with the NRU reactor. The protocol defines a framework within which CNSC staff will provide clear regulatory expectations to AECL.

MDS seeks $1.6 billion for the cancellation of the MAPLE project

In July 2008, MDS Inc., the parent company of MDS Nordion announced that it had filed a court claim against Atomic Energy of Canada Limited for negligence and breach of contract, and against the Government of Canada for inducing breach of contract and for interference with economic relations, in connection with the decision by AECL and the government to cancel the MAPLE project.

MDS stated that its primary objective is to have AECL honour its long-standing commitment to replace the NRU reactor by bringing the MAPLE reactors into service and provide a 40-year supply of medical radioisotopes.

MDS had entered into an agreement with AECL in 1996 for the design, development and construction of two nuclear reactors and a processing facility, known as the MAPLE project, funded by MDS. The project was intended to replace the ageing NRU reactor that produces about 50% of the world's medical radioisotopes. The project was to be completed by the year 2000 at a planned cost to MDS of $145 million.

By 2005 the project was not yet completed and MDS investment had grown to $360 million. MDS entered into mediation and a new agreement was reached in 2006 with AECL to take over the financial liability of the project, bring the MAPLE project into service by October 2008, and provide MDS with a 40-year supply of isotopes.

On May 16, 2008 AECL and the Government of Canada announced their intention to discontinue the MAPLE project, without prior notice to or consultation with MDS

SNC Lavalin and partner win contract for South African reactor

On August 22, 2008, SNC-Lavalin Nuclear announced that its joint venture company with Murray and Roberts of South Africa, Murray *& Roberts SNC-Lavalin Nuclear (Pty) Ltd. (MRSLN)*, had been awarded a contract to provide engineering, procurement, project and construction management services for Phase II of the Pebble Bed Modular Reactor (PBMR) Demonstration Power Plant at Koeberg, South Africa.

Phase II of the project entails construction of a commercial scale power plant at Koeberg near Cape Town, which is subject to obtaining a nuclear licence from the National Nuclear Regulator and a positive Record of Decision on the Environmental Impact Assessment.

The power plant will use advanced Generation IV technology and supply about 165 MWe (electrical) to South Africa's national grid once in service. Phase I, for the project's scope definition, was completed in June 2008. Phase II work began in July 2008 with an expected date of completion of September 2014. The approximate value of the contract is CAN$253 million (R 1,9 billion.)

"We are pleased with this opportunity to bring our experience in 'New Build' Generation IV nuclear technology to this benchmark project," said Patrick Lamarre, Executive Vice-President, SNC-Lavalin Group Inc., and President of SNC-Lavalin Nuclear. (Patrick Lamarre was Honorary Chair of the 2008 CNS Annual Conference.)

The Pebble Bed Modular Reactor is a generation IV high temperature, helium-cooled nuclear reactor. The main advantages of the technology are its inherent safe characteristics, modular design, process heat applications and short construction time.

Murray & Roberts is South Africa's leading engineering, contracting and construction services company, with a focus on the industry & mining, oil & gas, power & energy, building and infrastructure markets in Africa, Middle East, Southeast Asia, Australasia and North America.

Cameco suspends remediation work at Cigar Lake

On August 12, 2008, Cameco Corp announced that it has temporarily suspended remediation work at the No.1 shaft at its Cigar Lake uranium project, which flooded in 2006, due to an increase in the rate of water inflow to the mine.

In October 2006, a rockfall in the underground production area of the mine led to flooding. Cameco expected that closing bulkhead doors would contain the water inflow and protect mine shaft No.1, the future processing area, pumps, a refuge station and a heat exchanger for ore freezing.

Cameco began a five-phase remediation programme in early 2007 to remove water from the Cigar Lake mine. The company had expected to complete dewatering No.1 shaft in the second half of 2008. An increase in water flow, to 600 cubic metres per hour developed the day before. Such an inflow rate "is beyond the range that can be managed while sustaining work in the shaft,"the company said.

In a statement Cameco said, "Work in the shaft has been suspended while the situation is assessed to determine the source and characteristics of the inflow, implications for planned remediation work and the impact, if any, on our planned production date."

The current plan is to allow the water level in the shaft to rise to approximately 100 metres below surface to allow additional data to be gathered from instruments used to monitor groundwater conditions. After this is complete, the water will be allowed to return to the natural equilibrium level.

Cigar Lake is one of the world's most promising uranium deposits, with estimated reserves of 113 million pounds of U308 at grades as high as 20.7%. A consortium of Cameco, holding 50% of the project, Areva Resources Canada (37%), Idemitsu Canada Resources (8%) and Tepco Resources (5%) has been developing the deposit in northern Saskatchewan. Originally, the mine was expected to begin operating in early 2008. In July, Cameco said that the start of production at Cigar Lake was anticipated for 2011 "at the earliest."

On August 29, Cameco asked the Canadian Nuclear Safety Commission for a deferral of a hearing scheduled for September 18 on a requested amendment to the Construction Licence for Cigar Lake. Given the above event, Cameco stated that there is no need to amend the licence at this time.

After 50 years, first look at damaged Windscale reactor

On October 10, 1957 a fire damaged the Windscale 1 reactor in the United Kingdom. It was one of several plutonium production reactors which were graphite moderated and air-cooled. The graphite cores developed a build up of energy (termed "Wigner") due to the radiation. On that date a runaway release of the Wigner energy led to a fire that damaged the reactor beyond repair.

Clean up efforts were hampered by a lack of information about the state of the reactor core. Some fuel channels had been cleared but those in the fire-affected zone (FAZ) still contain damaged fuel. Recent computer modelling concluded that there was no possibility of criticality. Given that information regulatory approval was granted to look inside the FAZ for the first time. In mid-August, using an endoscope, sufficient information was obtained to confirm plans for removal of the fuel and fuel channels.

More problems at Olkiluoto

The construction of the first EPR nuclear power plant being built by Areva at Olkiluoto, Finland continues to be plagued with problems.

In mid August, the Finnish regulator STUK halted constructed until it had reviewed charges by Greenpeace that critical welds were faulty.

In late August the Finnish Construction Trade Union threatened a major strike unless an issue about improper deductions from the pay of Polish workers was resolved.

The French newspaper Les Echos reported, August 28, that the cost of the plant had risen 50 percent and the in-service date pushed back from 2009 to 2011. Areva reportedly has been forced to set aside one billion Euros to absorb the rise in costs.

However, at the same time Areva announced record profits of 750 million Euros despite the losses on the Finnish project.

Ontario decision deferred by 3 months

In late July Ontario Minister of Energy, George Smitherman, extended the deadline for submission of bids for new nuclear power plants from October 1 to December 31. He promised a decision by March 31, 2009.

