Annual Industry Review & Buyers Guide

2012

Nuclear Canada Yearbook

50 Years of Nuclear Electricity in Canada




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M.D. Gabbani, B.Sc., P.Eng
Vice President
Sales & Marketing

T 705 748 7944
F 705 748 7338
M 705 760 1288
mike.gabbani@ge.com
1160 Monaghan Road
Peterborough, ON K9J 7B5
Canada

HITACHI GE Hitachi Nuclear Energy Canada

T. Dale Cosh
Sales Manager
Nuclear Services

T 705 748 7946
F 705 748 7338
M 705 930 3681
dale.cosh@ge.com
1160 Monaghan Road
Peterborough, ON K9J 7B5
Canada

HITACHI GE Hitachi Nuclear Energy Canada

Ed Genge
Parts Sales Manager
Nuclear Services

T 705 748 7039
F 705 748 7076
M 705 875 8045
edward.genge@ge.com
1160 Monaghan Road
Peterborough, ON K9J 7B5
Canada

CNS President's Report

Frank Doyle

The past year has been very successful for the Canadian Nuclear Society with the delivery of six major conferences and two courses; the publication of the inaugural edition of the Yearbook under the CNS banner; the release of a documentary on Lord Rutherford sponsored by the CNS; the positive outcomes of the Officers' Seminar; and the numerous Branch and Committee activities throughout the year. Our society is vibrant and strong and continues to enjoy excellent support from our members and stakeholders. We can all be proud of what we have achieved over the years and, while the industry and the CNS face many challenges, we can look forward to building on our success and helping to maintain a strong nuclear industry in Canada.

CNS members continued to be engaged throughout the year in assessing the impact of the Fukushima event and disseminating information to our members and the public at large. The CNS was also an interested and active stakeholder in the restructuring of AECL and expressed the need for AECL to remain a viable supporter for the CANDU industry, and stressed the importance of maintaining a research and test reactor at the Chalk River Laboratories.

Throughout the year CNS continued to evolve its Strategic Plan for the future, including adoption of a protocol to strengthen the Branches and Divisions primarily serving the direct interests of the operating plants. Consistent with the Strategic Plan, Dr. Ben Rouben assumed the inaugural role of Executive Director and Dr. Jeremy Whitlock assumed the inaugural role of Communications Director. In addition, Dr. Dorin Nichita is in the process of establishing the infrastructure to commence publishing a scientific journal to serve the needs of the CNS. All these initiatives, consistent with the long term Strategic Plan, are designed to help ensure the CNS continues to serve the needs of our members and stakeholders in a viable and sustainable manner.

June 4, 2012 will be a milestone for Nuclear in Canada marking the 50th anniversary of the production of electricity from the Nuclear Power Demonstration (NPD) plant. Throughout 2012 the CNS is celebrating this event in our Branch seminars and in the June conference in Saskatoon. We are honoured to have with us at these events a number of the pioneers in Nuclear in Canada, including Dr. Lorne McConnell, the first NPD Station Manager. Participants at these events receive a specially designed commemorative coaster in honour of the occasion.

Looking to the future, the CNS will host the Pacific Basin Nuclear Conference (PBNC) in Vancouver in 2014. This resulted from a successful bid in 2011, and it will be the third time Canada will host this major conference. In our continuing engagement, the PBNC 2014 CNS organizing committee contributed significantly to PBNC 2012 in Korea with a plenary paper presented by Dr. Bill Kupferschmidt and additional papers presented by Dr. Ben Rouben and Mr. Juris Grava.

This brief message could only list but a few of the highlights of the year; you will find more on the CNS activities included in the Yearbook, quarterly Bulletin and on our website.

Frank W. Doyle
CNS President, 2011-12.

Construction at Qinshan, summer 2000

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Sources

Buyer's Guide

Publisher: Colin Hunt
Editor: Colin Hunt
Advertising Sales Manager: Marlene Thomas
Circulation Manager: DT Perspekta Consulting
Printer: General Printers
Graphic Design: excentric.ca

Published by the Canadian Nuclear Society
655 Bay Street, 17th Floor
Toronto, ON M5G 2K4
Tel. (416) 977-7620
Fax (416) 977-8131
Email: cns-snc@on.aibn.com
Website: www.cns-snc.ca
Price: $18.50

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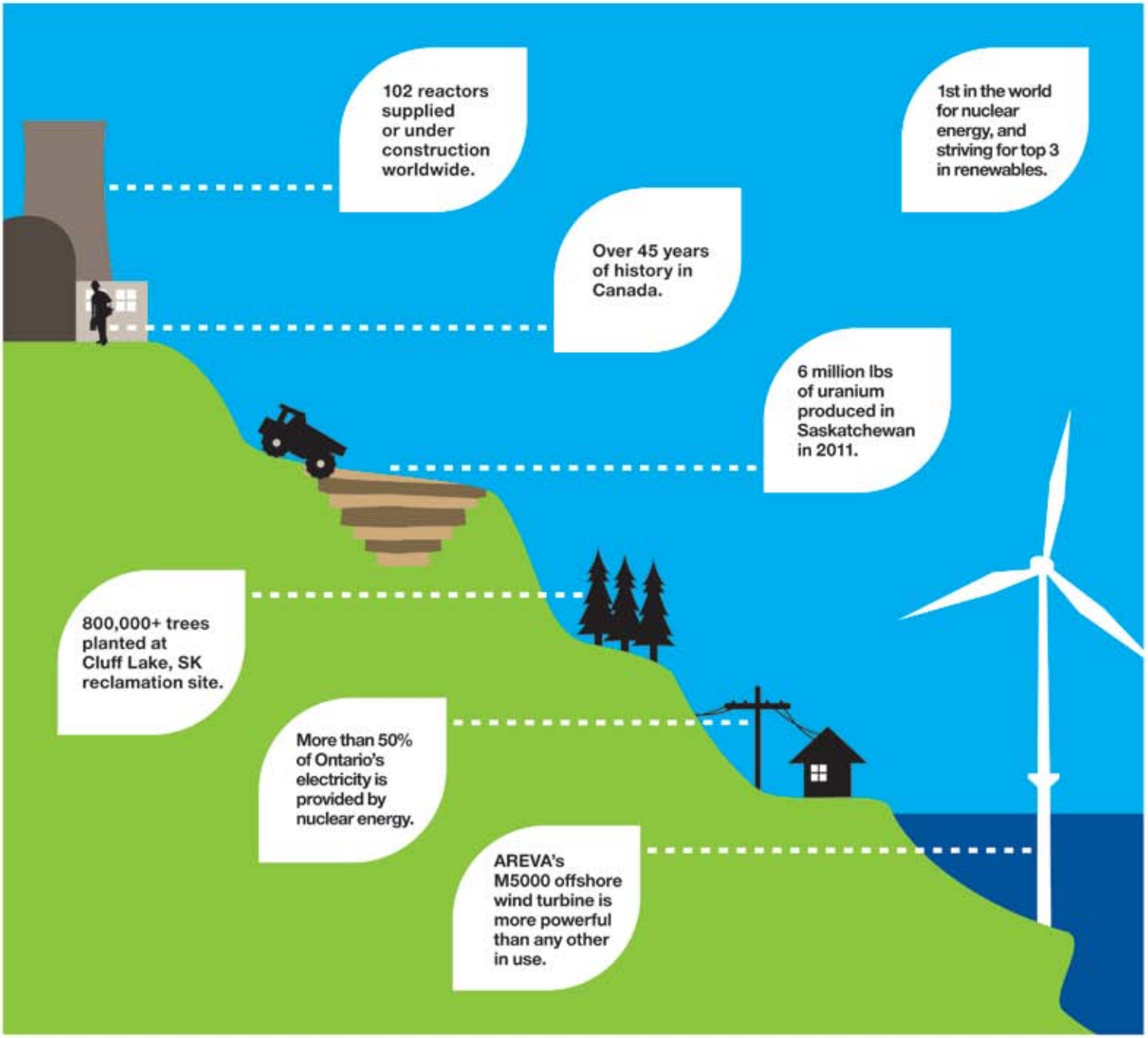

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2011 Year in Review

By Colin Hunt, Publisher and Editor
Nuclear Canada Yearbook

Colin Hunt

Overview

2011 was marked by a number of highly important events for nuclear power around the globe. The most important of these was the earthquake and tsunami that occurred in Japan on March 11 resulting in the accidents to four of the six reactors at the Fukushima-Daichi nuclear power plant. This accident was the focus of world attention for most of the remaining year during the efforts to contain the consequences. It was to have important effects on various nuclear programs around the world.

The year was also an important one for Canada's nuclear industry as well. There was a very large reorganization of Atomic Energy of Canada Limited (AECL) which saw the power reactor division of the company established as a separate business unit and sold to SNC Lavalin Inc and established as a new company, Candu Energy Inc.

Canada's nuiclear reactor fleet performed well during the year. Strong progress was made on the refurbishment of CANDU reactors, specifically Bruce Units 1 and 2 in Ontario, and Point Lepreau in New Brunswick. During the year, the Korea Electric Power Company (KEPCO) also completed its refurbishment of its Wolsong 1 reactor, becoming the world's first utility to complete the refurbishment of a CANDU 6 reactor.

CANDU 6 Nuclear Reactor Performance – December 2011

Reactor	In Service	Capacity (MW)	Performance In 2008 (%)	Lifetime Performance (%)
Point Lepreau*	1983	680	0	74.0
Gentilly 2	1983	675	59.6	77.1
Wolsong 1*	1983	622	0	81.2
Wolsong 2	1997	730	99.6	94.1
Wolsong 3	1998	729	97.5	95.2
Wolsong 4	1999	730	94.3	95.8
Embalse	1984	648	68.5	84.4
Cernavoda 1	1996	706	99.7	89.9
Cernavoda 2	2007	705	91.1	94.0
Qinshan 4	2002	700	94.9	90.4
Qinshan 5	2003	700	92.7	91.2
Total		**7625**	**72.2**	**87.9**

COG CANDU/PHWR Performance Indicators, December 2011.
*These reactors under reconstruction.

Earthquake at Fukushima

On Friday, March 11, 2011 at 2:46 p.m. eastern Japan was struck by a powerful earthquake measuring 9.0 on the Richter Scale. The earthquake occurred in the Pacific Ocean along 200 km of a fault line approximately 130 km distant from the city of Sendai. Fourof the nuclear reactors at the Fukushima-Daichi nuclear power station were damaged by the earthquake, particularly the tsunami. The immediate sequence of events during and immediately after the accident were described in last year's Yearbook.

Chalk River Laboratories

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2011 Year in Review

All of the subsequent activity in 2011 was preoccupied with recovery from the accident, achieving cold shutdown for all four reactors, and cleaning up damage and radiation contamination from the accident. The principal cause for concern occurred on March 15, 2011 when a series of hydrogen explosions resulted in several large airborne releases of radiation.

The first immediate requirement to contain the accident was the need to provide cooling water for the damaged reactors. Though all reactors were in a shutdown state, residual decay heat was still very much present and needed to be removed. What is now understood is that most of the fuel in Units 2 and 3 has melted into the bottom of the reactor vessels. In Unit 1, most of the fuel has fallen into the bottom of the reactor containment vessel.

The immediate need for cooling was met by pumping seawater into the reactors. Initially, the water was pumped through the reactors and into the building sub-basements. During May and June, there were several large leaks of this radioactive water to the ocean. In June however, the first of three water purification plants came on line. Instead of simply accumulating radioactive water, it was now purified and returned to the reactor as coolant, thus closing the reactor water cycle.

In addition to provision of cooling water, the following have all been achieved by the end of 2011:

- Radioactive rubble has been mapped, and large amounts removed to provide better site access. Inhibitors have been sprayed on soil within the plant to prevent airborne releases.
- A cover has been built over Unit 1 to prevent radiation releases. Similar covers over Units 3 and 4 will be completed in 2012.
- An additional support structure has been completed for the Unit 4 spent storage pool.
- Sea barriers have been placed around the station to prevent contaminated water from escaping.

With respect to the reactors themselves, the reactors continued to cool during the summer. Cold shutdown was achieved by October of all four units, and the government announced that this had been achieved after tests in December, 2011.

Recovery from the accident has led to a number of innovative techniques to contain the accident. These include:

- The use of concrete pump trucks to direct water into the spent fuel storage pools during the early days of the accident.
- The use of a floating platform to provide water storage.
- Using robots to map locations of the fuel elements and to determine building radiation levels.
- Establishing first-of-a-kind filtration systems capable of separating large amounts of radioactive materials.

At this time, all four reactors are in complete cold shutdown. There is no longer any significant possibility of large releases of radiation or radioactive material from any of the reactors. With the achievement of these conditions, TEPCO (Tokyo Electric Power Company has completed its long term plan for the site. All fuel elements will be removed from all four reactors. All spent fuel will be removed from all four storage pools. All of the radioactive water stored on site will be cleaned and processed. The plan is to fully decommision the plant after 40 years.

On March 12, 2011, the Japanese government ordered an evacuation of all population within 20 km of the plant. About 100,000 people were evacuated from this area. A further 10 km. radius was declared an emergency preparedness zone in which people were instructed to stay indoors or to leave. This latter restriction was ended in September.

The principal radiation escaping from the reactors came in the form of airborne releases of Iodine 131 and Cesium 137. The principal radiation hot spots were found within the nuclear plant boundary, but there were some highly localized hot spots found up to 50 km. distant from the plant, mostly to the northwest. These areas were also evacuated. Nearly all of the radiation releases occurred in the first two weeks after the accident. By the end of April, radiation releases had fallen by a factor of 10,000. And by August, the radiation releases had fallen to less than that deemed acceptable for a nuclear plant operating normally. It should be noted that, even damaged, plant containment structures retained most of the radioactive inventory within all four reactors. The total radiation release from all four reactors was approximately one-tenth that of Chernobyl Unit 4 in 1986.

The Japanese government set a very conservative requirement for evacuation for an estimated maximum dose 20 mSv/year. Many heavily populated areas of the world have much higher natural radiation background levels. As a consequence of this, no fatalities or injuries to the general public are expected. Japan has undertaken a large scale soil removal and decontamination program as well. The target is to reduce radiation exposure to less than 1 mSv per year. The International Atomic Energy Agency (IAEA) has recommended against an extensive soil removal program as providing no benefit for the very large cost.

Six plant workers have had doses slightly exceeding the emergency regulatory limit of 250 mSv. Based on this, no deaths or injuries from radiation are expected among the plant workers either.

The effect on the rest of Japan's nuclear reactor fleet has been profound. In response to heightened public concern, reactor operators decided that no reactor in the country would be restarted after it had been shut down for maintenance and refueling. At the time of writing, only two of Japan's 51 nuclear reactors are operating, a condition which has led to severe electricity shortages. The Japanese government ordered that none of the reactors would be restarted until they had passed a series of stress tests. Many have now submitted their results to the regulator, but no permission has yet been granted for the restart of any idled units. In addition, approval is required from the local prefecture.

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Building on our past ...

NPD historical plaque, installed by CNS and Ont. Heritage Foundation, June 2002

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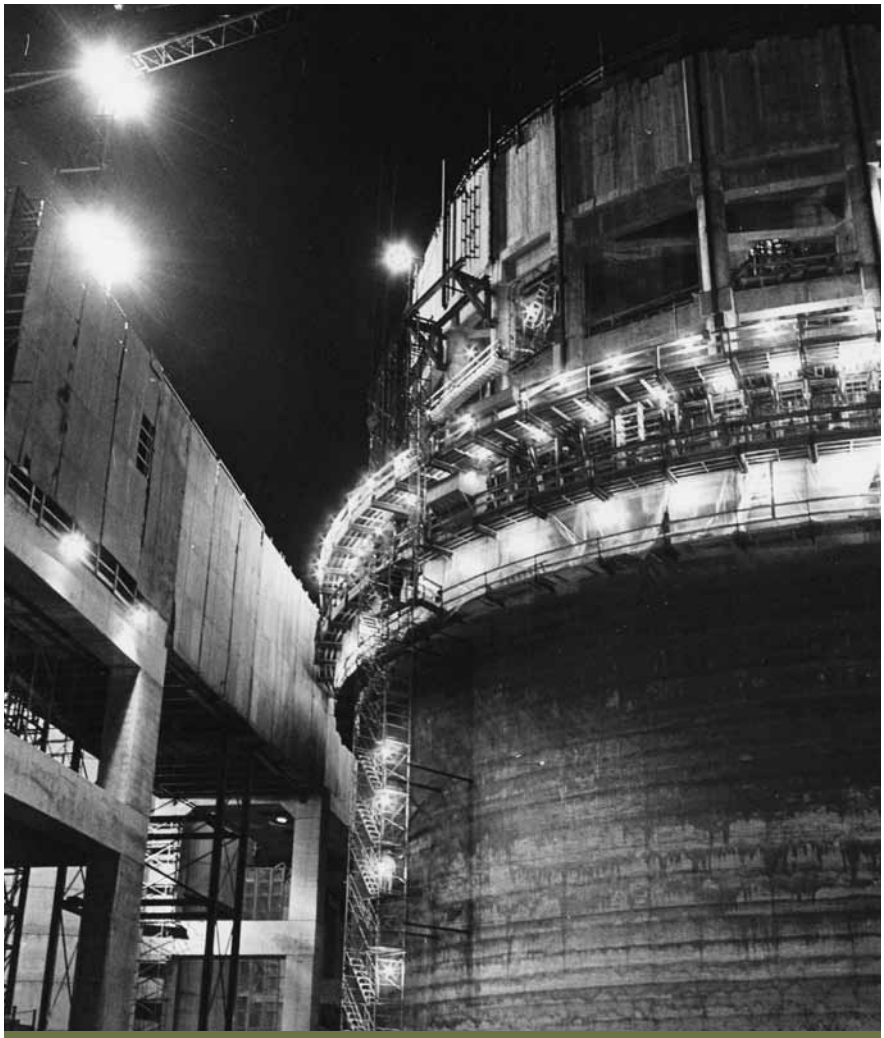
2011 Year in Review



CANDU construction at nighttime

At this time, all four reactors are in cold shutdown. There is no significant possibility of radiation release from the Fukushima-Daichi site. TEPCO has now commenced its full decommissioning of all four reactors. No plant worker or member of the public has been killed or injured by radiation released from the reactors. Given the dosages received, none will be in the future either.