Smitherman assumed that post just a month earlier. He stated that the extension was necessary because of the complexity of the bids and the need for more time for the bidders to consult with the government on the process.

Officials of Infrastructure Ontario, the agency in charge of procurement, stated that they still expected construction to start in 2012. A site adjacent to the OPG Darlington plant was chosen earlier this year.

Three companies are in the race: Atomic Energy of Canada Ltd. with its new ACR design; Areva NP with a version of its EPR design being built in Finland; and Westinghouse with its APR design.

Korean fusion reactor sustains plasma

In mid July the KSTAR experimental fusion reactor at the Korean National Fusion Research Institute in Daejon generated a sustained super-hot plasma field. The test followed months of tests by local and foreign scientists.

KSTAR stands for Korean Superconducting Tokamak Advanced Research project.

The reactor is a pilot device for the International Thermonuclear Experimental Reactor (ITER) being built in France. Korea is one of several countries in the ITER consortium.

The KSTAR reactor was completed in the fall of 2007 at a cost of about $300 million.

Final EIS Guidelines issued for Bruce new build

In late August 2008 the Canadian Environmental Assessment Agency and the Canadian Nuclear Safety Commission issued two documents related to the proposed Bruce Power New Nuclear Power Plant Project – the final Environmental Impact Statement Guidelines, and the Joint Review Panel Agreement.

The EIS Guidelines identify the information needed by Bruce Power to prepare the EIS and also list the requirements for a licence to prepare the site.

The JRP Agreement establishes how the panel will function and the terms of reference for conducting the environmental assessment.

Next steps include the appointment of JRP members, the submission of Bruce Power's EIS and licensing documentation to the JRP and a public consultation on the EIS.

The proposal by Bruce Power is for up to four new nuclear reactors at the existing Bruce site.

The final Guidelines and Agreement are available at both the CEAA and CNSC websites.

CNSC extends Pickering B licence and approves design rules

Following its meeting in mid June 2008, the Canadian Nuclear Safety Commission approved a five-year Operating Licence for the Pickering "B" plant of Ontario Power Generation.

The new Operating Licence deals only with the continuing operation of the plant and not the possible refurbishment. OPG is conducting an environmental assessment and business case to determine if the units could or should be refurbished for operation to 2060.

The Commission also approved for final publication and use two basic regulatory documents.

- Regulatory Document RD-346, Site Evaluation for Nuclear Power Plants
- Regulatory Document RD 337, Design of New Nuclear Power Plants

RD 337 is largely "technology neutral" meaning that light water reactors would probably be able to meet the requirements.

Both documents are available on the CNSC website or by request to the agency.

Obituary

Geoffrey Ballard, often called the father of the fuel-cell car engine, and promoter of "hydrocity", the combination of using nuclear power to produce hydrogen for use in fuel cells, died in Vancouver, August 2, 2008, at the age of 75.

A geophysicist by training Ballard spent the first years of his career working for the US Army in microwave communications and ice physics. In 1974 he was chosen to lead the newly created U.S. Federal Energy Conservation Research Program but resigned a few years later because of inadequate funding.

After an abortive attempt to develop lithium batteries he moved to Vancouver and with partners Paul Howard and Keith Prater created a company to develop and improve fuel cells. They convinced the provincial government to fund development of a bus that would run on hydrogen fuel cells and in 1993 celebrated by drinking the water exhaust.

In 1999 he started a company General Hydrogen to explore and market the fuel but sold the company in 2007. During those years he became very interested in nuclear as the source of energy to provide hydrogen and participated in several nuclear conferences.

"Badge-Draw" Winners at the 2008 September CNS Reactor Safety Course

At the end of the CNS CANDU Reactor Safety Course, on September 5, 2008, 13 prizes were awarded by random draw from among badges returned by Course attendees.

The winners:

- Karin Chang-Kue, of AECL, won a CNS multitool
- Nabel Sadek, of the CNSC, Mafamiya Beleshi, of Laurentian University, Colin Elwood, of Bruce Power, and Syed Haque, of AECL, each won a CNS silk tie
- Alanna Wong, of OPG, Tony Clouthier, of AECL, and Mathieu Gravel, of OPG, each won a CNS sweatshirt
- Jean-Pierre Labrie and Carl Turner, both of AECL, each won a CNS golf shirt
- Yan Jiang, of Bruce Power, Andrew Fitchett, of Candesco Corporation, and Greg Cully, of Laurentian University, each won a complimentary CNS membership to the end of 2009.

Congratulations to all the winners!

Gagnants de prix au tirage des porte-insigne au cours de septembre 2008 de la SNC sur la sûreté des réacteurs

À la fin du cours sur la sûreté des réacteurs, le 5 septembre 2008, 13 prix ont été tirés au sort parmi les porte-insigne retournés par les participants au cours.

Voici les gagnants des prix:

- Karin Chang-Kue, de l'EACL, a gagné un ensemble d'outils de la SNC
- Nabel Sadek, de la CCSN, Mafamiya Beleshi, de l'Université Laurentienne, Colin Elwood, de Bruce Power, et Syed Haque, de l'EACL, ont chacun gagné une cravate en soie de la SNC
- Alanna Wong, d'OPG, Tony Clouthier, de l'EACL, et Mathieu Gravel, d'OPG, ont chacun gagné un chandail sport de la SNC
- Jean-Pierre Labrie et Carl Turner, tous deux de l'EACL, ont chacun gagné une chemise de golf de la SNC
- Yan Jiang, de Bruce Power, Andrew Fitchett, de Candesco Corporation, et Greg Cully, de l'Université Laurentienne, ont chacun gagné une adhésion gratuite à la SNC jusqu'à la fin de 2009.

Félicitations à tous les gagnants!

CNS news

Meet the President by Fred Boyd

As president of the Canadian Nuclear Society for 2008 – 2009, Jim Harvie brings a wealth of experience and abilities to the job.

Born in Glasgow, Scotland, in 1945, Jim came to Canada in 1966 shortly after receiving (at the tender age of 21) an honours degree from the University of Glasgow in Science (majoring in Mathematics) and joined the team at Atomic Energy of Canada Limited's Chalk River Laboratory. He worked there on thermal-hydraulics until 1974 when he was inveigled to join the Atomic Energy Control Board (the predecessor to the Canadian Nuclear Safety Commission for those too young to remember the AECB).

His first role with the AECB was in its project office at the Bruce site of then Ontario Hydro when commissioning was still going on with the last units of the Bruce A plant and construction was beginning on Bruce B.

In 1979 he was moved to the AECB head office in Ottawa and from then to 1990 assumed a number of managerial roles in power reactor licensing and safety evaluation until 1990 when he was appointed Director General of Research and Safeguards. In 1996 he moved back to licensing as Director General of Reactor Regulation until taking early retirement in 2002.

Along the way in those two DG roles Jim served in a number of international activities, including:

- Canadian Representative on OECD-NEA Committees on Nuclear Regulatory Affairs (CNRA) and Safety of Nuclear Installations (CSNI)
- Member of Canadian delegation to Non-Proliferation Treaty Review and Extension Conferences, 1990 and 1995
- Head of Canadian delegation to first two meetings of G-7 Nuclear Safety Working Group, 1992
- Head of Canadian delegation to first Meeting of Parties to International Nuclear Safety Convention, 1999.

Since retiring Jim has been very active in the CNS, first as chairman of the Ottawa Branch, then Treasurer, 2nd Vice-President, 1st Vice-President and, as of the Annual General Meeting in June 2008, President.

Among his other activities Jim is an avid sailor and owner of a 26 foot Niagara sailing boat that he keeps near his home in Cumberland, east of Ottawa, which backs onto the Ottawa River. (He was slightly annoyed when the CNS Council convinced him to represent the Society at the 2008 Pacific Basin Nuclear Conference in late October as it conflicted with the schedule for taking his boat out of the river for the winter.)

Jim is also an enthusiastic cyclist. For years he cycled to work (despite the irony of taking part in an activity with a risk factor of 1 in 10 while at work insisting on 1 in 1,000,000 for nuclear plants). Two years ago he went on a lengthy cycling trip in South Africa and earlier this year another one on Vietnam.

He played soccer for many years but now claims he is too old for the game.

Jim's wife, Marion, owns and runs the Cumbrae School of Dancing, and he reports that he assists with "non-dance" activities. They have two daughters, Lisa and Amber, both into dancing, a son, Derek, in the entertainment business, and two grandchildren, Andrew and Jamie, children of Derek.

As Jim states in his *From the President* note, he has taken office at a challenging time for the Society. There is no doubt that he will steer the organization capably through whatever rough waters are ahead.

Jim and family – Back: grandson Andrew and wife Marion. Centre: Jim; daughter Amber; granddaughter Jamie. Front: daughter Lisa; son Derek

Jim on one of the easier roads in Vietnam.

In his beloved sailboat on the Ottawa River.

From The President

I seem to have assumed the role of President of the Canadian Nuclear Society at a particularly interesting time, when the Society is facing a range of issues and challenges.

Probably the most significant challenge at the moment is dealing with the recommendations of the report on the Governance/ Organization Task Force, prepared by Murray Stewart and Bob Hemmings. While some of the recommendations, such as the preparation of a formal annual Business Plan, are not controversial and simply reflect the need to improve the way we do business, others are leading to considerable debate in Council and have the potential to change significantly the way the CNS is operated.

The recommendation to create a new position of Executive Director of the Society is perhaps the most profound. It is becoming clear that the activities of the CNS are becoming sufficiently extensive that it is difficult to rely on the work of willing volunteers to manage all the conferences, courses, and workshops that are part of our current program. In some cases, we have already started to use professional conference organizers to take on some of the effort required for the administrative aspects of conferences. Appointment of an Executive Director to oversee day-to-day operations and to support all of the CNS programs, committees, and activities would undoubtedly make our organization more efficient and effective.

Some Council members consider the appointment of such an Executive Director as a progressive move which would enable the Society to broaden its activities and develop a wider range of conferences and courses, resulting in an increase in revenue to offset the cost of maintaining such a position. Others have a less optimistic view, and would like to see more gradual development to ensure that the potential benefits can realistically be achieved rather than making radical changes. Certainly the employment of an Executive Director without a corresponding increase in revenue would have a major effect on the overall finances of the Society. Your Council will be working hard over the coming months to resolve this issue in the best interests of the Society and its members.

Another interesting aspect of my new role has been my peripheral involvement in the Summer Institute of the World Nuclear University, held over six weeks this year at the University of Ottawa, an event which is reported on elsewhere in this issue of the Bulletin. I had the privilege of attending a few of the closing sessions at which the Fellows presented their conclusions on various nuclear-related issues, and also the Closing Dinner which concluded the program. It was wonderful to witness the unbridled enthusiasm of almost a hundred young people as they received their certificates of achievement before returning to their homes all over the world. They had not only acquired valuable knowledge about many aspects of the nuclear business, but had made contacts around the world which will be of great use as their careers develop. In addition, they went away with the benefit of exposure to Canada's successful nuclear technology and the technical expertise in the nuclear field which we are all proud of. The people responsible for the success of this Institute, and for bringing it to Canada this year, are surely to be commended for their efforts.

It has been the practice over the past few years to hold an annual Officers' Seminar at which all members of our Extended Council have an opportunity to discuss the overall direction of the CNS, and to get input on how the Society can better serve the interests of its members and Branches. These efforts have had varying success. We are trying to arrange such an activity this year, but we recognize that it can only be useful if it is attended by a broad spectrum of people who represent the various interests of our members, and this is proving difficult to achieve. Council has appointed a small working group to pursue this, and you should be hearing more about it through your branches in due course.

One issue which would surely be discussed at such a Seminar would be broadening our Society to include a wider range of people from different areas of the Canadian nuclear industry. Attendance by people with constructive ideas on this topic would be extremely valuable.

Preparations are already under way for our upcoming Annual Conference in Calgary next June, under the capable management of Dorin Nichita. While this will again be a major challenge, it will also be a great opportunity for the nuclear industry to expose the excellence of Canadian nuclear technology to those in Western Canada who will have a pressing need for large amounts of energy for the further development of our oil sands.

There is no doubt that my year as President will continue to be interesting.

Jim Harvie

Branch News

Most CNS Branches are more or less dormant in the summer. Following are reports from three that were not.

ALBERTA BRANCH – *Duane Pendergast*

(Prepared by Cosmos Voutsinos and Duane Pendergast)

Duane Pendergast placed a nuclear article in "Alberta Oil" magazine titled "Gone Fission: Alberta on the Threshold of the Nuclear Age". A copy is posted on his website.

Lawrence Hoye sent a letter to Dr. Kevin Taft – leader of the Alberta Liberals correcting inaccurate statements he made in the Alberta Legislature.

Cosmos Voutsinos sent letter to Alberta MP Mr. Backs with cc to the Premier and Minister of Energy correcting inaccurate statements made by Mr. Backs in the Alberta Legislature.

Duane Pendergast placed a letter in the Lethbridge Herald on the" expert panel" appointed by the Alberta Government to study and report on nuclear power. He sent a cc to Energy Minister Mel Knight, which was acknowledged.

Paul Hinman lent CNSA's AWARE Geiger counter to Mr Cliff Sosnowski at the St. Louis St., Laurence high school in Edmonton. He is developing teaching materials for his students.