Canada's Nuclear Industry

Canada's nuclear reactors performed well during 2011, as noted in the performance data tables located in this Yearbook.

Twelve of Canada's reactors performed well above 80 per cent capacity factor for the year. Particularly outstanding was the performance of Pickering 7 and 8, Bruce 4 and 6, and Darlington 2, 3 and 4, all of which performed well above 90 per cent. In general, Canada's nuclear reactor fleet continued the trend over the last decade of improving performance on a year over year basis.

There was also a very important decision made in 2011 with respect to new reactor construction. The environmental review process for new nuclear reactors at the Darlington site was completed. The joint federal-provincial review panel released its findings, concluding there were no adverse environmental impacts from the proposed construction at the site.

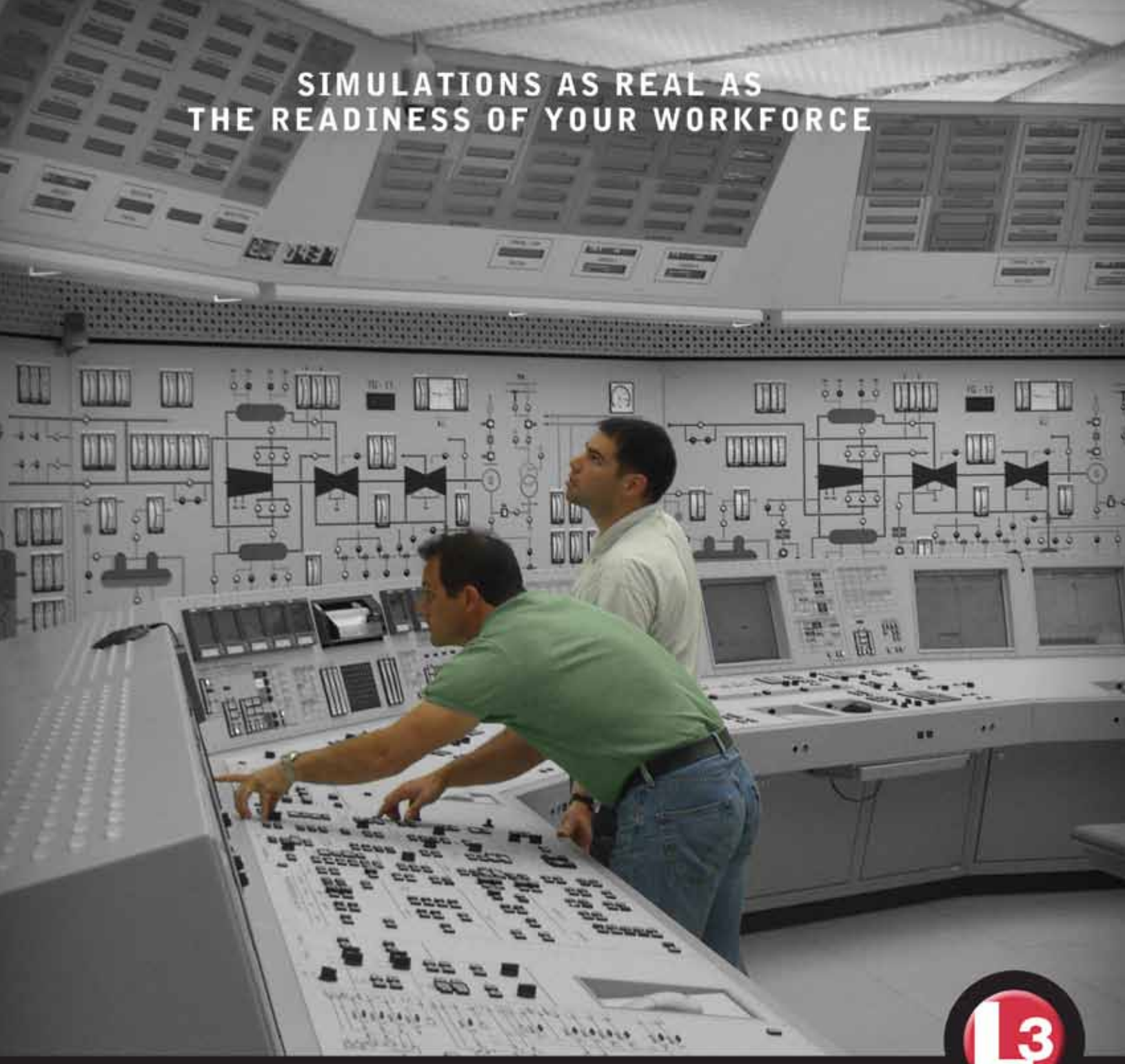
Three reactors continued their refurbishment programs, Point Lepreau, and Bruce Units 1 and 2. Bruce Unit 2 completed its construction activities on January 24, 2011, while work was completed on April 29. For both units, commissioning actvity commenced. Bruce Unit 2 completed fuel loading on July 11, while fuel loading was completed in Unit 1 on November 30. Refilling the reactors with heavy water was underway before the end of the year. Both units are expected to return to full service in 2012. With respect to Point Lepreau, it completed its fuel channel replacement on November 13. This reactor too is expected to return to service in 2012.

With respect to CANDU reactors outside Canada, performance during the year was also very good, as shown in the CANDU 6 reactor performance table. Seven of eleven CANDU 6 reactors performed well over 90 per cent capacity factor for the year. One of the oldest of the CANDU 6 reactors, Wolsong 1, completed its refurbishment activity during 2011. The reactor was restarted on June 3, achieving full power by July 18. The reactor was shut down for refurbishment in April 2009. Its refurbishment and restart in less than 27 months makes it the first CANDU 6 reactor to complete a full refurbishment including pressure tube replacement.

AECL Restructuring

On June 29, the government of Canada announced that it was divesting itself of the power reactor division of AECL. It was sold to SNC Lavalin Inc. and formed as a new company Candu Energy Inc. The agreement was formally concluded in October 2011.

Candu Energy Inc. has already attracted some new business during the year. In August, the company signed a new contract with NA-SA in Argentina for part of the full refurbishment of the Embalse nuclear



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power reactor. Candu Energy is currently completing its work at the Point Lepreau reactor, and it has finished its work with Bruce Power's Unit 1 and 2 refurbishment programs.

Employing a total of 1400, Candu Energy specializes in three project lines, CANDU services, life extension and new construction. The company is expected to concentrate its efforts on the CANDU 6 and Enhanced CANDU 6 nuclear reactors. Patrick Lamarre, President of SNC Lavalin Nuclear, a companion subsidiary of the SNC Lavalin Group, has indicated there is great potential for future new business in Romania, Argentina, China and India, all of which have existing CANDU technology. He has also indicated possible opportunities in Turkey, Ukraine, Jordan and Poland.

The government of Canada is expected to continue its programme of restructuring AECL by seeking partners for the research portion of AECL at Chalk River and Whiteshell Laboratories.

Uranium Mining

Cameco Corporation spent 2011 engaged in recovery of the Cigar Lake uranium mine. Cigar Lake is one of the largest and richest uranium ore bodies in the world. Mine development was halted in 2008 while under construction by water inflow. During 2010, Cameco completed dewatering of the mine and started restoration of the underground works.

During 2011, Cameco achieved the following important steps in recovering the mine:

- Underground miningy systems, infrastructure and development areas were restored.
- Freezing of the ore body commenced.
- A modified mine plan received regulatory approval.

A key milestone was achieved on January 3, 2012 when it completed the second shaft at Cigar Lake connecting to the main mine workings at 480 metres below the surface.

2011 also marked another important event for the company. Tim Gitzel was appointed President and CEO of the company, replacing retiring President Jerry Grandey. Mr. Grandey had served as President and CEO since 2003. In so doing, Cameco has continued to find its CEOs within the company rather than recruiting from outside. Mr. Gitzel was previously Senior Vice-President and Chief Operating Officer for Cameco.

International Developments

Two new heavy water reactors entered service in India during 2011. Kakrapar Unit 1 and Kaiga Unit 4 both started up in January 2011. Kakrapar 1 had been shut down for refurbishment and life extension in 2009. Kaiga 4 is a new nuclear reactor. Both are 235 MW units. Kaiga 4 is the last such heavy water reactor to be completed in India, with all the remaining heavy water reactors under construction of larger size.

With respect to other reactor activities, probably the most important were the reactions to the accident at Fukushima. The most extreme reaction was that of Germany. The government ordered eight of the country's 17 nuclear reactors to close. The remaining nine reactors were all to be closed by 2022. Neither the government nor Germany's regulatory authority provided technical reasons for the ordered closures. The operating utilities have indicated they would expect compensation from the government for the premature shutdown orders.

During the year six new nuclear reactors entered service around the world. A total of 13 were shut down, all but one as a result of the accident at Fukushima. The new reactors include Kaiga Unit 4 in India, Ling-Ao II Unit 2 and Qinshan II Unit 4 in China, Bushehr in Iran, and Kalinin Unit 4 in Russia. In addition, China also connected its firt fast reactor to the grid in July, the Chinese Experimental Fast Reactor (CEFR). In total the six units represent 4,000 MW of new generating capacity.

Three new nuclear reactors began construction during the year, Pakistan's Chashma 3 and India's Rajasthan 7 and 8. RAPS 7 and 8 are the first of India's 700 MW heavy water moderated reactors. China was expected to commence work on three reactors during 2011, but work was temporarily suspended as a result of Fukushima. The country has 25 reactors under construction at this time.

Only one reactor was closed for reasons other than Fukushima during the year. Britain's Oldbury Unit 2, a Magnox reactor in service since 1968, was closed at the end of its useful life for decommissioning.

In Closing

2011 has been a successful year for Canada's nuclear industry. Performance for all operating reactors was strong throughout the year. The Korean refurbishment project was completed, while those in Canada approached the final stages. In uranium mining, Cameco Corporation completed important work prior to full recovery of the Cigar Lake uranium mine.

However, events of the year were overshadowed by the accident at Fukushima. While no one was killed or injured by radiatin from the accident, it has caused operators and regulatory authorities around the world to reconsider some basic assumptions about nuclear safety and performance. In particular, increased scrutiny is being applied to consider safety implications of events resulting in a loss of grid connections and the need for reliable backup power supplies against external events.

NRU reactivity deck

NRU History and Overview

CANDU – a 50th anniversary

The story of NPD, the design that gave birth to CANDU. By Fred Boyd, CNS Bulletin Publisher

Fred Boyd

When people talk about the Canadian nuclear program, the word CANDU is prominent. This year, 2012, marks the 50th anniversary of the first nuclear power plant with the unique aspects of the CANDU design – natural uranium fuel; heavy water moderator and coolant; on-power fuelling; computer control; independent safety systems.

All of these characteristics were first introduced in a small (20 MWe) plant called Nuclear Power Demonstration (NPD) which first started operation in the early hours of April 11, 1962. That historic start-up was witnessed by a small crowd of scientists, engineers, operators, regulators, and others. (*See historic photo.*) Almost exactly two months later, on June 11, 1962, it sent out the first nuclear generated electricity in Canada to the Ontario grid with much less fanfare. It was not called CANDU. That acronym came a few years later after the start-up of the larger (200 MWe) demonstration plant called Douglas Point.

Prelude

The origins of the NPD design go back to the Montreal Laboratory during the Second World War. A small number of British and European nuclear scientists were moved

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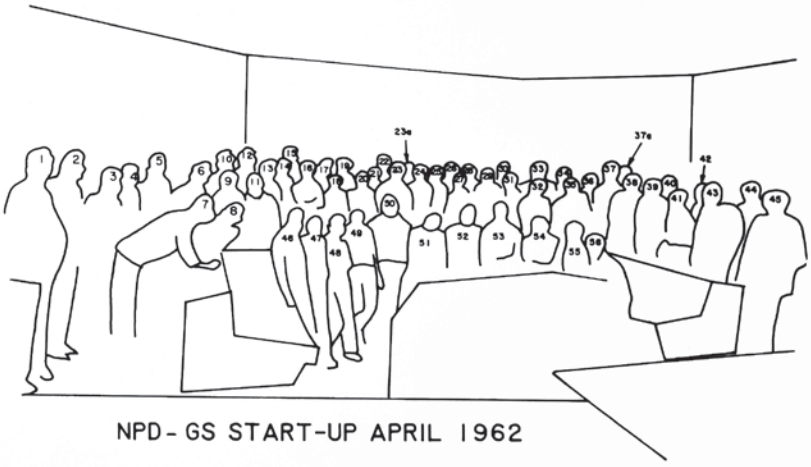

NPD: the startup station crew

from the UK to Canada in 1942 for a joint UK, Canada, USA, project related to the effort to create a nuclear weapon. Those scientists were joined by a number of Canadians headed by George Laurence who had built a sub-critical reactor at the National Research Council in Ottawa.

The Montreal Laboratory team developed the theories and concept for a natural uranium fuelled, heavy water moderated, reactor that could also produce plutonium as part of a UK, USA, Canada wartime objective.

Following the choice in 1944 of Chalk River as the site for a nuclear laboratory, a small reactor named ZEEP (from Zero Energy Experimental Pile) using natural uranium rods in a vessel of heavy water, was built to test the concept. When it first went critical on September 6, 1945, it was the first reactor outside the USA. At the same time a large (40 MWth) reactor called NRX (Nuclear Research Experimental) was under construction. It started operation on July 22, 1947.

When the Second World War ended in 1945, the Canadian government was faced with the question of the future of the fledgling Canadian nuclear program. It decided to redirect the program to peaceful applications and passed the Atomic Energy Control Act in May of 1946. That Act established the Atomic Energy Control Board (AECB) which would have "control and supervision over the development, application and use of atomic energy in Canada". Later that year the AECB assumed responsibility for the Chalk River Nuclear Laboratory (CRNL) and then assigned operating responsibility for CRNL to the National Research Council, establishing what was called the Atomic Energy Project.

In December, 1950, federal government approval was given to build a much larger research reactor, NRU (National Research Universal). NRU achieved first criticality on July 22, 1957, exactly 10 years after NRX... Its neutron flux was the highest flux of any research reactor in the world at that time. Of particular note, NRU incorporated technology to enable the

NPD: the moment of Canada's first electricity from nuclear power

reactor fuel to be changed while the reactor remained in full operation. This ability to refuel without shutting down the reactor was a world "first" and was, subsequently, to play an important role in the success of the CANDU power reactors.

In early 1952 the Canadian government created Atomic Energy of Canada Limited (AECL) as a crown corporation to take over the assets and responsibilities of the Atomic Energy Project. The minister in charge, C. D. Howe, aware of the potential for nuclear reactors to generate electricity, included four senior Canadian utility representatives on AECL's first Board of Directors. One was Richard Hearn, the Chief Engineer of the Hydro Electric Power Commission of Ontario (HEPC, to later become Ontario Hydro). Hearn was attracted to the concept of nuclear-generated electricity because Ontario was running out of undeveloped hydraulic capacity.

HEPC and AECL agreed to proceed with a jointly-funded feasibility study aimed at defining a pilot nuclear power plant. Given the experience with NRX, the heavy water moderated, natural uranium fuelled, reactor concept was considered to be the first choice. Harold Smith, a senior engineer with HEPC was appointed head of the study team with John Foster, on loan from Montreal Engineering, as his deputy.

The team recommended proceeding with the design and construction of a small demonstration power reactor which the AECL Board approved, in principle, in late 1954. Seven private Canadian companies were invited to submit proposals for this work. As well as funding the project, AECL undertook to provide nuclear-related technical data and undertook responsibility for supplying nuclear fuel, heavy water, and appropriate expert personnel from its staff to the envisaged project.

Although NRX had shown the viability of the heavy water moderated, natural uranium fuelled design, it operated at low temperatures. To produce power the coolant temperature would have to be increased significantly.

The study team proposed the use of a pressure vessel. Basically the concept was to place an NRU-type core inside

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a thick-walled steel pressure vessel. By pressurizing the heavy water coolant and moderator to about 100 times atmospheric pressure the operating temperature of the coolant could be increased to about 300 degrees Celsius, suitable for power production.

It was decided to use an alloy of the metal zirconium as the fuel cladding material, instead of aluminum as in NRX and NRU. Zirconium offered acceptable tensile strength at elevated temperatures with a low capture of neutrons. Tests for the US program, done in NRX, had shown the suitability of this new alloy, called Zircaloy.