Cosmos Voutsinos transferred his P. Eng retired status from New Brunswick to P.Eng. active status in Alberta after Peace River environmentalists filed a complaint with APEGA that he used the word "engineer" illegally last year during his Peace River visit.

Duane Pendergast placed letters with the Lethbridge Herald disputing claims that radiation from TMI had caused mutations in plants and supplemented that with a posting on his website which provides more background. Locke Bogart kindly arranged for an expert review.

Duane Pendergast and Cosmos Voutsinos placed independently letters in the National Post commenting on an editorial by Mr. Corcoran, which claimed nuclear energy is not economic.

We have a new member at CNS Alberta, Mr. Dick Buckland P. Eng., from Calgary. Welcome onboard Dick.

Copies of Cosmos Voutsinos booklet, "Using Nuclear Energy to get the most out of Alberta's Tar Sands" have been sent to 59 members of the Saskatchewan Legislature.

GOLDEN HORSESHOE – *Dave Novog*

The Golden Horseshoe Branch at McMaster University is looking forward to a new semester starting in September and is in the process of lining up new speakers for the coming school year. A priority for this year is to encourage graduate student membership and activity in local branch affairs and to engage GHB members from outside McMaster to participate in more seminars and events.

NEW BRUNSWICK - *Mark McIntyre*

On July 23, 2008 the NB Branch was pleased to host guest speaker, Ian McQueen, at the Saint John Free Public Library.

Ian L. McQueen has BSc and MEngSc degrees in chemical engineering. Since being upset by the numerous exaggerations and untruths of Gore's "An Inconvenient Truth", he has spent 2-6 hours a day for the past 18 months researching climate. He offered information and commentary based on that research.

His topic was: *Is Gore's message science or science fiction? Is the world really heading for a "climate crisis"? Do we truly need a carbon tax to save the planet?*

The presentation sparked a lively debate that was covered in the local press (Telegraph Journal) on July 24.

ALSO: At the start of this meeting an important Award Presentation was given to CNS Charter Member, Neil Craik. Neil won the Outstanding Contribution Award at the Canadian Nuclear Achievement Award ceremony in Toronto in June 2008. Unfortunately Neil was unable to attend the Toronto meeting.

The CNS New Brunswick Branch was pleased to make this presentation to Neil for a distinguished career in the Canadian nuclear industry and for extraordinary breadth of contributions to the CANDU program. Before the CNS meeting an informal dinner was held at "Vito's" restaurant where Neil and Monica Craik, Ian Sutherland, Bob and Micheline Hemmings, and a few selected NB Branch executive attended.

Membership Note

It is almost the end of summer, and before the blink of an eye it will soon be time to renew your CNS membership for 2009. Many members have inquired whether you can renew on-line, and this year, for the first time, you will soon be able to do this, using a link available on the CNS website. Look for a renewal reminder from the CNS office in due time. A feature of the on-line renewal is that the renewal fee will be automatically 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 earlybird 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

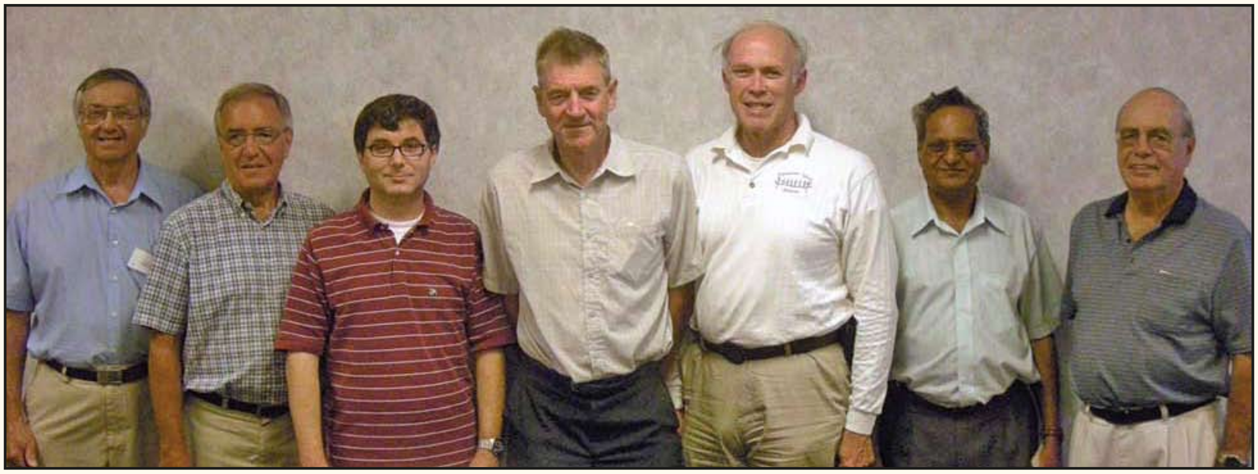
Note d'adhésion

C'est déj presque la fin de l'été, et dans moins d'un clignotement d'il il sera bientôt temps de renouveler votre adhésion la SNC ! Beaucoup de membres ont demandé s'il est possible de renouveler en ligne, et cette année, pour la premire fois, vous pourrez le faire, partir d'un lien au site web de la SNC. Vous recevrez un rappel de renouvellement du bureau de la SNC quand il sera temps. Le renouvellement en ligne permet le changement automatique des frais d'adhésion précoces aux frais standard le 1er janvier 2009, il est donc dans votre intérêt de renouveler tôt !

Si vous êtes inscrit(e) au renouvellement automatique, le bureau de la SNC fera le travail pour vous à temps chaque année, et vous profiterez ainsi toujours des prix réduits de renouvellement, sans vous préoccuper ! Si vous n'êtes pas encore inscrit(e) au renouvellement automatique, mais aimeriez profiter de ce service très commode, veuillez contacter le bureau de la SNC à 416-977-7620 ou à cns-snc@on.aibn.com.

Et souvenez-vous de toujours garder votre numéro de membre à portée de la main. Vous en aurez besoin pour vous identifier en tant que membre quand vous vous inscrirez à une conférence ou à un cours de la SNC ! Votre numéro de membre de la SNC apparaît sur votre carte annuelle de membre. Ce serait peut-être un bonne idée de garder la carte dans votre portefeuille. Le numéro de membre apparaît maintenant aussi sur les certificats des nouveaux membres.

Ben Rouben
président du comité d'adhésion



CNS Executive for 2008 – 2009

Left to Right: Ben Rouben, Ed Hinchley, Dorin Nichita, Jim Harvie (president), Eric Williams, Prabhu Kundurpi, Ken Smith.