AECL received proposals from the private companies interested in undertaking the design and construction work early in 1954. The chosen bidder was Canadian General Electric (CGE)[1] because of its broad-based engineering and manufacturing capability and its offer to contribute significant funding to the program. HEPC offered to participate through providing the conventional portion of the power plant and undertaking to purchase the steam produced. The arrangement was accepted by AECL and, subsequently approved by the federal cabinet on March 23, 1955.

Design team

An initial design team, numbering less than 30, was assembled in mid-1955 in a relatively new building at CGE's works in Peterborough, Ontario. Some were from the joint study team; others were recruited from within AECL and CGE. The initial accommodation was primitive by today's standards. It was a young team, most were in their 20s a few in their 30s.

Called the Civilian Nuclear Power Department (CAPD) the group was nominally headed by Ian McRae, the Chairman of CGE, with Ian Mackay, of AECL, as Manager of Engineering and John Foster, Manager of Design.

Some members of the joint study team, including Harold Smith, stayed at Chalk River to work on the conceptual design of a much larger unit (200 MWe) intended to follow the smaller unit.

A site for NPD was chosen near HEPC's Des Joachim hydraulic generating station on the Ottawa River which was close to AECL's Chalk River laboratory and had access to power transmission lines.

Based on tests carried out for the U.S. navy in the NRX reactor it was decided to switch from uranium metal as the fuel material to uranium dioxide (UO_2) which had excellent dimensional stability during irradiation and much greater corrosion resistance.

Major Design Change

While work proceeded on the detailed design of NPD, the study team at Chalk River reached a conclusion of major importance regarding the larger reactor; that it should use pressure tubes rather than a pressure vessel. This conclusion was driven by two factors.

The pressure vessel required for the larger reactor would be far bigger and heavier than could be manufactured in Canada with any existing facilities. It would have a diameter of about fifteen feet and weigh several hundreds of tonnes.

The other was that early in 1957, contractors for the U.S. Atomic Energy Commission had established a viable fabrication process for pressure tubes made of Zircaloy. Testing had been done in NRX. The availability of Zircaloy pressure tubes meant that a practical pressure tube reactor could be built.

This conclusion then posed a vital question. Should NPD continue as a pressure vessel reactor or should it be redesigned as a pressure tube reactor? Work had already begun on the site and a pressure vessel was being built in Scotland. Changing the fundamental design would involve a major project delay and additional costs. Nevertheless, in March, 1957, the AECL Board made the historic decision to redesign NPD as a pressure tube reactor.

In six months the CGE design team, which had grown to about 150 (including draftsmen who, at that time, were an important part of the team) produced a comprehensive report of about 500 pages titled "Preliminary Design Study for NPD 2"[2]. The new design incorporated all of the fundamental aspects of what later became to be known as CANDU.

Reactor

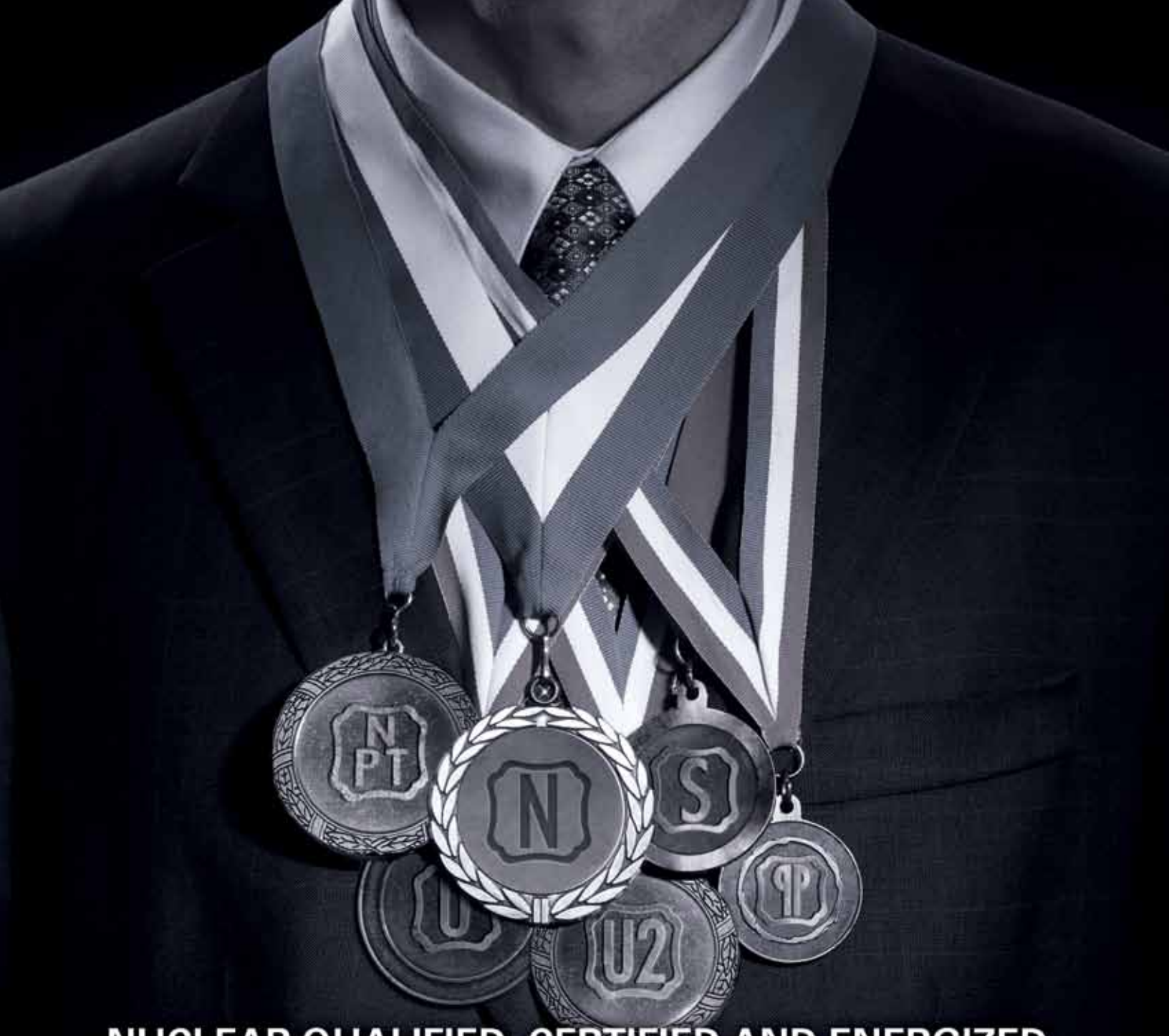
Unlike the vertical arrangement of NRX and NRU a horizontal orientation was selected to facilitate on-power fuelling. This still left the questions of reflector and control mechanisms. After comparing the advantages and disadvantages of heavy water, light water and graphite as reflectors, light water was chosen and has remained a feature of CANDU designs.

The calandria was a cylindrical aluminum vessel with double side and end walls to accommodate the light water reflector. There were 132 fuel channels with Zircaloy coolant (pressure) tubes of 8.25 cm. diameter surrounded by aluminum calandria tubes of approximately 10 cm diameter. Each coolant tube accommodated nine fuel bundles.

Moderator level was chosen for reactivity control, a concept that was not followed for subsequent CANDU designs. Control of the moderator level was achieved by pumps drawing from a "dump" tank. For shutdown there were three large "dump" valves that could be opened rapidly. Helium was used as a cover gas. The dump valves were triplicated and operated on a two out of three basis. This allowed individual valves to be tested during operation, a concept that continues today.

The reactor physics computation were done largely by hand although CGE acquired an early IBM machine that filled a dining-room size space and did no more than the simplest hand calculators of today.

1 The company is now called General Electric Hitachi Canada.
2 The name NPD-2 was used throughout the subsequent design and early operation.



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Fuelling Machines

The fuelling machines presented a major mechanical design challenge, which was taken on by a small team led by Bill Brown.

The scheme chosen used two identical fuelling machines, which would be connected to each end of the pressure tube being refuelled. One of the machines would push in the desired number of new fuel bundles, displacing the same number of spent bundles into the other machine. This meant closures on each end of the fuel channel which could be opened and closed by remotely operated fuelling machines. The machines would also need to be able to accept fuel from new fuel ports at each end of the reactor vault and discharge irradiated spent fuel to transfer ports for discharge to the spent fuel bay. All of this with minimal, preferably zero, leakage

These basic features of the refuelling arrangements have been retained in all subsequent CANDU reactors.

The initial NPD fuelling machine used internal hydraulic drives to preclude the problem of seals. There were a number of "teething" problems with the original fuelling machines and the first successful on-power refuelling did not take place until November 24, 1963. The system was not fully in service until 1964.

The original machines were replaced in 1969 by ones using an alternative arrangement developed for the prototype Douglas Point plant, involving ball screws and special shaft seals. This Mark II design was installed in 1969 and operated successfully for the balance of the life of the plant. Subsequent CANDU fuelling machines have used this concept.

Fuel

The fuel design chosen was a bundle 50 cm. long composed of seven elements of 2.5 cm. diameter. Some bundles with 19 smaller diameter elements were placed in the centre of the core where the flux was the highest. For the early fuel, wire wrapping was used to separate the elements and enhance mixing of the coolant. A modification was made for later fuel using pads brazed to the fuel sheaths. That feature has continued for subsequent CANDU units.

Although the basic fuel bundle concept remains, the design of CANDU fuel has evolved markedly over the years to achieve higher energy ratings and to meet various observed or predicted safety issues.

Control

The overall control of the plant, developed by a team under Warren Brown, was automated as much as feasible with computing systems of the time. This contrasted with the early power reactors in the USA, such as Shippingport, which required an operator to be continuously adjusting the control rods manually.

Safety

The accident at the NRX reactor in December 1952 resulted in much review of reactor safety by senior people at CRNL, such as George Laurence, Ernie Siddal and Don Hurst. One important conclusion was that the shutdown system should be separate from the operating control one. Another was the triplication of shutdown devices with operation on a two out of three system. This permitted one of the three to be tested while the reactor was operating. These concepts were incorporated in the NPD design and have been continued in all subsequent CANDU units.

Licensing

When AECL was created in 1952, the Atomic Energy Control Act, that had been passed in 1946 (one of the first in the world), was modified to transform the AECB from an overall government supervisory body to primarily a regulatory one. Although the Act did not bind the Crown, the participation of HEPC provided the basis for the AECB to license the plant.

NPD today, former training centre in foreground

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At the time, the AECB had only one professional staff who was largely involved in security and international affairs. However, in 1956, the AECB had established a Reactor Safety Advisory Committee (RSAC) to review the research reactor being built at McMaster University. The chairman was George Laurence, a senior director at Chalk River, who had been the senior Canadian at the Montreal Laboratory. The Board asked the RSAC to review NPD.

In early 1958, the NPD team prepared a "Preliminary Hazards Report" which consisted of one volume of about 300 pages. The report proposed a risk-based approach which had been pursued by Laurence and others. Although it did contain analyses of a number of possible failures, notably breaking of the primary system piping, those analyses would be considered simplistic against today's safety analysis standards.

Training facility

NPD became the basic training centre for the expanding HEPC/Ontario Hydro (OH) nuclear program. To accommodate the growing numbers of trainees and the training staff under George Howey, a new building was erected on the NPD site. The NPD Training Centre contributed greatly to the success of the rapidly expanding OH nuclear program in the 1965 to 1985 period.

Final shutdown

NPD operated for 25 years, providing invaluable experience to later designs and serving for many years as a vital training facility for later generations of operating staff. It was taken out of service in 1987 when its pressure tubes had reached the end of their service life. NPD had more than fulfilled its original intended purpose and the cost of retubing the reactor could not be justified in view of its small (20 MWe) electrical generation capacity.

Legacy

Douglas Point

The design concept of NPD became the starting point for all of the CANDU type reactors that followed.

Before the construction of NPD was completed HEPC and AECL jointly decided to proceed with the design of a larger 200 MWe "demonstration" plant. In 1958 AECL created a Nuclear Power Plant Division headed by Harold Smith and located it initially in a large HEPC property in the Toronto suburb of Mississauga.

Initially the demonstration plant was called CANDU for CANadian Deuterium Uranium but, when built was named the Douglas Point NPP. CANDU became the generic name for the concept.

In 1959 Smith was named Chief Engineer of HEPC and John Foster was appointed head of NPPD. Initially NPPD had a staff of about 30, half from AECL, the remainder on loan from various companies such as Babcock and Wilcox, Montreal Engineering, Dominion Bridge and others. The staff grew rapidly. By 1969 it numbered 875 by which time it had moved to Sheridan Park in Mississauga.

Douglas Point achieved criticality on November 15, 1966 and delivered its first electricity to the Hydro grid the following January. It encountered a number of early operating problems. Nevertheless, once these problems were overcome, Douglas Point operated successfully for many years, providing invaluable experience which benefitted the subsequent CANDU units. Douglas Point was removed from service in 1984 when replacement of its pressure tubes, which were nearing the end of serviceability, could not be economically justified.

However, the Douglas Point design lived on in India. In 1963, with the approval of the Canadian and Indian governments, AECL signed an agreement with the Indian Department of Atomic Energy (DAE) to build two similar units in Rajasthan. India subsequently built 12 more plants of the same basic design and six of a higher power version.

Pickering-A

In June of 1963, with Douglas Point under detailed design and construction and NPD in its early operating phases, agreement was reached between HEPC and AECL for the conceptual design of a 500 MW electric CANDU unit. This was undertaken by a small team of engineers in AECL's NPPD. The unit size was chosen to match that of the 500 MW coal-fired units of Hydro's new Lambton station and represented a unit size which previous studies had indicated would permit the economics of a CANDU unit to compare favourably with those of a Lambton unit.

The concept drew heavily on the design of Douglas Point and on the early operating experience gained with NPD.

One major design departure was adopted for the reactor itself, relative to Douglas Point and NPD, viz., a change to the internal diameter of the pressure tubes. This was increased from approximately 8 cm to approximately 10 cm with a corresponding increase in the number of fuel elements per fuel bundle from 19 to 28. In the interest of conservatism, the size of the individual fuel elements was not changed.

An agreement between AECL, Ontario Hydro and both the federal and provincial governments was developed. Ontario Hydro contributed the equivalent of two coal-fired plants; the federal government (through AECL) provided 54% and the Ontario government 46% of the additional cost. The Agreement called for the two governments to recover their investments in any savings in operating costs compared to the Lambton coal-fired units. (AECL derived an income from these plants for several years.)

HEPC proposed a site in the small town of Pickering about 30 km east of downtown Toronto. That site had been earlier proposed for the prototype Douglas Point plant but the AECB rejected it as being too close to populated areas. HEPC designers offered an enhanced, novel, containment system, using a large building connected to the reactor containment buildings. The concept was that in the case of a large loss of coolant accident (LOCA) the steam resulting from the LOCA would be automatically sucked into the building which would be kept at very low pressure. Hence the name "vacuum building".

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The RSAC/AECB accepted the concept with the stipulation that if the "vacuum building" became unavailable all units connected to it would have to shut down.

In 1965, HEPC decided to add two more units to the Pickering station. For those units a different zirconium alloy, using niobium, was used for the pressure tubes, a choice which has continued. Zr – Nb is more resistant to stress-corrosion cracking.

In 1969, before the completion of the first four units at Pickering, HEPC decided to build a four-unit station near the Douglas Point unit. It was called Bruce, after the name of the County. HEPC became the primary designer with AECL-NPPD contracted for the reactor design. The power of each unit was increased over those of Pickering to 750 MWe.

A major design change was the use of square reactor buildings. The designers could not convince the AECB's RSAC that the plant could sustain a "dual failure" which included failure to shut down. A year long discussion ensued with the AECB finally dictating that the reactor must have two independent shutdown systems. That concept is now standard on CANDU plants.

CANDU 6

With HEPC assuming primary design of its nuclear units, about 1970 AECL began looking at a single station design based on that of the Pickering reactors. By increasing the power to 600 MWe, this evolved into the CANDU 6 design. In the 1970s five CANDU 6 units were sold. These were Gentilly 2; Point Lepreau, Embalse (Argentia); Wolsong 1 (Korea) and Cernavoda (Romania). In the early 1990s, Korea added three more CANDU units to its Wolsong station. In the first decade of the 21st century two CANDU 6 units were built in China.

Diversions

The creation of NPPD essentially shut CGE out of the Ontario nuclear program. A small number of the CAPD staff did move to NPPD but CGE attempted to continue as a nuclear plant designer. In 1965 it signed an agreement with the Pakistan Atomic Energy Commission to supply a 137 MWe plant. This was designed very similar to NPD, including using moderator level for control.

NPD older aerial photo – Des Joachims dam (Ont. Hydro) and Hwy17 in background

Known as KANUPP, it started operation in 1972, was shutdown in 2002 for refurbishment and restarted in 2007. It is the oldest operating CANDU reactor.

Both AECL – CRNL and CGE studied other possible coolants than heavy water, specifically an organic one and boiling light water. In 1959 when AECL decided to open another research site in Manitoba CGE was contracted to design and build a heavy water moderated, organic cooled research reactor. It went into operation in 1965. Although successful, the organic program was discontinued in 1972, primarily because the CANDU design had proven successful and HEPC wished to continue with it.

Quebec expressed an interest in a nuclear plant but wanted substantial federal contribution. That was only available for a prototype. AECL proposed building a plant with a heavy water moderated reactor cooled with boiling light water. That proceeded and was built near the village of Gentilly. A design team headed by George Pon was established within NPPD. The plant started operation in 1972 but was shut down permanently in 1978 after intermittent operation. There were serious control problems associated with the boiling light water.

Concluding comments

The design of NPD incorporated many of the features that have been retained in successive versions of the CANDU concept. This is a testimony to the inventiveness and capabilities of the members of the relatively small and young design team who were supported by an enlightened management, supportive governments (federal and provincial) and a licensing system that concentrated on a risk-based approach.

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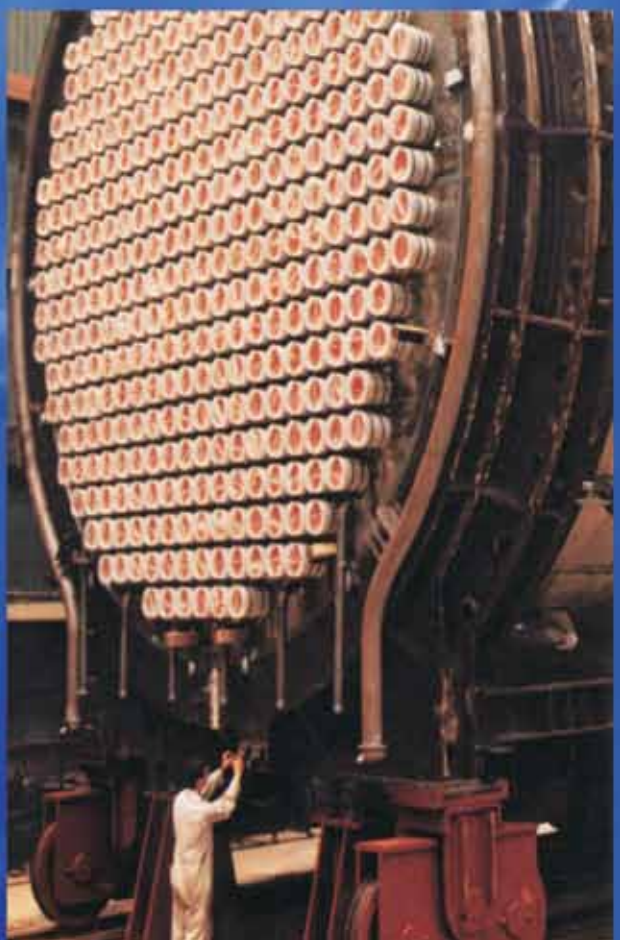

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2011 – CNS Program Review

By Len Simpson, CNS Program Chair

Consistent with its mandate, the CNS has a strong track record of organizing conferences, courses and seminars on subjects related to nuclear science and technology.

The combined CNS Annual Conference and CNS/CNA Annual Student Conference gathers together scientists, engineers, technologists, senior management, government officials, and students from across Canada, and from other countries. The central objective of this conference is to exchange views on how nuclear science and technology can best serve the needs of humanity, now and in the future. The 2011 Annual Conference was held in Niagara Falls and attracted more than…papers and 400 participants. The 2012 CNS Annual Conference is to be held in Saskatoon and in 2013 it will return to Toronto.

In addition to its Annual Conference, the CNS organizes various other conferences (normally on a bi-annual basis) as well as courses. The following events were held during the past year:

The CNS CANDU Reactor Safety Course was held in Toronto in March 2011.

The CANDU Reactor Safety Course is one of the most popular courses organized by the CNS. It has been offered at least once a year (and sometimes twice a year) since 1996. In each of the last two offerings the attendance was over 40 and this is quite typical. The course addresses a broad set of topics on reactor safety, and attendees always find that this allows them to get a better understanding of the way in which different disciplines impact reactor safety.

The CNS CANDU Reactor Physics Course was held in Toronto in March 2011

This course was organized by the newly formed Reactor Physics Group, a sub group of the Nuclear Science and Technology Division. It was very successful and attracted 47 participants. Along with the Reactor Safety Course, these courses are of great value to the industry

The 5th International Symposium on Supercritical-Water-Cooled Reactors (ISSCWR5) which was held in Vancouver in March 2011.

This biennial symposium, the premier venue for the exchange of technical information on Supercritical Water-cooled Reactors (SCWRs), was attended by 130 delegates from 16 countries. Canadian university participation at the symposium was high, with a large number of student presentations.

CNS Conference on Waste Management, Decommissioning, and Environmental Restoration for Canada's Nuclear Activities, 2011 Sept. 11-14, Toronto, ON

This conference was hosted by the CNS in Toronto September 11-14, 2011 and was attended by 400 participants, including nearly 50 representatives from potential host communities for locating a high level waste depository. The conference was followed by site visits on September 15 to Darlington, Port Hope, Kincardine and Bruce.

NURETH-14, 2011 Sept. 25-30, Toronto, ON

The NURETH 14 International Conference which was co-hosted by the CNS and the Thermal Hydraulics Division of the American Nuclear Society. It was held in Toronto September 25-30, 2011 and was attended by 500 participants, including 400 international participants from 30 counties with major representation from Europe, the Far East and the USA. Minister Joe Oliver gave the September 26 luncheon address with an upbeat message on the Canadian energy scene which included nuclear, and particularly the dominant role in the Ontario market.

CNS International Conference on the Future of Heavy-Water Reactors, 2011 October 2-5, Ottawa, ON

This conference was very successful in spite of the state of the economy and the uncertainty over the CANDU business at that time. This was mainly due to Laurence Leung's excellent work as Technical Program Chair.

9th CNS International Conference on CANDU Maintenance, 2011 Dec. 4-6, Toronto, ON

This conference was held at the Metro Toronto Convention Centre on Dec 4-6. The Conference met or exceeded all of its objectives:

- Delivery of the 'Needs and Interests of the Operating Utility (NIOU) message,
- Execution of an absolutely flawless conference program, and
- Success in securing continuing support from the industry.

Registrations were just shy of the target of 400, and the combined revenue from the sponsorships and exhibits were at target. Feedback from many of the >200 attendees was that the special 30 minute program held during the reception was one of the best they had seen in a long time, and that it really set the tone for the conference. The CANDU Configuration Overview Course, held as a concurrent session on Tuesday morning, was booked solid. This clearly shows the continuing need for these sessions to bring industry colleagues not acquainted with CANDU up to speed.

Comments From the Program Chair

All the above conferences were successful and are our prime source of revenue for the CNS. 2011 was a particularly busy year and the Division leaders played an important role in keeping their Divisions active. Our Fuel Division suffered somewhat from the personnel and ownership changes to the CANDU Business but are poised to put on a course in the coming year. Conferences are planned by the Nuclear Science and Technology Division and the Design and Materials Division in 2012.

The Design and Materials Division and the Operating and Maintenance Division are co-ordinating their activities to provide their conferences in alternate years and are reaching out to the reactor operators to increase the utilities' involvement in the various CNS Branches in their vicinity.

Continued on page 27...

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- OPG Pickering (8 Units)
- OPG/BP Bruce (8 Units)
- Quinshan China (2 Units)
- Embalse Argentina (1 Unit)

Designers and OEM's:
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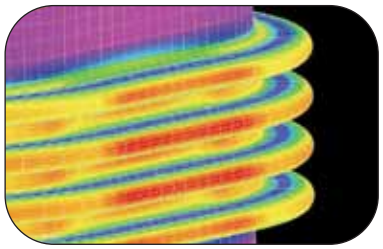

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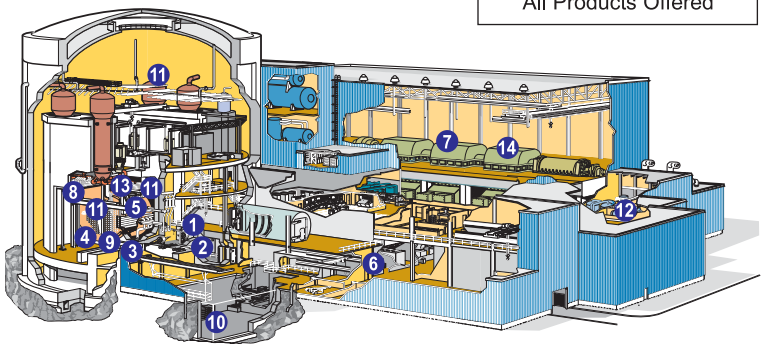

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3. F/M Catenary System Metallic and Non-Metallic Hoses and Adapters
4. F/M Head Fluid Quick Disconnects
5. Ion Exchanger Flexible Piping Systems and Quick Couplings
6. Water Treatment Flexible Piping Systems
7. Steam Metallic Braided Flexible Piping Systems
8. Core Feeder Flexible Piping Freezing Systems
9. Fueling Machine Flexible Piping Systems
10. Maintenance Gate, Transfer Canal Tube, Transition Piece & Containment Passage
11. Bellows Assemblies for F/C Annulus Seals Main Steam Penetration and Reactivity Mechanism Expansion Joints
12. Large Diameter Elastomeric and Metallic Expansion Joints for RSW, CWC and CWS Piping Systems
13. F/M Head Separator Assembly, Bellows Assembly and Linear Potentiometer Assembly
14. Pressure Balanced Crossover Expansion Joint

Main Steam Penetration Gimbal Expansion Joint

Containment Passage Rectangular Expansion Joint

Main Steam Crossover Expansion Joint

Inline Pressure Balanced Expansion Joint

Fueling Machine Head Separator Assembly

Inline Pressure Balanced Rubber Expansion Joint

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MADE IN CANADA

2011 – CNS Committee Activities

The Canadian Nuclear Society has established a number of Committees to support its various activities and to interface with other organisations. Perhaps the largest of the CNS activities is led by the Education and Communication Committee (ECC), chaired by Jeremy Whitlock and Peter Lang. The ECC implements the CNS' mandate of public communication and educational support, and represents a significant area of financial investment on behalf of the CNS membership.

During the past year, the ECC has expanded its program of public education on nuclear science and technology matters. A second Ionising Radiation Workshop road kit (with experiments involving monitoring of naturally-occurring radioactive materials, or NORM, and consumer items) was developed, allowing one to be placed in Alberta (hosted by the University of Calgary for science teacher workshops in Western Canada), while the second kit remains available for Eastern Canada opportunities. The Ionising Radiation Workshop was presented three times in 2010. The road kits were used at several other outreach activities. The CNS has donated Geiger Kits to a total of 91 Canadian High Schools with two on order at the end of 2010, and has 40 outstanding requests for donations. The CNS appreciates the support received from Kinectrics Inc. for one Geiger Kit donation. The ECC has received encouraging response to our search for a commercial partner to provide support services for the Geiger Kit donations and workshop presentations.

The inaugural Nuclear Education and Outreach Symposium (NEO-2010) held at the University of Calgary attracted 50 participants from Canada, the United States of America and the European Union. NEO-2011 is planned for June 8-9, to follow the CNS Annual Conference in Niagara Falls.

Other important committees and their main activities are as follows:

- The Branch Affairs Committee, chaired by Syed Zaidi, coordinates the activities of the various branches of the CNS, and supports them financially and administratively. The CNS Branches organised seminars for their members and interested members of the public. Several Branches supported student science fairs, provided scholarships for high school students, and participated in science fairs, science-teacher conferences and outreach events held in their regions.
- The Membership Committee, chaired by Ben Rouben, manages all the membership activities, such as renewal notices, the membership database, membership drives, and membership communications. Members in good standing can update their profile online. They can also download and print their receipts and their CNS membership card. In addition they can view (and also download) the membership directory.
- The Finance Committee, chaired by Mohamed Younis, manages the members' equity in the Society, following a conservative investment strategy.
- The main task of the Past Presidents' Committee, chaired by the current Past President of the Society, Adriaan Buijs, is to establish the slate of candidates for election to Council at the next AGM.
- The CNS/CNA Honours and Awards Committee, chaired by Krish Krishnan, manages the nomination and selection process for awards that are handed out to deserving individuals and teams in the Canadian nuclear industry and academia.
- The International Liaison Committee, chaired by Kris Mohan, establishes and maintains ties with nuclear societies in other countries by means of formal agreements. Information is exchanged through the International Liaison Committee, and on occasion non-financial sponsorship is provided for events of common interest. The CNS is a member of the Pacific Nuclear Council and of the International Nuclear Societies Council, and participates in the meetings of these international bodies.
- The Internet Committee, now chaired by Adriaan Buijs, oversees the internet services provided to the Society. The CNS website is maintained by a professional webmaster, Elmir Lekovic. It is the internet portal of the Society to the world. It provides information on the CNS' objectives, its organisational structure and activities, links to other nuclear organisations and a page on Canada's nuclear history. The CNS website includes full web pages for CNS conferences and courses, including links to paper-submission sites for CNS conferences and online registration pages.
- The Universities Committee, chaired by John Luxat, maintains the ties of the Society with the Canadian universities and the University Network of Excellence in Nuclear Engineering (UNENE).
- The Scholarships Committee, chaired by Mohamed Younis, manages the process of soliciting and judging proposals for summer and doctoral scholarships, and of administering the awarding of scholarships.
- The Intersociety Committee, chaired by Eric Williams, maintains the ties with other learned societies in Canada, mainly in the context of the Engineering Institute of Canada (EIC). The CNS has a seat on the Council of the EIC and participates in common activities such as a career database and the organisation of conferences such as the very successful series of Climate Change Conferences, of which the next will be held in Montréal in 2013. The EIC also has a Fellows program and an Awards program for which several CNS members have been nominated successfully in recent years.
- The Program Committee, chaired by Len Simpson, oversees the conference and course program of the CNS. It is described in more detail elsewhere in the Yearbook.

Another important activity of the CNS is to publish a quarterly Bulletin that outlines current activities and industry highlights. Fred Boyd and Ric Fluke manage all aspects of the Bulletin. A more

Continued on page 27...

CCTC 2013

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DEMANDE DE COMMUNICATIONS

TOPICS

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3. Education program & Strategy
4. Risk Management
5. Engineering Standards & Safety
6. Modeling, Analysis & Design
7. Cost Benefits and Affordability
8. Alternative Solutions
9. Technological & Research Advances
10. Lessons Learned
11. Natural Catastrophe/Disaster Planning
12. Miscellaneous Topics of Interest

CATÉGORIES

LES CATÉGORIES DE SUJETS PROPOSÉES POUR LA CONFÉRENCE SONT:

1. Échelonnage des projets d'ingénierie pour atténuer les impacts
2. Ingénierie pour l'adaptation
3. Programme d'éducation et stratégies
4. Gestion des risques
5. Normes d'ingénierie et sécurité
6. Modélisation, analyse et conception
7. Coûts, bénéfices et abordabilité
8. Solutions de rechange
9. Avancées technologiques et de recherche
10. Leçons retenues
11. Planification contre les catastrophes et désastres naturels
12. Sujets divers

Proposals should be submitted, by **September 15, 2012** via the Conference website (preferred), by mail, or e-mail.

Les propositions doivent être reçues d'ici le **15 septembre 2012** via le site Internet de la conférence (de préférence), par la poste ou courriel.

FOR MORE INFORMATION PLEASE VISIT / POUR DE PLUS AMPLES RENSEIGNEMENTS INFORMATIONS, VEUILLEZ VISITER: **WWW.EIC-ICI.CA**

Mail/poste:
Mr. Eric Williams
Technical Subcommittee Chair,
Président du comité technique

c/o Canoe-About Inc.,
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Tiverton, Ontario,
N0G 2T0

e-mail/courriel: info@canoe-about.ca
phone/tél: 519-396-8844

...2011 – CNS Program Review, continued from page 23

An Officer's Seminar was held in November, which included the extended council members, to implement aspects of the strategic plan. The extended council is the elected Council plus the Division and Branch leaders. Each Division addressed how they can be more effective and productive. Co-operation and communication was stressed. Some smaller divisions will need more volunteers to keep them viable. The partnership between DMD and OMD described above was born here. There was also discussion of issues with some of the smaller branches. Amalgamations were suggested in some cases and the outreach to the reactor operators was also started here.

All of the technical conferences are held under the umbrella of one of the CNS Technical Divisions. The list of CNS Divisions and the current Chairs of these Divisions is provided below.