New Members / Nouveaux membres

Ed Note: *Because of layout restrictions the list of new members as of June 19 was omitted from the June 2008 issue of the CNS Bulletin. It is the first list below, followed by the recent list.*

We would like to welcome the following new members, who have joined the CNS in the last few months, up to 2008 August 23.

Nous aimerions accueillir chaudement les nouveaux membres suivants, qui ont fait adhésion à la SNC ces derniers mois, jusqu'au 23 août 2008.

Farzin Abbasian, Ryerson University
Ayman Samy Abdalla, UOIT
Rohaan Ahmed, AECL
Dawood K.H. Al-Askar
Takashi Arakida, Hitachi Canada Ltd.
Don Bennett, Black & McDonald Limited
Laura Gail Blomeley, AECL
S. Locke Bogart
Patrick Bruskiewich, UBC Dept. of Physics & Astronomy
Soo Hyun Byun, McMaster University
Eric R. Chappel, UOIT
Jean Dipama, Ecole Polytechnique de Montréal
Regan Mary Dow, Chemical Engineer
Amjad Abdulkarim Farah, UOIT
Majid Fassi Fehri, École Polytechnique de Montréal
William Fatoux, University of New Brunswick
Tom Jonathan Fawcett, UOIT
Matthew Foster, Canadian Nuclear Association
Emil D.Y. Fung, Canalaska Uranium Ltd.
Sugata Ganguli, Kinectrics Inc.
Akashdeep Singh Gill, AECL
Douglas Lloyd Gould, Cantech
Adam Haines, Industrial Audit
George E. Henline
Victoria Elizabeth Hopps, AECL
Manou Hosseini, Nuclear Safety Solutions Ltd.
Behrooz Khorsandi, Candesco Corporation
Krysten Leigh King, UOIT
Rebecca Marie Krulicki, UOIT
Joseph H. Lam, Hitachi Canada Ltd.
Randy Bruce Lockwood, AECL
Michel Losier, NB Power
Chris Guang Lu, Bruce Power
Haiyang Lu, Carleton University
Hugh MacDiarmid, AECL
Peter MacDougall, CWFC, Farris Engineering
Barbara J. Mackenzie, AECL
Benjamin Edward McIntee, UOIT
Andrew C. Morreale, McMaster University
Dale Hans Morris, McMaster University
Robert C. Neely, Agency Cables
Arden Okazaki
Steve Palleck, AECL
Caleb Richard Pascoe, UOIT
Yatinkumar Patel, Cameco Corporation
Nghi Phan, McMaster University
Dan Popov, AECL
Tracy Lynn Primeau, Bruce Power
Arif H. Qureshi, UOIT
Radomir Radivojcevic, Promation Engineering Ltd.
Jeremy Rasmussen, Industrial Audit Corporation
Colin Reid, Babcock & Wilcox Canada
Adrianexy Rodriguez-Prado, UOIT
Shelley Rolland, AECL
Melanie Sachar, AECL
Kate Sarsfield, CNSC
Tapan Sengupta, Wardrop Engineering Inc.
Sepehr Sepehri, PMP Ltd.
Afzal Hussain Shaheedi, New Brunswick Community College
Khaled Shaheen, Royal Military College of Canada
Samih Zuhair Sheikh, UOIT
Naheeda Sheikh, AECL
John Philip Slade, NB Power - Nuclear
Justin Harvey Spencer, McMaster University
Brad A. Statham, McMaster University
Subaskaran Subanesarajah, Ryerson University
Peiwei Sun, U of Western Ontario
Sellathurai (Sam) Suppiah, AECL
Kristina Taylor, McMaster University
Galina Nenkova Teneva, Nuclear Safety Solutions Ltd.
Gaëtan Thomas, NB Power
Ian B. Trotman, AECL
Carmel Lynn Vivier, Atlantic Nuclear ServicesL td.
Graham Bruce Wilkin, AECL
Carol M. Wilson Hodges, Energy Solutions
Christina E. Wu, Kinectrics Inc.
Mark Zimny, Promation Engineering Ltd.

Hani Khaled Al Anid, Royal Military College of Canada
Holly Lynn Anderson, CANDU Owners Group Inc.
Peter Angell, AECL
Mohammadreza Baghbanan, Nuclear Safety Solutions Limited
Dick Buckland
Sheamus Doherty, Technical Service Manager
Yolanda Dworschak
Yashar Esfandi, Ryerson University
Paul Andrew Feenstra, AECL
Saad Haseen, UOIT
Alex Herold, Ontario Power Generation
Yan Jiang, Bruce Power
Youcef Kerboua, Nucleonex Inc.
Jerry Keto, Ontario Power Generation
Chutima Leelasangsai, University of New Brunswick
Odette Ma, Nucleonex Inc.
Robert Frank Miles, Blackwood Miles Consulting
Grant Mitchell, OPG, Pickering A
Babatunde Moses Oginni, Ohio University
Jeremy Pencer, AECL
Céline Poirier, Nucleonex Inc.
Christine Racicot, AECL
Laura D. Rook, AECL
Alexi Shkarupin, UOIT
Andre Dion Small
Ron Smith Nuvia
Zacharey Spike, Bishop Smith Catholic High School
Joshua Spike, St. Francis of Assisi Elementary School
Ralph A. Thrall Jr., McIntyre Ranching Co. Ltd.
Grace Wang, Bruce Power
Pasit Warumphaisal, University of New Brunswick

*[**Ed.Note:** This year the WNU Summer Institute was held at the University of Ottawa. Below are two reports on the event, one from Bill Garland, a facilitator, and from Jason Wight, an attendee.]*

A Facilitator's Report

by Bill Garland, UNENE President and Professor Emeritus, McMaster University; CNS Council member at large

I had the opportunity this summer to spend 6 weeks with some of the most gifted young professionals in the world when I helped facilitate the World Nuclear University Summer Institute held this year at the University of Ottawa. This was the fourth such event and, by all accounts, the most successful. You can find out more about the WNU SI at http://www.world-nuclear-university.org/ but in brief, the World Nuclear University is a global partnership committed to enhancing international education and leadership in the peaceful applications of nuclear science and technology. The founding partners are IAEA, WNA, WANO and NEA. Jason Wight (Canada) gives an account from his perspective as one of those gifted young professionals (called Fellows) who attended. He understates the leading role he took in preparing a number of outreach videos during some of the breakout workshops. In fact, he and a few others set up a web site at www.upandatom.net. It is under construction at the moment but you will soon be able to view some of their videos there. In the meantime, go to http://www.youtube.com/watch?v=JNzePixjlMg to see a sample.

Another Canadian Fellow, Andrew Meyer, spearheaded the creation of the WNU SI Resolution expressing a commitment to work together to continue sustainable development of nuclear technology. The resolution outlines the key facts and challenges facing the industry, as well as a pledge to continue the spirit of international co-operation developed over the last six weeks. Well done.