Program Chair (representing the CNS Executive) – *Len Simpson*
Design & Materials Division – *Juris Grava*
Environment & Waste Management Division – *Ken Dormuth*
Fuel Technologies Division – *Steve Palleck*
Fusion Division – *Blair Bromley*
Medical Applications & Radiation Protection Division – *Anthony Waker*
Mining & Processing Division – *John Roberts*
Nuclear Operations & Maintenance Division – *Jacques Plourde*
Nuclear Science & Engineering Division – *Elisabeth Varin*

...2011 – CNS Committee Activities, continued from page 25

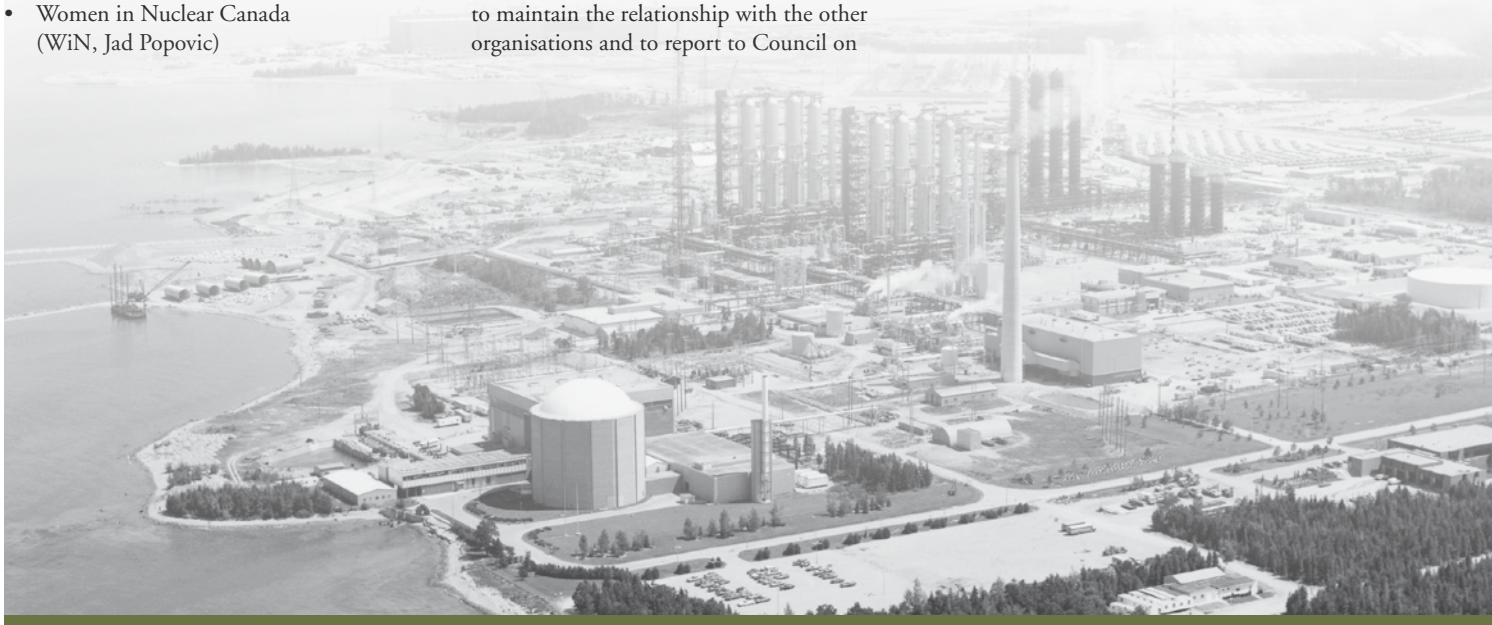
detailed description of the Bulletin is given elsewhere in this Yearbook.

The interface committees are generally chaired by persons who are members of both the CNS and the other organisation. They are as follows (with the Chair shown in parentheses):

- Canadian Nuclear Association (CNA, Denise Carpenter)
- Women in Nuclear Canada (WiN, Jad Popovic)
- CANDU Owners' Group (COG, Frank Doyle)
- Organisation of CANDU Industries (OCI, Frank Doyle)
- Young Generation in Nuclear (NA-YGN, Natalie Sachar)
- Partnership Group for Science and Engineering (PAGSE, Fred Boyd).

The purpose of the interface committees is to maintain the relationship with the other organisations and to report to Council on activities that are relevant to the activities of the CNS.

It should be stressed that all committees of the CNS have volunteer members and are chaired by volunteers. During 2011/2012, the Society had a most successful year – thanks to the efforts of the many volunteers serving on the various committees.



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Canadian Nuclear Association (CNA) Report

By Denise Carpenter, President and CEO

The year 2011 was a challenging one as we were all touched by the tragic events that unfolded on March 11, 2011 in Japan's Sendai region. The nuclear incident in Fukushima, and the ensuing concerns on nuclear safety issues, dominated the global nuclear agenda for much of 2011. In March 2012, we paused to remember not only the loss of life and the noble dedication of our brothers and sisters, but that it remains critical for the nuclear industry around the world to share valuable lessons learned from the tragedy, and ensure that safety standards and policies reflect current findings.

The year 2011 also revealed volatility in our global economy. Our Governments have been proud of Canada's resilience in this recent economic storm, and they have stated our leadership will continue. What that means to us in the business community is the necessary goal to return to balanced budgets in the medium term, to ensure the money we spend is effective, and that the elimination of wasteful spending is common sense.

There were, however, positive developments for our industry in 2011, and more to look forward to in 2012. Last June it was announced that SNC-Lavalin Group Inc. had acquired the commercial division of AECL to form a new company, CANDU Energy Inc. The CNA proudly welcomes CANDU Energy Inc. as a new member. We recognize their commitment to a strong tradition of designing and delivering state-of-the-art CANDU reactors, carrying out life extension projects, and providing services for existing nuclear power stations. OPG had a very eventful year with Joint Review Panel hearings taking place for new nuclear units at Darlington Station. These hearings were held in the immediate aftermath of Fukushima events in spite of major challenges in the public environment, and we commend the Government of Canada for moving ahead with those hearings. The process led to a positive report released by the Panel stating that the Darlington New Nuclear Project will not result in any significant adverse environmental effects, given proposed measures to minimize effects on workers, the public and the surrounding environment. This is good news for OPG – and for the industry. New and refurbished nuclear units are an integral part the Government of Ontario's commitment to maintaining nuclear power at 50 per cent of the province's energy supply in the Long-Term Energy Plan.

2011 was also a busy, successful, transitional year for Bruce Power. The Restart program continues to be on track to return Units 1 and 2 to service, while Units 3 through 8 experienced strong, sustained operations. Bruce Power also announced $500 million of continued investment in the site's operating units ensuring safe, reliable operations, and a continued investment in their people with 340 new full-time employees, and the creation of hundreds of jobs.

Our friends in the uranium mining business got very good news early in 2012 when the Prime Minister announced the broadening of the Canada-China Nuclear Cooperation Agreement. This means hundreds of new jobs and billions in new investments for Canada, and greater security of nuclear fuel supply for China.

The CNA kicked off 2012 with our annual Conference in Ottawa, themed *Leadership Through Innovation*. After a challenging year that was 2011, this was a perfect theme to propel us forward. We heard from renowned speakers from within and outside of the nuclear industry who had much to say about Leadership and Innovation. Given that 2012 is also the 50th anniversary of nuclear power in Canada, we wanted to use this theme as a reminder of our innovative history and our ability to remain a relevant, competitive, and cutting- edge industry around the world.

The CNA has been working hard over the past two years to build a "NU" brand and a strong voice through many communications vehicles. The NUze is the latest addition to this suite of products, which also includes our "TalkNUclear" social media channels on Twitter, Facebook, YouTube, and our TalkNUclear blog (TalkNUclear.ca). As always, I invite you to visit us on online at **www.cna.ca**, post your comments and let us know if you wish to contribute in any other way.

Our five-year strategic plan, "Dialogue for Understanding and Growth," recognizes the importance of talking with our members, but also the value of sharing information about our members with those beyond our industry. We are aiming to tell the stories about our industry, the actions we continuously undertake to ensure safe, reliable operations and the men and women who work to bring these stories to life.

These are fundamental milestones to making significant progress towards the achievement of our Vision for the industry. We will seize the opportunity, earning the trust and focusing the dialogue for a robust, vibrant nuclear industry in Canada.

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Organization of CANDU Industries (OCI) Report

By Dr. Ron Oberth, President and CEO

2011 a busy year for workshops and trade missions

OCI is an association of more than 160 leading Canadian suppliers to the nuclear industry in Canada and offshore. OCI member companies employ collectively more than 30,000 highly skilled and specialized individuals, many of whom are dedicated to manufacturing equipment and components and providing engineering services and support for the 20 CANDU nuclear power plants in Canada as well as for CANDU and LWR reactors in offshore markets. OCI is the leading voice of the Canadian nuclear supply chain and actively promotes the production of safe, clean and reliable nuclear base load electricity as a key part of a balanced electricity generation portfolio in Ontario and also advocates for the continued production of nuclear electricity in Quebec and New Brunswick.

OCI also offers a variety of services and support to member companies to help them become the suppliers of choice in the domestic nuclear market and to bring them opportunities in offshore CANDU markets and targeted LWR markets by organizing trade missions and market specific seminars.

OCI organizes annual Supplier Day events with key customers such as Ontario Power Generation, Bruce Power, CANDU Energy Inc., AECL Nuclear Laboratories. These focused trade shows enable member companies to showcase and discuss their products and services with engineers and procurement specialists in these organizations. OCI Supply Days typically include 60 to 80 exhibitor booths and include a forum for product presentations by OCI companies as well for the customer Supply Chain and staff to outline key procurement challenges and issues. OCI also hosts technical and business seminars on topics of current relevance to member companies. These seminars expose member companies to potential new market opportunities or provide insights to emerging supply chain trends. In addition, the Supplier Days and Seminars create networking opportunities that often lead to member companies collaborating on business solutions and joint ventures.

Finally OCI supports nuclear engineering education with the OCI -Jack Howett Award Bursaries that are awarded annually to deserving students at McMaster University, the University of Ontario Institute of Technology, École Polytechnique, and the University of New Brunswick. OCI also provides an annual grant to the Deep River Science Academy that delivers a six week summer science education program for high school students.

OCI appointed in new president, Dr Ron Oberth, in June 2011. Ron brings more than 30 years of nuclear industry experience with Ontario Hydro, Ontario Hydro International, OPG and AECL. OCI member companies elected five new directors to the 13-person OCI Board in October 2011. At its first meeting in November 2011 the OCI Board elected Ron Moleschi of SNC-Lavalin Nuclear as chair, Doug Burton of Cameco Fuel Manufacturing as treasurer and Terry McNally of Gowlings Lafleur Henderson LLP as secretary.

Some key OCI events in 2012 include the organizing and hosting of Suppliers Days/ Trade Shows at Ontario Power Generation on April 11, 2012, at AECL-Nuclear Laboratories on September 11/12, 2012, at Candu Energy on September 27, 2012, and at Bruce Power on October 22/23, 2012.

OCI also organized two successful workshops: "Supplying the US Nuclear Market" on December 7, 2011 and an OCI –Utility Supply Chain Workshop on March 27, 2012 and is planning workshops on "Supply Chain Skills Development" in May 2012 and on "Small Modular Reactors Supply Opportunities" in the fall of 2012.

A small OCI trade mission visited the Carolinas Nuclear Cluster anchored in Charlotte, NC on Oct 25-26, 2011 to present OCI member supply capability to nuclear utilities and architect/engineers in the US Southeast. Larger trade missions are being planned to Argentina in August 2012 and to the UK in March 2013, the latter in cooperation with the Ontario Ministry of Economic Development and Innovation and the Canadian High Commission, London.

Contacts:
Dr. Ron Oberth, President (ron.oberth@oci-aic.org or 905-839-0073). Ms. Marina Oeyangen, Manager Member Services (marina.oeyangen@oci-aic.org or 905-839-0073).

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CANDU Owners Group (COG) Report

By Bob Morrison, President and CEO

CANDU Owners Group Inc. (COG) is a private not-for-profit corporation funded voluntarily by its Members. Membership in the CANDU Owners Group is open to all CANDU owners/operators and Atomic Energy of Canada Ltd. (AECL).

COG is dedicated to providing programs for co-operation, mutual assistance and exchange of information for the successful support, development, operation, maintenance and economics of CANDU Technology.

COG has two categories of Members: Voting and Non-Voting. Voting Members are those who, in addition to their membership fee, fund a significant portion of the overall COG program (Voting Members currently provide 90% of COG funding). Non-Voting Members enjoy the same rights and obligations as Voting Members, except that they do not have the right to vote at the Annual General Meeting and they do not nominate a Director to the COG Board of Directors.

COG has a Supplier Participant Program whose objectives are to increase the capability base for identifying and resolving Member issues, and to ensure that organizations considered crucial to Members' success have access to event information and issues in the CANDU industry. Eligibility is limited to suppliers that have made a significant investment in CANDU technology or are major suppliers of services directly related to CANDU technology. Supplier participants are accepted by unanimous approval of the COG Board of Directors.

COG has four major lines of business to assist its Members. The base program, Information Exchange, includes the dispensation of important operating information to all Members and facilitates many Workshops and Working Groups to allow member representatives to share challenges, solutions and good practices. Research and Development has programs in Safety and Licensing, Fuel Channels, Chemistry and Metallurgy, and Health and Safety. Joint Projects are those in which two or more Members combine on initiatives important to them but not necessarily all COG Members (e.g. Fuel Channel Life Management Project). The Regulatory Affairs program primarily assists Canadian COG members in their initiatives with the federal regulator, the Canadian Nuclear Safety Commission.

COG's Management Team is entrusted with day-to-day operations as well as longer term strategic planning subject to the oversight of the Board of Directors.

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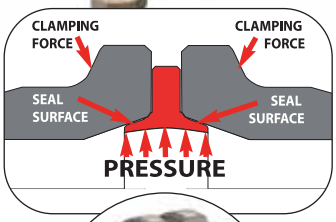

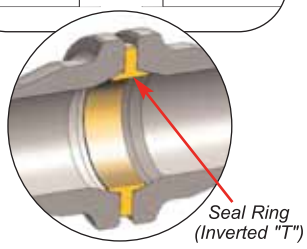

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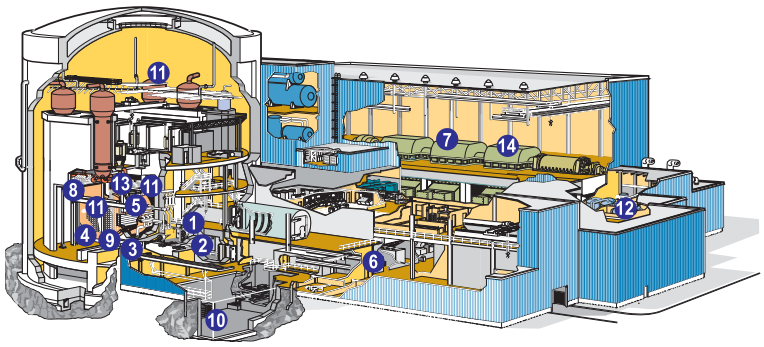

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6. Water Treatment Flexible Piping Systems
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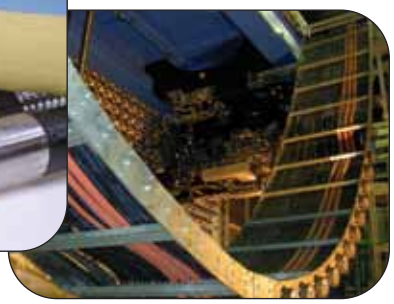
12. Large Diameter Elastomeric and Metallic Expansion Joints for RSW, CWC and CWS Piping Systems
13. F/M Head Separator Assembly, Bellows Assembly and Linear Potentiometer Assembly
14. Pressure Balanced Crossover Expansion Joint

CRN Registration For All Products Offered



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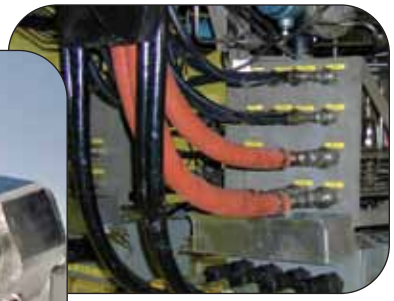

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Women in Nuclear (WiN) Canada Report

By Colleen Sidford, President

Women in Nuclear (WiN) is a world-wide association of women working in various fields of nuclear energy and radiation applications. WiN-Canada formed in 2004, represents 1,136 members and five chapters across Canada.

Our activities are focused on the following objectives to:

1. Develop a dialogue with the public to promote awareness around the factual contribution to people and society from nuclear technologies.
2. Contribute to knowledge and experience exchange among members and chapters.
3. Promote career interest in nuclear engineering, science, technology, the trades and other nuclear-related professions, especially among women and young people.

In 2011, WiN held its first election resulting in Colleen Sidford, from Ontario Power Generation, taking over the role of President and leading a new board for a 2-year term.

Our Facebook and Twitter posts were well populated with information about Fukushima from reliable sources to members and the public. WiN raised $5,000 for a community project to be developed in the Fukushima area by selling wristbands.

WIN hosted five GIRLS Science Clubs and two camp sessions in 2011. Over 100 girls participated, providing a hands-on science experience in a fun and safe environment. Led by female mentors who have been successful in the science being studied, the sessions are meant to spark a scientific curiosity in the girls so they are one day better equipped to make informed decisions on topics such as climate change and energy sources.

To promote career interest, we partnered with The Learning Partnership and produced a video and educator's guide around different careers in the nuclear industry. The video and guide are geared to students in grades seven through ten, in both official languages, and are used in classrooms across Ontario.

In September, WiN-Canada's annual conference was hosted by WiN-Golden Horseshoe West with 145 delegates attending in Oakville, Ontario. The conference Enhancing Public Opinion on Nuclear, provided our members with an opportunity to learn more about the industry and how to best share that knowledge in their communities.

In October, WiN participated in a Parliament Hill Day, organized with the Canadian Nuclear Association and North American Young Generation Nuclear (NAYGN). Over 40 WiN and NAYGN members participated in a professional development session and met with MPs, Senators and staffers to talk about our personal experiences in the industry.