And that is only a taste of the 'goings-on' at the event. Amazing. But for all the fun and accomplishments, the most important outcome is the establishment of a network of colleagues worldwide, a network that will last a lifetime – literally. Next summer, the plan is to hold the event in Oxford, England. Now is not too early for you young professionals to start thinking and preparing to be there.

An Attendees Report

by Jason Wight

This summer I was lucky enough to attend the World Nuclear University – Summer Institute in Ottawa, Ontario.

It was certainly a summer to remember.

The World Nuclear University – Summer Institute (WNU-SI) drew 99 people from 36 different countries, each individual considered a young professional in the industry, to discuss the predominant issues in today's nuclear environment. Issues such as climate change, sustainable energy challenges, Generation IV reactors, and public perception were among the many topics that were discussed.

Each morning we would receive lectures from industry leaders such as Dr.Dale Klein of the US Nuclear Regulatory Commission, Andy White – Chairman of the World Nuclear Association and President and CEO of General Electric, and Greenpeace founder Dr. Patrick Moore. Following the lectures we would organize into working groups to discuss what was presented.

There were also technical tours of nuclear facilities such as the Ontario Power Generation Darlington Nuclear Generation Station and Atomic Energy of Canada Limited's Chalk River Laboratory – giving us a unique insight into Canada's long-standing role in the peaceful use of nuclear technology.

But as much as I enjoyed the lectures, working groups, and technical tours it was the interaction and relationships that I developed with my peers from different nations that provided me the most value. Over the course of six weeks, we would spend most of our time together either in lectures, going out to dinner, or to the pub where we would bicker about which country has the best beer (Canadian beer was of course the correct answer).

As I came home and unwound, I found it difficult to quantify to my peers what I found to be one of the most interesting and rewarding experiences of my life. My perspective of the industry has changed, from a small town Canadian perspective, to an international global perspective with an understanding how the other nations interact and impact each other. It is hard to put a price tag on such an experience

I will always remember watching the Opening Ceremonies to the Olympic Games surrounded by the 36 different nations of

Fellow of the 2008 World Nuclear University Summer Institute.

the WNU-SI. Each person was cheering on each other's athletes as they paraded into the stadium. It was a moment that made me very proud and hopeful for the future of Nuclear Industry.

It became clear to us that the Summer Institute was not necessarily an academic endeavour, but a forum to allow us to develop relationships such that we may eventually have a global impact on the World in which we live. We promised to continue that vision.

Note From The CNS:

Expressing a commitment to work together to continue sustainable development of nuclear technology, the Fellows banded together to create a resolution outlining the key facts and challenges facing the industry, as well as a pledge to continue the spirit of international co-operation developed over the last six weeks. *(Ed. Note: The Resolutions are on separate pages of this Bulletin.)*

About The World Nuclear University

The World Nuclear University, inaugurated in 2003 in London, England, is a non-profit global partnership committed to the improvement of education and leadership in the peaceful applications of nuclear science and technology. Its six-week Summer Institute aims to offer outstanding young nuclear professionals at the start of their careers a chance to interact with top international experts and form professional networks with each other.

The resolution is shown on pages 50 and 51.

The Canadian Contingent of the 2008 World Nuclear University Summer Institute.

FELLOWS' RESOLUTION

WORLD NUCLEAR UNIVERSITY

Summer Institute 2008 Ottawa, Canada

We, the Fellows of the World Nuclear University 2008 Summer Institute,

Noting that world energy demands are increasing rapidly,

Recognising that nuclear power is a necessary part of sustainable development,

Recognising that increased carbon emissions may be contributing to climate change,

Recognising that nuclear power is a low-carbon technology,

Recognising the need to maintain the excellent safety record of nuclear power,

Noting continuing developments in nuclear technology that are making more efficient use of nuclear fuel,

Recognising the role of renewable energy sources and energy conservation in meeting energy demand,

Noting the substantial beneficial uses of nuclear technology beyond electricity production,

Recognising the right of all nations to benefit from peaceful nuclear technology,

Recognising the benefits of international cooperation,

Recognising the importance of involving the younger generation in resolving global challenges,

Noting the aging workforce in the nuclear industry and the need to transfer skills and knowledge,

Noting the importance of public engagement in the peaceful utilisation of nuclear technology,

Recognising the need to safely and responsibly manage nuclear and radioactive material throughout its life-cycle,

Recognising the need to manage security and non-proliferation of nuclear material,

Recognising the need for independent and effective regulation,

COMMIT to work towards developing sustainable nuclear technology,

COMMIT to maintain the contacts we have developed and promote further international cooperation,

CALL ON the international community to work towards resolving the continuing challenges in nuclear technology,

CALL ON all nations to recognise that global problems require global solutions.

Ahmed BOURENANE
Analia CANOBA
Marcela ERMACORA
Pablo LUNA
Ariel TARAZAGA
Mark ALEXANDER
Michael VAUGHAN
Verena EHOLD
Mohammad BHUIYAN
Paul VAN DEN HENDE
Elida CAMPOS
Kalin LAFCHIEV

Neman ALI
Steven FORD
Monica GARRARD
Burak GULER
Helene HERBERT
Mehran KHOSRAVINEJAD
Mandeep LUDU
Andrew MEYER
Armado NAVA-DOMINGUEZ
Ebru Nihan ONDER
Karim OSMAN
Julia STAFFORD
Scott STAFFORD
Jessica SUN
Jason WIGHT
Yan XING
Mario BARRERA
Zhaojun WANG
Lukas KOSEK
Michaela RATAJOVA

Yasser ABO-ELNAGA
Tiina KETTUNEN
Ronan CAVELLEC
Olivier GASTALDI
Stephane GRANDJEAN
Edouard HOURCADE
Laurent JERRIGE
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David TORCY
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UOIT professor receives grants for radiation detecting mask

Dr. Ed. Waller, a professor at the University of Ontario Institute for Technology (UOIT) and a CNS member, has received a number of grants, totalling over $116,000 to date, for his work on a "radiological triage mask" (RTM).

The mask enables rapid identification of radioactive contaminants in individuals who may be the victims of radiological dispersal devices, otherwise know as "dirty bombs".

The design is similar to an oxygen mask. It is placed over the victim's nose and mouth and detects radiation from material present on the face, which is in direct proportion to the amount inhaled. The RTM quickly determines the type of exposure and amount inhaled providing the ability to establish a course of treatment.

Dr. Waller has been researching radiological dispersal devices for many years and has been a Canadian delegate for the past four years in a NATO working group investigating radiation biological effects and countermeasures.