WiN recognized an estimated 40 percent of skilled tradespeople set to retire in Canada by 2020, as an opportunity to promote careers in the skilled trades to young women. Through our partnership with Skills Canada-Ontario we co-authored a position paper, *Women Working in the Skilled Trades and Technologies – Myths and Realities*, which we launched in November. WiN also provided mentors for the Skills Canada-Ontario Young Women's Conference reaching over 325 students in grades seven to twelve to learn more about a day-in-the-life of a skilled tradeswomen in the industry. Through sponsorship from the industry, WiN sponsored four Skills Work! for Women Networking Dinners and provided mentors for 13 dinners across Canada.

WiN's Board of Directors will drive our strategic plan forward in 2012. We plan to expand our membership by launching a new chapter in Saskatchewan and develop a promotional video for new and existing members. WiN will continue to engage today's youth in science and promote career opportunities in our industry and reach out to the public by pitching stories to women's publications. We will provide professional development opportunities through chapter meetings and our annual conference hosted by WiN-Bruce on October 25 and 26 in Kincardine, Ontario.

WiN-Canada is proud to support and put a fresh face on the nuclear industry.

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Canadian Nuclear Workers Council (CNWC) Report

By David Shier, President and CEO

The Canadian Nuclear Workers Council (CNWC), founded in 1993 is an umbrella organization of Unions representing workers in all sectors of the Canadian nuclear industry. Represented sectors include electric power utilities, uranium mining and processing, radioisotope production for medical and industrial purposes and nuclear research.

CNWC activities are focused on the following objectives:

- Ensure that the interests and perspectives of nuclear workers are heard by decision-makers;
- Strengthen the collective role of nuclear workers as a partner in their industry;
- Enhance public knowledge and understanding of nuclear issues by providing factual information, and;
- Build support for the nuclear industry and its future potential

During 2011, several presentations and briefs were made on behalf of the membership. In March, the CNWC made a supportive presentation to the Joint Review Panel for Ontario Power Generation's Darlington New Build Project. An April presentation by the CNWC to the Canadian Nuclear Safety Commission (CNSC) offered full support for Hydro-Quebec's application to combine their waste management facility license with their Gentilly-2 operating license.

The CNWC, International Brotherhood of Electrical Workers (IBEW) and the International Boiler Makers Union (IBB) supported NB Power's application for a five- year licence for Point Lepreau at the CNSC's December 1 hearing, held in St. John. The CNWC also commented on the review of the Canadian Environmental Assessment Act (CEAA) asking the review committee to find opportunities to improve the environmental assessment process without reducing standards or compromising the overall level of environmental protection. The CNWC suggested that delays and duplication could be reduced by providing greater certainty on EA process timeliness and by increasing co-ordination among involved government agencies.

The CNWC were among the intervenors at the October hearing for AECL's successful application to renew the operating license for the Chalk River Laboratories for five years. The CNWC joined the local United Steel Workers union to make a December submission to the CNSC in support of the renewal of Cameco's operating licenses for the fuel manufacturing plant and the nuclear fuel conversion facility.

The CNWC's 2011 education and outreach activities included attendance at the Canadian Nuclear Association's 2011 Annual Conference, the Canadian Labour Congress, the CUPE National Convention, the Ontario Federation of Labour, meetings with the President and staff of the CNSC, and the International Nuclear Workers' Union Network (INWUN). The CNWC also participated along with other Canadian Unions and nuclear industry stakeholders in the delivery of basic radiation protection training for mine workers in Namibia. Public communications included four newsletters, fact sheets on the Council and it's objectives and on CNWC's position on CANDU nuclear technology.

In 2012, CNWC education and outreach activities will focus on the: development of a Canadian nuclear industry strategy; activities of the Nuclear Waste Management Organization; Deep Geologic Repository Project; Darlington New Build Project; and, refurbishment of the next Bruce, Darlington and Gentilly-2 units; As well, the CNWC will represent its membership at several conventions/ conferences – the Canadian Labour Congress, CUPE National Convention, Ontario Federation of Labour and the Annual INWUN.

CNWC Member Unions:

- Canadian Union of Public Employees – Locals 1500 & 267
- Communication, Energy & Paper Workers Union – Local 599-O & Local 48–S
- International Association of Firefighters
- International Association of Machinist & Aerospace Workers – Local 608
- International Brotherhood of Electrical Workers
- Power Workers' Union
- Professional Institute of the Public Service of Canada (PIPS) – CRPEG & WRPEG
- Public Service Alliance of Canada
- United Steel Workers – Locals 8914, 7806, 14193, 13713
- Chalk River Technicians and Technologist Union
- Allied Trades Council
- Society of Professional Engineers & Associates (AECL)
- Hydro Quebec Professional Engineers Union
- International Brotherhood of Boilermakers Local 128

The ZED-2 (200 Watt) low power reactor in service at Chalk River Laboratories

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At 1:31 p.m. on June 4, 1962, a switch is turned on and electricity from the 20-megawatt Nuclear Power Demonstration reactor near Rolphton, Ontario flows into the local power grid. This quiet occasion, made possible through the facilities, expertise and innovation of AECL's Chalk River Nuclear Laboratories coupled with industrial partners from across the country, demonstrated the nuclear technology that - fifty years later - continues to safely and reliably power the lives of Canadians.

2012 is also a milestone year for AECL, as we celebrate 60 years as Canada's leading nuclear science and technology organization. We continue that tradition of innovative thinking coupled with technical strength, and we welcome opportunities to collaborate with industrial and academic partners.

For more information, please contact us directly or visit our website at **www.aecl.ca**

Le 4 juin 1962, à 13 h 31, on ferme un interrupteur et près de 20 mégawatts d'électricité produite par le réacteur nucléaire de démonstration installé près de Rolphton, en Ontario, se mettent à circuler dans le réseau électrique local. Cet événement sans éclat, rendu possible grâce aux installations, à l'expertise et à l'innovation des Laboratoires nucléaires de Chalk River associés à des partenaires industriels de partout au pays, faisait la démonstration de la technologie nucléaire qui, cinquante ans plus tard, continue de fournir aux Canadiens une énergie sûre et fiable.

2012 est également une année marquante pour EACL, alors que nous célébrons nos 60 ans en tant que chef de file en science et en technologie nucléaires du Canada. Nous poursuivons cette tradition de pensée innovatrice et de force technique. Par ailleurs, nous accueillons avec plaisir les occasions de collaboration avec des partenaires industriels et universitaires.

Pour plus d'informations, prière de nous contacter directement ou de visiter notre site Web **www.aecl.ca**

2012 Conference Schedule

This programme lists events which are organized or co-sponsored by the Canadian Nuclear Society or considered to be of interest to its members.

The current listing of events is posted on the CNS website at **www.cns-snc.ca**

2012

2012 February 22 – 24
CNA Nuclear Industry Conference and Tradeshow
Westin Hotel Ottawa, ON
Organized by CNA
Website: www.cna.ca/conference/cna/en/

2012 Spring
CANDU Reactor Safety Course
Toronto, ON
Organized by CNS, NSE Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2012 March 18 – 23
18th Pacific Basin Nuclear Conference
Busan, Korea
Organized by KAIF & KINS
Co-sponsored by CNS
E-mail: CHANG HO-HYUN [hohchang@kaif.or.kr]
Website: www.pbnc2102.org

2012 March 19 – 22
2nd International Nuclear and Renewable Energy Conference
Amman, Jordan
Co-sponsored by CNS
Website: http://inrec12.inrec-conf.org/

2012 April
CNS CANDU Fuel Technology Course
Organized by CNS, FT Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2012 April 9 – 27
Seminar and Training to transfer competence, knowledge and experience in the area of Scaling, Uncertainty and 3D Coupled Code Calculations (3D S.UN.COP 2012)
Daejon, Korea (KAERI)
Website: http://www.grnspg.ing.unipi.it/3dsuncop

2012 April 18 – 20
3rd China-Canada Joint Workshop on Supercritical-Water-Cooled Reactors
Nanyang Hotel, Xi'an, Shaanxi, China
Organized by NPIC and AECL
Co-sponsored by CNS
E-mail: junligou@mail.xjtu.edu.cn

2012 April 15 – 20
International Topical Meeting on Advances in Reactor Physics (PHYSOR 2012)
Knoxville, TN
Organized by ANS, Co-sponsored by CNS
Website: www.physor2012.org/

2012 April 23 – 24
Nuclear 101 Course
McMaster University
Hamilton, ON
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2012 June 10 – 13
33rd Annual CNS Conference & 36th Annual CNS/CNA Student Conference
Saskatoon, SK
Organized by CNS
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: http://www.cns-snc.ca/events/conf2012/

2012 Jun 24 – 28
ANS Annual Meeting
Chicago, IL
Website: www.new.ans.org/meetings

2012 Jul 30 – Aug 3
20th International Conference on Nuclear Engineering (ICONE 20)
Anaheim, CA
Co-sponsored by ASME, CNS
Website: http://www.asmeconferences.org/ICONE20Power2012/

2012 Aug 26 – 28
Nuclear Education Outreach Workshop (NEO-2012)
Sheraton Hotel, Hamilton, ON
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2012 Sep 9 – 13
9th International Topical Meeting on Nuclear Thermal-Hydraulics, Operation and Safety (NUTHOS)
Kaohsiung, Taiwan
Co-sponsored by CNS
Website: www.NUTHOS-9.org

2012 Sep 24 – 28
Nuclear Plant Chemistry Conference NPC 2012
Paris, France
Co-sponsored by CNS
E-mail: jean-luc.bretelle@edf.fr

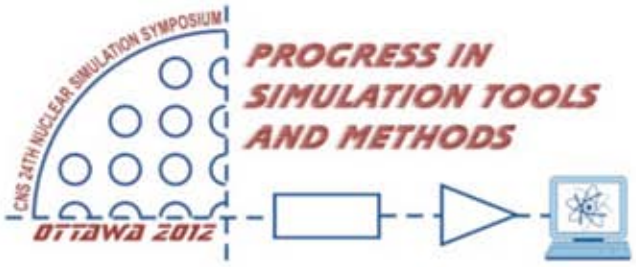
2012 Autumn
CANDU Reactor Safety Course
Toronto, ON
Organized by CNS NSE Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

Canadian Nuclear Society/Société Nucléaire Canadienne

24th Nuclear Simulation Symposium
24e Symposium de Simulation Nucléaire

PROGRESS IN SIMULATION TOOLS AND METHODS
PROGRÈS DANS LES OUTILS ET MÉTHODES DE SIMULATION

14-16 October/Octobre 2012



The Canadian Nuclear Society is organizing its 24th Nuclear Simulation Symposium. The symposium will be held in Ottawa (Ontario, Canada) from October 14 to 16, 2012.

Objective

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.

Topics of interest

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.

La Société Nucléaire Canadienne organise son 24e Symposium de Simulation Nucléaire. Le symposium aura lieu à Ottawa (Ontario, Canada) du 14 au 16 octobre 2012.

Objectif

L'objectif du symposium est de fournir un forum de discussion et d'échange d'informations, de résultats et de points de vue entre les scientifiques, les ingénieurs et les universitaires qui travaillent dans divers domaines du génie nucléaire.

Sujets d'intérêt

La portée du symposium couvre tous les aspects de la modélisation et de la simulation nucléaire, y compris, mais non limités à: physique des réacteurs, thermohydraulique, analyses de sûreté, combustible et canaux de combustible, modélisation et codes de calcul.

CANADIAN NUCLEAR SOCIETY ® SOCIÉTÉ NUCLÉAIRE CANADIENNE

INFO:
http://www.cns-snc.ca/events/24-nss/

CNS Office / Bureau de la SNC
cns-snc@on.aibn.com

Technical program co-chairs / Co-présidents du programme technique
Dr. Adriaan Buijs, buijsa@mcmaster.ca
Geneviève Harrisson, genevieve.harrisson@polymtl.ca

Photo taken at / Photo prise à Ottawa, October/Octobre 14, 2006 (© zen! / Flickr)

2012 Conference Schedule

2012 Oct 14 – 16
24th Nuclear Simulation Symposium
Ottawa, ON
Organized by CNS, NSE Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2012 Nov. 11 – 14
7th International Conference on Steam Generators. Heat Exchangers, Pumps, Valves and Controls, (SHPVC)
Toronto, ON
Organized by CNS, D&M Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2012 Nov. 11 – 15
ANS Winter Meeting and Technology Expo
San Diego, CA
Website: www.new.ans.org/meetings

2013

2013 February
CNA Nuclear Industry Conference and Trade Show
Westin Hotel Ottawa, ON
Organized by CNA
Website: www.cna.ca/conference/cna/en/

2013 Spring
CANDU Reactor Safety Course
Toronto, ON
Organized by CNS, NSE Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2013 May 12 – 17
15th International Topical Meeting on Nuclear Reactor Thermal Hydraulics (NURETH 15)
Pisa, Italy
Co-sponsored by CNS
E-mail: dlshubring@ufl.edu
Website: www.dth.ans.org

2013 May 27 – 29
Third Climate Change Technology Conference
Concordia University, Montréal, QC
Organized by EIC including CNS
Website: www.cctc2013.ca

2013 June
34th Annual CNS Conference & 37th Annual CNS/CNA Student Conference
Toronto, ON
Organized by CNS
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail:cns-snc@on.aibn.com
Website: www.cns-snc.ca

2013 Autumn
CANDU Reactor Safety Course
Toronto, ON
Organized by CNS, NSE Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2013 Autumn
CNS CANDU Fuel Technology Course
Organized by CNS, FT Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail:cns-snc@on.aibn.com
Website: www.cns-snc.ca

2013/14 Winter
10th CNS International Conference on CANDU Maintenance
Toronto, ON
Organized by CNS, O&M Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2014

2014 August 24 – 28
19th Pacific Basin Nuclear Conference (PBNC-2014)
Vancouver, BC
Organised by CNS
Contact : Canadian Nuclear Society Office
Tel: cns-snc@on.aibn.com
Website: www.cns-snc.ca

2014 Fall
8th International Conference on Steam Generators and 2nd Conference on Heat Exchangers, Valves and other Components
Location to be determined
Organized by CNS
Website: www.cns-snc.ca

2015

2015 Fall
10th CNS International Conference on CANDU Maintenance
Location to be determined
Organized by CNS, O&M Division
Contact: Canadian Nuclear Society Office
Tel: 416-977-7620
E-mail: cns-snc@on.aibn.com
Website: www.cns-snc.ca

Organization/major sponsorship by CNS (Class A, B)

In-name only co-sponsorship by CNS (Class C)

For information:
Canadian Nuclear Society
Société Nucléaire Canadienne
655 Bay Street, 17th Floor
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Nuclear Power and Uranium Resources

World Reactor Performance

Top 25 units by capacity factor, December 31, 2011

Rank	Country	Plant	Type	Capacity (MW)	Capacity (%)
1	Japan	Takahama 3	BWR	870	106.14
2	India	Rajasthan 2	PHWR	200	104.73
3	US	San Onofre 2	PWR	1127	103.71
4	US	Shearon-Harris	PWR	960	102.56
5	Taiwan	Kuosheng 1	BWR	985	102.41
6	Russia	Balakovo 3	PWR	1000	102.29
7	Japan	Ohi 2	PWR	1175	102.06
8	Japan	Kashiwazaki 5	BWR	1100	101.76
9	US	Farley 1	PWR	918	101.14
10	US	Calvert Cliffs 1	PWR	890	101.12
11	Japan	Ikata 2	PWR	566	101.05
12	Korea	Yonggwang 1	PWR	985	101.04
13	Taiwan	Maanshan 1	PWR	952	100.31
14	India	Rajasthan 5	PHWR	220	100.24
15	Japan	Shimane 2	BWR	820	100.16
16	US	Braidwood 1	PWR	1242	100.05
17	US	Clinton	BWR	1062	100.03
18	Korea	Shin Kori	PWR	1038	100.02
19	Japan	Mihama 2	PWR	500	99.83
20	China	Daya Bay 1	PWR	984	99.67
21	Korea	Ulchin 1	PWR	986	99.65
22	**South Korea**	**Wolsong 2**	**PHWR**	**730**	**99.57**
23	**Canada**	**Darlington 4**	**PHWR**	**934**	**99.35**
24	US	Dresden 3	BWR	909	99.04
25	**Romania**	**Cernavoda 1**	**PHWR**	**706**	**99.03**

All figures taken from Nucleonics Week. All numbers have been rounded.

Nuclear Power and Uranium Resources

CANDU Nuclear Reactor Performance

December 2011 Reactor	In Service	Capacity (MW)	Performance In 2011 (%)	Lifetime Performance (%)
Point Lepreau	1983	680	0*	71.4
Gentilly 2	1983	675	59.6	77.1
Wolsong 1	1983	622	0*	81.2
Wolsong 2	1997	730	99.6	94.1
Wolsong 3	1998	729	97.5	95.2
Wolsong 4	1999	730	94.3	95.8
Embalse	1984	648	68.5	84.4
Cernavoda 1	1996	706	99.7	89.9
Cernavoda 2	2007	705	91.1	94.0
Qinshan 4	2002	700	94.9	90.4
Qinshan 5	2003	700	92.7	91.2
Pickering 1	1971	542	81.5	64.2
Pickering 4	1973	542	53.3	65.5
Pickering 5	1983	540	44.2	73.2
Pickering 6	1984	540	71.3	77.9
Pickering 7	1985	540	96.7	78.3
Pickering 8	1986	540	90.4	76.9
Bruce 3	1978	750	77.2	64.3
Bruce 4	1979	750	94.4	64.6
Bruce 5	1985	817	85.9	84.0
Bruce 6	1984	817	91.4	80.8
Bruce 7	1986	817	80.4	84.0
Bruce 8	1987	787	89.8	82.8
Darlington 1	1992	934	81.7	84.6
Darlington 2	1990	934	98.1	78.6
Darlington 3	1993	934	98.7	86.8
Darlington 4	1993	934	99.5	86.2
Total/Average		**19 643**	**85.3**	**81.4**

COG CANDU/PHWR Performance Indicators, December 2011.
*These reactors were under reconstruction during part or all of 2011.

World Uranium Production – 2010

Country or area	Production (tU) 2007	2008	2009	2010
Australia	8 611	8 430	7 982	5 900
Brazil	299	330	345	148
Canada	9 476	9 000	10 173	9 783
China*	712	769	750	827
Czech Rep	306	263	258	254
France	4	5	8	7
Germany	41	-	-	-
India*	270	271	290	400
Kazakhstan	6 637	8 521	14 020	17 803
Namibia	2 879	4 366	4 626	4 496
Niger	3 153	3 032	3 234	4 198
Pakistan*	45	45	50	45
Romania*	77	77	75	77
Russia*	3 413	3 521	3 564	3 562
South Africa	539	566	563	583
Ukraine*	846	800	840	850
USA	1 654	1 430	1 453	1 660
Uzbekistan	2 320	2 338	2 429	2 400
Other			112	-
Total	**41 279**	**43 764**	**50 772**	**52 993**

* UI estimate
All figures taken from the World Nuclear Association

World Reactor Capacity

June 2011

Country	Operating (June 2011)		Planned or Under Construction		Electricity Generation (2010)	
	No	MW	No	MW	%	TWh
Argentina	2	935	4	2 199	5.9	6.7
Armenia	1	376	1	1060	39.4	2.3
Bangladesh			2	2000		
Belarus			2	2000		
Belgium	7	5 728			51.1	45.7
Brazil	2	1 901	1	1 245	3.1	13.9
Bulgaria	2	1 906	2	1 900	33.1	14.2
Canada	18	12 679	9	9 700	15.1	85.5
Chile	0	0	4	4 400		
China	11	8 587	197	208 120	1.8	70.1
Czech Republic	6	3 686	2	3 400	33.3	26.4
Egypt			2	2 000		
Finland	4	2 696	2	2 600	28.4	28.4
France	58	63 236	3	4 890	74.1	410.1
Germany	9	12 003			28.4	133.0
Hungary	4	1 755	2	2 000	42.1	14.7
India	19	4 183	43	44 274	2.9	20.5
Indonesia			6	6 000		
Iran			4	3 115		
Israel			1	1 200		
Italy			10	17 000		
Japan	51	44 642	15	20 588	29.2	280.3
Jordan			1	1 000		
Kazakhstan			4	1 200		
Korea, N			1	950		
Korea, S	20	17 716	12	14 890	32.2	141.9
Lithuania			1	1 350		
Malaysia			2	2 000		
Mexico	2	1 310	2	2 000	3.6	5.6
Netherlands	1	485	1	1 000	3.4	3.4
Pakistan	3	725	5	2 900	2.6	2.6
Poland			6	6 000		
Romania	2	1 310	2	665	19.5	10.7
Russia	32	22 811	54	51 810	17.1	159.4
Slovakia	4	1 760	3	2 040	51.8	13.5
Slovenia	1	696	1	1 000	37.3	5.5
South Africa	2	1 842	6	9 600	5.2	12.9
Spain	8	7 448			20.1	59.3
Sweden	10	9 399			38.1	55.7
Switzerland	5	3 252	3	4 000	38.0	25.3
Taiwan	6	4 927	8	10 600	19.3	39.9
Thailand			6	6 000		
Turkey			3	3 600		
UAE			14	20 000		
UK	19	11 035	13	18 680	15.7	56.9
Ukraine	15	13 168	13	13 900	48.1	84.0
USA	104	101 607	31	39 980	19.6	807.1
Vietnam			10	10 000		
Total	**442**	**363 814**	**514**	**556 856**	**14**	**2 635.5**

Notes
All figures taken from the World Nuclear Association

CNS Council and Staff

CNS Executive

Frank Doyle
President

John Roberts
1st Vice-President

Adriaan Buijs
Past President

Len Simpson
2nd Vice President

Mohamed Younis
Treasurer

Colin Hunt
Secretary

Benjamin Rouben
Executive Administrator

Ken Smith
Financial Administrator

The Canadian Nuclear Society

The Canadian Nuclear Society (CNS) was established in 1979 as an organization of individual members, paying membership dues. It was established as an independent section of the Canadian Nuclear Association in order to benefit from the office support structure of the CNA. In 1979, after twenty years of operation in this mode, and after building its own asset base, the CNS obtained a federal charter as an independent not-for-profit organization. The CNS, through its base of individual members, promotes the exchange of information on all aspects of nuclear science and technology – including uranium mining and refining, electricity generation by nuclear power, medical and industrial uses of radionuclides, management of radioactive wastes, and various associated research and development activities.

The activities of the CNS are managed by a Council that is elected by the CNS members at the Annual General Meeting, normally held in June. The Council term of office is one year. A group photo of Council Members at a recent meeting is provided on the next page. The elected Council consists of six Executive Officers plus up to nineteen Members-at-Large – all volunteers. Various members of Council are appointed to Chair Committees that look after specific issues. A list of Committee Chairs appears on the next page. The Council is supported by a full time Office Manager, and by other part-time specialists.

Elected Executives for June 2011 to June 2012:

Frank Doyle President	John Roberts 1st V-P	Len Simpson 2nd V-P	Colin Hunt Secretary	Mohamed Younis Treasurer	Adriaan Buijs Past President

Part-time Specialists and Office Staff:

Ben Rouben Executive Administrator	Ken Smith Financial Administrator	Brian Blosser Accountant	Amanda Blosser Bookkeeper	Denise Rouben Office Manager	Bob O'Sullivan Office Assistant

The CNS is organized into Branches and Technical Divisions, both directed towards involvement of the individual member. Branches are established on a geographical basis, and hold local meetings on issues of interest. Technical Divisions are established for specific technical areas of interest – and are responsible for organizing topical conferences, courses, and seminars.

The Chairs of the various Branches and Division are listed on the next page.

An outline of the activities of the CNS, including a list of upcoming conferences and courses, is provided elsewhere in this Yearbook.

CNS Members at Large


Parvaiz Akhtar


Parva Alavi


Denise Carpenter, President, Canadian Nuclear Association, Ex-Officio


Emily Corocoran


Juris Grava


V.S. (Krish) Krishnan


Peter Lang


David Malcolm


E.M (Dorin) Nichita


Dave Novog


Jacques Plourde


Jad Popovic


Natalie Sachar


Nick Sion


Gordon Tapp


Jeremy Whitlock


Syed Zaidi

CNS Staff


Denise Rouben
CNS Office Manager


Fred Boyd
Publisher
CNS Bulletin


Ric Fluke, Editor
CNS Bulletin


Brian Blosser
Accountant


Amanda Blosser
Bookkeeper

International Nuclear Organizations

ARGENTINA

Autoridad Regulatoria Nuclear (ARN)
Av. Del Libertador 8250
(1429) Buenos Aries
Tel: 54-1 704 1218
Fax: 54-1 703 2845

Comision Nacional de Energia Atomica (CNEA)
Avenida del Libertador 8250
Buenos Aires 1429
Tel: +54 1 70 7711

AUSTRIA

International Atomic Energy Agency (IAEA)
Wagramerstrasse 5
P.O. Box 100
A-1400 Vienna, Austria
Tel: +43 12600-0

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
P.O. Box 500
A-1400 Vienna, Austria
Tel: +43 1 211 31, ext. 4330

AUSTRALIA

Australian Nuclear Science and Technology Organization
Lucas Heights Res. Labs.
New Illawarra Road
Lucas Heights
Private Mail Bag 1,
Menai 2234
N.S.W.
Tel: +61 2 9717 3111
Fax: +61 2 9543 5097

Uranium Information Centre Ltd.
GPO Box 1649N
Melbourne, 3001
Tel: 03 9629 7744
Fax: 03 9629 7207

BANGLADESH

Bangladesh Atomic Energy Commission
G.P.O. Box 158, 4 Kazi Nazrul Islam Avenue, Dhaka-1000
Tel: +880 2 502 600
Fax: +880 2 861 3051

BELGIUM

Commission of the European Communities Nuclear Safety Research Directorate
200, rue de la Loi
B-1049 Brussels, Belgium
Tel: +32 2 2299 11 11

FORATOM – European Atomic Forum
Rue Belliard, 15-17
1040 Brussels, Belgium
Tel: +32 2 502 4595
Fax: +32 2 502 3902

Forum Nucléaire Belge (ASBL)
Avenue Ariane 7
B-1200 Bruxelles
Tel: +32 2 773 93 79
Fax: +32 2 773 98 00

Institute for Reference Materials and Measurements (IRMM)
European Commission
Joint Research Centre
Retieseweg, B-2440 Geel
Belgium
Tel: +32 14 57 12 11
Fax: +32 014 58 4273

Joint Research Centre (JRC)
Commission of the European Communities
Rue de la Loi 200
B-1049 Brussels, Belgium
Tel: +32 2 299 11 11

Ministere des Affaires Economiques Administration de L'Energie
Service des applications Nucléaires
North Gate III, boul. du Roi Albert 11, 16
1000 Bruxelles
Tel: 02 206 42 58
Fax: 02 206 57 11

Union of the Electricity Industry EURELECTRIC
Bd de l'Impératrice 66
1000 Brussels
Tel: +32 2 515 1000
Fax: +32 2 515 1010

BRAZIL

Comissao Nacional de Energia Nuclear (CNEN)
22294 Rua General Severiano 90
Rio de Janeiro, R.J.
Tel: (021) 546-2320
Fax: (021) 546-2282

CANADA

North American Young Generation in Nuclear
c/o PO Box 1268
Fredericton NB E3B 5C8
Tel: (877) 526-2946

TRIUMF
4004 Westbrook Mall
Vancouver BC V6T 2A3
Tel: (604) 222-1047

CHINA

Beijing Institute of Nuclear Engineering (BINE)
P.O. Box 840
100840, Beijing
Tel: 86-10-8802-2213
Fax: 86-10-6841-5067

Chinese Nuclear Society
P.O. Box 2125
100822, Beijing
Tel: +86 1 801 2211
Fax: +86 1 867 188

National Nuclear Safety Administration (NNSA)
P.O. Box 8088
Beijing 100088, PRC
Tel: 86-10 6225 8583
Fax: 86-10 6225 7804

CZECH REPUBLIC

State Office for Nuclear Safety (SUJB)
Senovazne namesti 9
110 00 Prague 1
Tel: 420-2 323 185
Fax: 420-2 242 20200

Denmark
Danish Energy Agency
Amaliegade 44
DK-1256 Copenhagen K.
Tel: +45 3392 6700

EGYPT

Arab Republic of Egypt Atomic Energy Authority
101 Kasr El-Eini St.
Cairo, Egypt
Tel: +20 2 355 8269
Fax: +20 2 354 0982

FINLAND

Advisory Committee on Nuclear Energy, Ministry of Trade and Industry
Energy Department
Pohjoinen Makasiinikatu 6
P.O. Box 32
00023 GOVERNMENT
SF-000130 Helsinki 13
Tel: +358 9 1601

Centre for Radiation and Nuclear Safety (STUK)
Laippatie 4/P.O. Box 14
00880 Helsinki, Finland
Tel: 358 9 759 811
Fax: 358 9 759 88 500

Finnish Nuclear Society
C/o VTT Energy,
Nuclear Energy
P.O. Box 1604, FIN-02044
VTT, Finland
Tel: 358 94 561
Fax: 358 9 456 5000

FRANCE

Direction de la Sureté des Installations Nucléaires (DSIN)
99, rue de Grenelle
75353 Paris 07 SP
Tel: 33-1 43 19 70 87
Fax: 33-1 43 19 70 69

Electricité de France
2, rue Louis Murat
75384 Paris Cedex 08
Tel: +33 1 40 42 22 22

Forum Atomique Francais
48, rue de la Procession
F-75015 Paris
Tel: +33 1 45 76 07 70

Institut Laue-Langevin
6, rue Jules Horowitz
BP 156-38042
Grenoble Cedex 9 – France
Tel: +33 4 76 20 71 11
Fax: +33 4 76 48 39 06

International Energy Agency (IEA)
9, rue de la Fédération
75739 Paris, Cedex 15, France
Tel: +33 140 5765
Fax: +33 140 57 6559

International Radiation Protection Association (IRPA)
Route du Panorama
BP48-F92263
Fontenay-aux-Roses Cedex
France
Tel: +33 1 46 547 476
Fax: +33 1 40 849 034

OECD Nuclear Energy Agency (NEA)
Le Seine Saint-Germain
12, boulevard des les
F-92130 Issy-les-Moulineaux
France
Tel. +33 (1) 45 24 82 00
Fax. +33 (1) 45 24 11 10

Societé Francaise d'énergie Nucléaire (SFEN)
67, rue Blomet
75015, Paris
Tel: 01 53 58 3214
Fax: 01 53 58 32 11

GERMANY

Bundesministerium fur Umwelt, Naturschutz und Reaktorsicherheit (BMU/GRS)
Alexanderplatz 6
10178 Berlin
Tel: +49 1888/305-0
Fax: +49 1888/305 4375

Bundesministerium für Wirtschaft und Arbeit (BMWA)
Scharnhorststr. 34-37
10115 Berlin
Tel: +49 1888-615-0
Fax: +49 1888-615-7010

Deutsches Atomforum e. V. (DAtF)
Robert-Koch-Platz 4
10115 Berlin
Tel: +49 30 498555-0
Fax: +49 30 498555-19

German Nuclear Society Kerntechnische Gesellschaft (KTG)
Robert-Koch-Platz4
10115 Berlin
Tel: +49 30 498555-10

HUNGARY

Hungarian Atomic Energy Authority (HAEA)
H-1539 Budapest 114
P.O. Box 676
Tel: 36-1 375 3586
Fax: 36-1 375 7402

INDIA

Department of Atomic Energy
Government of India
Anushakti Bhavan
Chatrapathi Shivaji Maharaj Marg
Mumbai- 400001, India
Tel: +91-22-2202 6823

INDONESIA

Badan Pengawas Tenaga Nuklir (BAPETEN)
MCA Bldg., 6th fl., JL. M. H. Thamrin no. 55
Jakarta Pusat
Tel: 62-21 513 694
Fax: 62-21 525 1110

ISRAEL

Israel Atomic Energy Commission
26 Chaim Levanon St.
P.O. Box 7061
Tel-Aviv 61070
Tel: +972 646 2922

ITALY

Comitato Nazionale per la Ricera e per lo Sviluppo dell'Energia Nucleare e dell Energia Alternative (ENEA)
Lungotevere Thaon di Revel
76 – 00196 Roma
Tel: +39 6-36271
Fax: +39 6-36272591/2777

Ispra-Joint Research Centre
1-21020 Ispra (Varese), Italy
Tel: +39 332 789 743
Fax: +39 332 789 903

JAPAN

Japan Atomic Industrial Forum Inc. (JAIF)
6th Floor, Toshin Building
1-13, 1-chome Shimbashi
Minato-Ku
Tokyo 105-8605
Tel: +81 3 508 2411

Atomic Energy Society of Japan (AESJ)
1-1-13 Shimbashi,
Minato-Ku
Tokyo 105-0004
Tel: +81 3 3508 1261

KOREA

Ministry of Science and Technology (MOST)
Government Complex-Gwacheon Gwacheon City
Kyunggi-Do 427-760
Tel: 82-2 503 7645
Fax: 82-2 503 7673

Koreal Atomic Industrial Forum (KAIF)
21 Youido-doug
Yongdungpo-ku
Seoul 150-875
Tel: +82 2 785 2570

NETHERLANDS

Nederlands Atoomforum
P.O. Box 1
NL-1775 ZG Petten
Tel: +31 2246 4082

Nederlands Nuclear Society
c/o Kema NV
Utrechtsweg 310
NL-6812 AR Arnhem
Tel: +31 85 56 2491

NORWAY

OECD Halden Reactor Project
P.O. Box 173
N-1751 Halden, Norway
Tel: +47 69 21 22 00
Fax: +47 69 21 22 01

PAKISTAN

Pakistan Atomic Energy Commission
P.O. Box 1114
Islamabad
Tel: +92 51 9204276

PERU

Instituto Peruano de Energia Nuclear (IPEN)
Av. Canada 1470-San Borja
Lima 41-Peru
Tel: 511226-0030/ 511226-0038
Fax: 511224-8991

POLAND

National Atomic Energy Agency
36 Krucza Str.
00-921 Warsaw
Tel: +48 2 628 27 22

ROMANIA

National Commission for Nuclear Activities Control (CNCAN)
14 Libertatii Blvd.
Bucharest – 5, Romania
Tel: 401 410 27-54
Fax: 401 411 14 36