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Do you **BLOG?**

Dr. David Jackson, McMaster University and CNS member has set up a BLOG website called
"Nuclear Reactors for Canada – Canada's choice of new nuclear reactors".

Have something to say? Interested in what others are saying? Check it out!

www.reactorscanada.com

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Canadian Nuclear Society
Société Nucléaire Ckanadienne

10th International Conference on CANDU Fuel

Delta Ottawa Hotel and Suites, Ottawa, Ontario

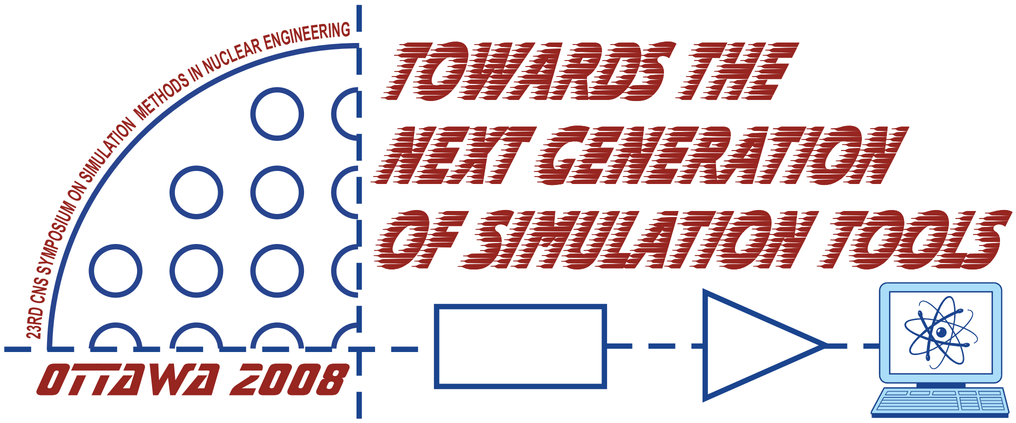
October 5 – 8, 2008

For information and registration go to the CNS website: www.cns-snc.ca

Canadian Nuclear Society

23rd Symposium on Simulation Methods in Nuclear Engineering

November 2-4
Ottawa, Ontario, Canada



The Canadian Nuclear Society invites you to its 23rd Nuclear Simulation Symposium in Ottawa, November 2-4.

The objective of the Symposium is to provide a forum for discussion and exchange of information, results and views amongst scientists, engineers and academics working in various fields of nuclear engineering.

The scope of the Symposium covers all aspects of nuclear modelling and simulation, including, but not limited to:

- Reactor Physics
- Thermalhydraulics
- Safety Analysis
- Fuel and Fuel Channels
- Computer Codes and Modelling

Ottawa Marriott Hotel

100 Kent St., Ottawa, Ontario, Canada

The hotel reservations must be made directly, recommended with the link provided on our website (URL below), or with the Ottawa Marriott hotel at 1-800-853-8463, using the reservation under Canadian Nuclear Society, code CNSCNSA. The special conference rate is $149 per night. The Marriott room-block cutoff date is October 3. However, we encourage you to reserve as soon as possible, to ensure availability.

General questions regarding the Symposium:

Denise Rouben, CNS Office Manager
e-mail: cns-snc@on.aibn.com
Tel.: 416-977-7620

www.cns-snc.ca/simulation2008.html

PUBLICATIONS

Book review

Core Issues – Dissecting Nuclear Power Today

by Steve Kidd

2008 ISBN 9781903077566

Nuclear Engineering International £25

web: neimagazine.com

Core Issues provides a review of the current state of nuclear power around the world and analyses the various challenges: economics, public acceptance, reprocessing, waste disposal, and proliferation. The author offers his views on how the industry can overcome the many obstacles in its path.

Steve Kidd is Director of Strategy & Research at the World Nuclear Association based in London, UK. He acts as secretary to many WNA working groups, organises training courses and writes a monthly column for the magazine *Nuclear Engineering International* that provided the basis for this book.

Publications

Implementing Adaptive Phased Management 2008 – 2012 (revised June 2008)

Nuclear Waste Management Organization

Toronto, Ontario

web: www.nwmo.ca

In June 2007 the Nuclear Waste Management Organization was given responsibility for implementing "Adaptive Phased Management", the accepted long-term plan for used nuclear fuel. A draft Plan was released in April 2008. Following receipt of many comments the plan was revised and is now issued in its final form.

Regulatory Documents from the Canadian Nuclear Safety Commission

The following two Regulatory Documents were formally approved by the CNSC in July 2008 for issue and use. They are available on the CNSC website www.nuclearsafety.gc.ca

RD 346 Site Evaluation for Nuclear Power Plants

RD 346 sets out the CNSC expectations concerning the evaluation of a proposed site for a new nuclear power plant. It takes into account all phases of the life of the plant from site preparation to abandonment. It provides technical information that the CNSC will review upon receipt of an application for a *Licence to Prepare Site* for a new nuclear plant.

RD 337 Design of New Nuclear Power Plants

RD 337 sets out the expectations of the CNSC concerning the design of new water-cooled nuclear power plants. It establishes a set of comprehensive design expectations that are risk-informed and align with international codes and practices. To the extent practicable, the guidance is technology neutral.

RD 337 represents the CNSC staff's adoption of the principles set forth by the International Atomic Energy Agency in *NS-R-1, Safety of Nuclear Plant Design* and the adaptation of those principles to align with Canadian expectations. However, RD 337 goes beyond NS-R-1 to address the interfaces between nuclear power plant design and other topics such as: environmental protection, radiation protection, ageing, human factors, security, safeguards, transportation and emergency response planning.

Publications from the OECD Nuclear Energy Agency

The following three publications from the OECD Nuclear Energy Agency are free and available through its website www.nea.fr or by request to e-mail: neapub@nea.fr

Occupational Exposures at Nuclear Power Plants

16th annual report of the ISOE program
120 pages 1.3 mb

The Regulatory Goal of Assuring Nuclear Safety

56 pages 333kb

The Role of Research in a Regulatory Context

Proceedings of a Workshop held in Paris, December 2007
136 pages 3.9 mb

Scientific Issues and Emerging Challenges for Radiation Protection

This is a report of the Expert Group on the Implications of Radiological Protection Science, published in 2007

It notes that the system of radiological protection is based on a number of assumptions and simplifications, most notably the linear no-threshold hypothesis (LNT) but states that no other overall system has been proposed. The report states that the system remains robust in its practical application and affords a high level of protection for both workers and public.

Publication of the International Atomic Energy Agency

Books

Chernobyl: Looking Back to Go Forward

Proceedings of an international conference held in Vienna, September 2005, with the same title. It offers consensus on the environmental consequences and health effects attributable to radiation exposure and advice on remediation and further research.

ISBN 978-92-0-110807 60 Euro

web: www.iaea.org/books

Publication of the Centre for International Governance Innovation

Report

The Economics of Nuclear Power: Current Debates and Issues for Consideration

by David McLellan

The Centre for International Governance Innovation is located at the University of Waterloo. This study report reviews the findings of numerous nuclear power cost studies for Ontario, in the USA and the UK and describes the economic challenges new nuclear plants face in competitive electricity markets.

Downloadable from website: www.cigionline.org

Wikipedia Recognises the CNS!

Thanks to Jeremy Whitlock, Co-Chair, CNS Education and Communications Committee, the CNS now appears in Wikipedia:

http://en.wikipedia.org/wiki/Canadian_Nuclear_Society


Join us in Calgary in 2009 for our 30th Annual Conference!
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CALENDAR

2008

Sept. 7 - 11
PSA 2008 – International Topical Meeting on Probabilistic Safety Assessment and Analysis
Knoxville, Tennessee
contact: George Flanagan
email: flanagangf@ornl.gov

Sept. 14 - 19
Physor 2008
Interlaken, Switzerland
website: www.physor2008.ch

Sept. 20 - 26
IYNC 2008 – International Youth Nuclear Congress
Interlaken, Switzerland
website: www.iync.org

Sept. 30 - Oct. 4
NURETH 12 – International Topical Meeting on Nuclear Reactor Thermal Hydraulics
Pittsburgh, Pennsylvania
website: www.nureth12.org

Oct. 5 - 9
NUTHOS-7 7th International Meeting on Nuclear Reactor Thermal Hydraulics, Operation and Safety
Seoul, Korea
website: www.nuthos-7.org

Oct. 5 - 8
10th CNS International Conference on CANDU Fuel
Delta Hotel, Ottawa, Ontario
website: www.cns-snc.ca

Oct. 13 - 18
16th PBNC – 16th Pacific Basin Nuclear Conference
Aomori, Japan
website: www.pbnc2008.org

Oct. 19 - 24
IRPA 12 – 12th International Congress of the International Radiation Protection Association
Buenos Aires, Argentina
website: www.irpa12.org.ar

Nov. 2 - 4
CNS Symposium on Simulation Methods in Nuclear Engineering
Marriotte Hotel, Ottawa, Ontario
website: www.cns-snc.ca

Nov. 9 - 13
2008 American Nuclear Society Winter Meeting
Reno, Nevada
website: www.ans.org

Nov. 16 - 18
8th CNS International Conference on CANDU Maintenance
Metro Toronto Conference Centre and Intercontinental Hotel, Toronto, Ontario
website: www.cns-snc.ca

2009

May 12 - 15
EIC Climate Change Technology Conference
McMaster University
Hamilton, Ontario
email: 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

Aug. 9 - 14
SMiRT 20 Conference
International Association for Structural Mechanics in Reactor Technology
Espoo, Finland
website: www.iasmirt.org

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

Outstanding Achievement Award

As noted in the June 2008 Edition of the CNS Bulletin, Neil Craik was awarded the CNS Outstanding Achievement Award. Neil was unable to attend the Awards Banquet at the 2008 Annual Conference in Toronto. Neil's long-time colleague Bob Hemmings (shown right) presented the award at the Saint John Regional Library before the CNS New Brunswick Branch lecture in July 2008. Congratulations to Neil Craik!

The Pride and Some of The Glory

by Jeremy Whitlock

Toronto photographer Sandy Nicholson's new book "2nd: The Face of Defeat" (Magenta Publishing for the Arts, 2008) celebrates the unsung second-place finishers in sport and other competitive fare: the respectable "also-rans", the "first losers", the folks that cameras normally ignore once the finish line is crossed by someone else.

Canada can almost be defined as a nation content to be second. It's one of the subtleties that separate us from the Americans (finding and discussing such subtleties also being part of our nature). Their birthright is our holy grail, and the journey to almost get there is, to us, worth entering the race.

When we say "it's an honour just to be nominated" we mean it, and frankly, most of the time we're not entirely sure what we'd do with the top honour if we ever won it anyway. There are a few exceptions, of course. Hockey is one. Our beer is unequalled on this continent. And grumble though we might, we're fairly proud of our universal medicare.

Witness the national pride in our "silver streak" at the Beijing Olympics. Eighteen trips to the podium, fifteen of them for almost winning. We cheered just as much when Mike Brown narrowly missed bronze by 0.09 seconds in the 200-metre breaststroke, as when Simon Whitfield found his extra gear and almost took the marathon.

Whereas the Chinese openly cry when one of their poster athletes misses his or her mark, we raise a glass to the noble effort. According to a Canadian Press/Harris Decima poll almost 80% of us were quite satisfied with our athletes' performance in Beijing.

And why not: it was our second-best Olympics of all time.

For the second-largest country on the planet, with the ninth-largest economy and the thirty-sixth-largest population, any day we're invited to eat at the big people's table is a good day. We earned that right gradually during the 20th century, and at no more remarkable a time than during and directly after World War II.

It was a time of great sacrifice, but also great scientific progress and some rare firsts for Canada, especially in the nuclear field. As the war began the NRC's George Laurence unpretentiously built the world's first graphite pile, and by war's end we were putting together the world's most powerful research reactor.

Our greatest nuclear achievement at this time, however, was a silver medal: second nation to create a sustained nuclear chain reaction (ZEEP), which was also the world's second heavy-water reactor. We ended the war with the world's second-largest nuclear infrastructure and we were pretty darned proud of it.

Then something strange happened.

The war had bootstrapped us to the gold medal podium in nuclear science, and for many years afterward it seemed to be Canada that set the standard. Nuclear physics, metallurgy, chemistry, radiobiology, environmental science, electronics, digital control, plant design… The world beat a path to our door.

Eventually times changed and budgets shrank, but we emerged with a world-leading power reactor that still holds the silver medal for popularity around the world. Moreover, as times continue to change the dream of resource efficiency and fuel-cycle flexibility is arousing new interest in our strange machine (which still holds the gold medal in those areas).

Ironic, because at home we seem to have trouble, at times, deciding whose technology to go forward with. At least that's the official story, and it's downright insulting to Canadians who paid over $6 billion to develop a home-grown industry which competes in the big leagues. That the question is even asked is astounding.

Like our Olympic athletes, the CANDU reactor deserves this country's fullest support in maintaining its competitive edge, and there should be no question about where taxpayers' money will be spent on new machines.

It is our Adam van Koeverden, and a Canadian rarity: something sent into the game to win. This isn't entitlement but earned respect.

In the cut-throat world of reactor sales, it ain't no honour to just be nominated.

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