SOUTH AFRICA

National Nuclear Regulator (NNR)
PO Box 7106
CENTURION 0046
Tel: 27 12 663 5500
Fax: 27 12 663 5513

SPAIN

Cosejo de Seguridad Nuclear (CSN)
c/o Justo Dorado,
11 – 28040 Madrid
Tel: 34-913 460105
Fax 34-913 460103

Foro de la industria nuclear espanola
Boix y Morer 6 – 28003 Madrid
Tel. +34 1 553 63 03
Fax. +34 1 535 08
Email: correo@foronuclear.org

Sociedad Nuclear Espanola (SNE)
Campoamor 17
E-28004 Madrid
Tel: +34 1 308 63 18

SWEDEN

International Commission on Radiological Protection (ICRP)
SE-171 16 Stockholm, Sweden
Tel: +46 8 729 727 5
Fax : +46 8 729 729 8

Statens Karnkraftinspektion (Swedish Nuclear Power Inspectorate)
Klarabergsviadukten 90
SE-106 58 Stockholm
Tel: 468 698 8400
Fax: 468 661 9086

International Nuclear Organizations

Stockholm International Peace Research Institute (SIPRI)
Signalistgatan 9
SE-16970, Solna, Sweden
Tel: +46 8 655 9700
Fax: +46 8 655 9733

Swedish Atomic Forum
C/o Energiforum AB
Allhegonavagen 25
S-61135 Nykoping
Tel: 46 155 281070

SWITZERLAND

CERN European Laboratory for Particle Physics
CH-1211 Geneva 23
Switzerland
Tel: +41 22 767 61 11

European Nuclear Society
Belpstrasse 23
P.O. Box 5032
CH-3001 Berne, Switzerland
Tel: +41 31 320 6111

Hauptabteilung fur die Sicherheit der Kernanlagen (HSK)
CH-5232 Villigen – HSK
Tel: 41 56 310 39 36
Fax: 41 56 310 49 36

Schweizerische Vereinigung fur Atomenergie (SVA)
(Swiss Association for Atomic Energy)
Postfach 5032
Ch-3001 Bern
Tel: +41 31 32 065 25

TAIWAN

Atomic Energy Council
No, 67, Lane 144, Sec. 4,
Keelung Rd.
Taipei, Taiwan, R.O.
Tel: 886 2 2363 4180

TURKEY

Turkish Atomic Energy Authority (TAEK)
Eskisehir Yolu 9. km
Lodumlu, 06530 ANKARA
Tel: 90-312 287 1529
Fax: 90-312 285 1537

UNITED KINGDOM

British Nuclear Energy Society (BNES)
1-7 Great George Street
London SW1P 3AA
Tel: +44 20 7222-7722

British Nuclear Industry Forum (BNIF)
First Fl., Whitehall House
41 Whitehall
London, SW1A 2BY
Tel: +44 20 7766 6640
Fax: +44 20 7839 4695

British Nuclear Fuels PLC (BNFL)
Risley Warrington
Cheshire WA3 6AS
Tel: +44 925 832 000

CNSC-H&SE/NII
Railway Inspectorate
2nd floor SW, Rose Court
2 Southwark Bridge
London SE1 9HS
Tel: 44-171 717 6887
Fax: 44-171 717 6095

JET Joint Undertaking
Abingdon, Oxfordshire
United Kingdom OX14 3EA
Tel: +44 235 528 822
Fax: +44 235 464 755

Scottish Power (Head Office)
Cathcart House, Spean St.
Glasgow, Scotland G44 4BE
Tel: +44 41 637 7177

United Kingdom Atomic Energy Authority (UKAEA)
Marshall Bldg.
521 Downs Way
Harwell, Didcot, Oxfordshire
OX11 ORA
Tel: +44 1235 820 220

Women in Nuclear Global (WiN)
c/o World Nuclear Association
Carlton House
22a St. James' Square
London SW1Y 4JH
United Kingdom
Tel: +44 (0)207 451-1520
Fax: +44 (0)207 839-1501

World Association of Nuclear Operators (WANO)
King's Buildings,
16 Smith Square
London. United Kingdom
SW1P 3HQ
Tel: +44 71 828 2111
Fax: +44 71 828 6691

World Energy Council (WEC)
5th Floor, Regency House
1-4 Warwick St.
London, United Kingdom
SW1B 5LT
Tel: +44 20 7734 5996
Fax: +44 20 7734 5926

World Nuclear Association
22a St James's Square
London, United Kingdom
SW1Y 4JH
Tel: +44 (0)20 7451 1520
Fax: +44 (0)20 7839 1501

UNITED STATES

American Nuclear Society (ANS)
555 North Kensington Ave.
La Grange Park, Illinois 60526
Tel: (708) 352-6611

Argonne National Laboratory (East)
9700 South Cass Ave.
Argonne, Illinois 60439
Tel: (630) 252-2000

Argonne National Laboratory (West)
P.O. Box 2528
Idaho Falls, Idaho
83403-2528
Tel: (208) 533-7341

Brookhaven National Laboratory (BNL)
Upton, NY 11973-5000
Tel: (631) 344-8000

CNSC-USNRC Office of Public Affairs (OPA)
Washington, D.C. 20555
Tel: 301-415 0317
Fax: 301-415 2395

Edison Electric Institute (EEI)
701 Pennsylvania Ave. NW
Washington, D.C.
20004-2696
Tel: (202) 508-5000

Electric Power Research Institute (EPRI)
3412 Hillview Ave.
P.O. Box 10412
Palo Alto, California 94303
Tel: (415) 855-2000

Environmental Protection Agency (EPA)
1200 Pennsylvania Ave., NW
Washington, D.C. 20460
Tel: (202) 260-2090

Lawrence Livermore National Laboratory
P.O. Box 808
Livermore, CA 94551-0808
Tel: (925) 422-1100

Los Alamos National Laboratory (LANL)
P.O. Box 1663
Los Alamos, N.M. 87545
Tel: (505) 667-7000

National Council on Radiation Protection and Measurements (NCRP)
7910 Woodmont Ave.
Suite 800
Bethesda, Maryland
20814-3095
Tel: (301) 657-2652

Nuclear Energy Institute
1776 I Street, NW, Suite 400
Washington, D.C.
20006-3708
Tel: 202.739.8000
Fax: 202.785.4019

Nuclear Regulatory Commission (NRC)
Mail Stop TA-13
Washington, D.C. 20555
Tel: (301) 415-8200

Oak Ridge National Laboratory (ORNL)
P.O. Box 2008
Oak Ridge, Tennessee 37831
Tel: (615) 574-4160

Sandia National Laboratories
Albuquerque, N.M
87185-5800
Tel: (505) 844-5678

U.S. Department of Energy (DOE)
1000 Independence Ave., S.W.
Washington, D.C. 20585
Tel: (202) 586-5000

Yugoslavia Federal Secretariat for Energy and Industry
Bulevar AVNOJ-A 104 11070
Novi Beograd
Tel: (38-11) 195 244

Guide to Nuclear-Related Organizations

FEDERAL GOVERNMENT

Atomic Energy of Canada Limited (AECL)
Place de Ville, Tower B112 Kent St., Suite 501
Ottawa ON K1P 5P2
Tel: (613) 237-3270

AECL Chalk River Laboratories
Chalk River ON K0J 1J0
Tel: (613) 584-3311

AECL Low-level Radioactive Waste Management National Office
Suite 200
1900 City Park Drive
Ottawa ON K1J 1A3
Tel: (613) 998-9442

AECL Whiteshell Laboratories
P.O. Box 550
Pinawa MB R0E 1L0
Tel: (204) 753-2051

Canadian Nuclear Safety Commission
P.O. Box 1046
280 Slater Street
Ottawa ON K1P 5S9
Tel: (613) 995-5894

Department of Foreign Affairs and International Trade (DFAIT)
Lester B Pearson Bldg.
125 Sussex Dr.
Ottawa ON K1A 0G2
Tel: (613) 996-9134

DFAIT – Global Partnership Program (GPX)
Outreach and Communication
Department of Foreign Affairs and International Trade
125 Sussex Drive
Ottawa ON K1A 0G2
Tel: (613) 944-2536

Environment Canada
351 Joseph Blvd.
Hull QC K1A 0H3
Tel: (613) 997-2800

Health and Welfare Canada
A.L. 0900C2
Ottawa ON K1A 0K9
Tel: (613) 957-2991

Mine Environmental Neutral Drainage Program Canada Centre for Mineral & Energy Technology
Natural Resources Canada
555 Booth Street
Ottawa ON K1A 0G1
Tel: (613) 992-8736

National Energy Board
444 Seventh Ave. SW
Calgary AB T2P 0X8
Tel: (403) 292 4800

National Research Council
Canada Institute for Scientific and Technical Information (CISTI)
Bldg. M55, Room 148
Montreal Rd. Campus
Ottawa ON K1A 0S2
Tel: (613) 993-1600

Natural Resources Canada (Uranium, Nuclear Energy & Waste Management)
580 Booth Street
Ottawa ON K1A 0E4
Tel: (613) 995-0947

Natural Sciences and Engineering Research Council of Canada (NSERC)
350 Albert St., Tower 2
Ottawa ON K1A 1H5
Tel: (613) 995-5992

Nuclear Waste Management Organization (NWMO)
49 Jackes Avenue,
First Floor
Toronto ON M4T 1E2
Tel: 416-934-9814

PROVINCIAL ORGANIZATIONS

Hydro-Québec
75 René-Lévesque Blvd., West
Montréal QC H2Z 1A4
Tel: 514 289-2211

Hydro-Québec Gentilly 2 Nuclear Power Station
4900 Becancour Blvd.
Gentilly QC G0X 1G0
Tel: (819) 298-2943

New Brunswick Power
515 King Street
P.O. Box 2000
Fredericton NB E3B 4X1
Tel: 1-800-663-6272

New Brunswick Point Lepreau Generating Station
P.O. Box 600
Lepreau NB E5J 2S6
Tel: (506) 659-2220

Ontario Power Generation (OPG)
700 University Ave.
Toronto ON M5G 1X6
Tel: (416) 592-5111

Ontario Power Generation Darlington Generation Station
Information Centre
P.O. Box 4000
Bowmanville ON L1C 3Z8
Tel: (905) 623-7122

Ontario Power Generation Pickering Generating Station
Information Centre
1675 Montgomery Park Rd.
Pickering ON L1V 2R5
Tel: (905) 839-0465

ASSOCIATIONS

Association of Consulting Engineers of Canada
130 Albert St., Suite 616
Ottawa ON K1P 5G4
Tel: (613) 236-0569

Association of Major Power Consumers of Ontario (AMPCO)
P.O. Box 69, 595 Bay St.
Suite 1201
Toronto ON M5G 2C2
Tel: (416) 260-0225

Canadian Association of Medical Radiation Technologists
130 Albert St., Suite 1501
Ottawa ON K1P 5G4
Tel: (613) 234-0012

Canadian Association of Radiologists
1740 Cote Vertu Blvd.
Saint-Laurent QC H4L 2A4
Tel: (514) 738-3111

Canadian Electricity Association
66 Slater Street, Suite 1210
Ottawa ON K1P 5H1
Tel: (613) 230-9263

Canadian Standards Association (CSA)
178 Rexdale Blvd.
Rexdale ON M9W 1R3
Tel: (416) 747-4000

Engineering Institute of Canada
1295 Hwy 2 East
Kingston ON K7L 4V1
Tel: (613) 547-5989

Electricity Distributors Association
20 Eglinton Ave. W.
Suite 500
P.O. Box 2004
Toronto ON M4R 1K8
Tel: (416) 483-7739

Guide to Nuclear-Related Organizations

Institute de Recherche d'Hydro-Québec (IREQ)
1800, boul. Lionel-Boulet
Varennes QC J3X 1S1
Tel: (514) 652-1321

Radiation Safety Institute of Canada
1120 Finch Avenue W.
Suite 607
Toronto ON M3J 3H7
Tel: (416) 650 9090

UNIVERSITY/ EDUCATION

Association of Universities and Colleges of Canada
350 Albert St., Suite 600
Ottawa ON K1R 1B1
Tel: (613) 563-1236

Carleton University
1125 Colonel By Drive
Ottawa ON K1S 5B6
Tel: (613) 788-7400

Dalhousie University
1459 Oxford St.
Halifax NS B3H 4R2
Tel: (902) 494-2211

École Polytechnique
C.P. 6079 Centre-Ville
Montréal QC H3C 3A7
Tel: (514) 340-4711

Institut Armand-Frappier
531, boulevard des Prairies
C.P. 100
Laval QC H7V 1B7

Institut National de la Recherche Scientifique (INRS)
2600, boulevard Laurier
C.P. 7500
Ste-Foy QC G1V 4C7
Tel: (418) 654-2500

McGill University
845 Sherbrooke St. W.
Montréal QC H3A 2T5
Tel: (514) 398-4455

McMaster University
1280 Main St. W.
Hamilton ON L8S 4L8
Tel: (905) 525-9140

Queen's University
99 University Ave.
Kingston ON K7L 3N6
(613) 533-2000

Royal Military College of Canada
Station "Forces"
P.O. Box 17000
Kingston ON K7K 7B4
Tel: (613) 541-6000

Trent University
1600 West Bank Dr.
Peterborough ON K9J 7B8
Tel: (705) 748-1011

University of Alberta
114 Street – 89 Ave.
Edmonton AB T6G 2M7
Tel: (708) 492-3111

University of British Columbia
2329 West Mall
Vancouver BC V6T 1Z4
Tel: (604) 822-2211

University of Manitoba Department of Physics and Astronomy
Winnipeg MB R3T 2N2
Tel: (204) 474-8880

Université de Montréal
C.P. 6128, Succursale A
Montreal QC H3C 3J7
Tel: (514) 343-6111

University of New Brunswick
3 Bailey Dr.
P.O. Box 4400
Fredericton NB E3B 5A3
Tel: (506) 453-4864

University of Ontario Institute of Technology
2000 Simcoe Street North
Oshawa ON L1H 7L7
Tel: (905) 721-3190

University of Ottawa
550 Cumberland
P.O. Box, 450 Stn. A
Ottawa ON K1N 6N5
Tel: (613) 562-5700

University of Saskatchewan
Physics Department
116 Science Place
Saskatoon SK S7N 5E2
Tel: (306) 966-4343

University of Toronto – Centre for Nuclear Engineering
Contact: Brian C.
Wallberg Bldg.
184 College Street
Toronto ON M5S 3E5
Tel: (416) 978-2127

University of Victoria
Faculty of Engineering
PO Box 3055, EOW 248
Victoria BC V8W 3P6
Tel: (250) 721-8677

University of Western Ontario
1151 Richmond Street
Suite 2
London ON N6A 5B8

University Network of Excellence in Nuclear Engineering (UNENE)
For more information
please contact your local UNENE
representative

World Nuclear University (WNU)
Atoms for Sustainable
Development
For more information
please visit their website
at www.world-nuclear-
university.org

Nuclear Power Plant Operators
Bruce Power Inc.
P.O. Box 1540, B32
Tiverton ON N0G 2T0
Tel: (519) 361-7777

Hydro-Québec Gentilly 2 Nuclear Power Station
4900 Becancour Blvd.
Gentilly QC G0X 1G0
Tel: (819) 298-2943

New Brunswick Point Lepreau
Generating Station
P.O. Box 600
Lepreau NB E5J 2S6
Tel: (506) 659-2220

Ontario Power Generation Darlington Generation Station
Information Centre
P.O. Box 4000
Bowmanville ON L1C 3Z8
Tel: (905) 623-7122

Ontario Power Generation Pickering Generating Station
Information Centre
1675 Montgomery Park Rd.
Pickering ON L1V 2R5
Tel: (905) 839-0465

National Organizations

Canadian Nuclear Association
130 Albert Street
Suite 1610
Ottawa ON K1P 5G4
Tel: (613) 237-4262

Canadian Nuclear Society (CNS)
480 University Avenue
Suite 200
Toronto ON M5G 1V2
Tel: (416) 977-7620

Canadian Nuclear Workers Council
244 Eglinton Ave. E.
Toronto ON M4P 1K2
Tel: (416) 484-4491

CANDU Owners Group
480 University Ave.
Suite 200
Toronto ON M5G 1V2
Tel: (416) 595-1888

The Canadian Centre for Energy Information
201, 322 – 11 Avenue, SW
Calgary AB T2R 0C5
Tel: (403) 263-7722

Organization of CANDU Industries (OCI)
1 Yonge St., Suite 1801
Toronto ON M5W 1W7
Tel: (416) 363-7845

INTERNATIONAL ORGANIZATIONS

Commission of the European Communities Nuclear Safety Research Directorate
200, rue de la Loi
B-1049 Brussels, Belgium
Tel: +32 2 2299 11 11

European Nuclear Society
Rue Belliard, 15-17
1040 Brussels, Belgium
Tel. +32 2 505 30 50
Fax: +32 2 502 3902

FORATOM – European Atomic Forum
Rue Belliard, 15-17
1040 Brussels, Belgium
Tel: +32 2 502 4595
Fax: +32 2 502 3902

International Atomic Energy Agency (IAEA)
Wagramerstrasse 5
P.O. Box 100
A-1400 Vienna, Austria
Tel: +43 12600-0

International Energy Agency (IEA)
9, rue de la Fédération
75739 Paris, Cedex 15 France
Tel: +33 140 5765
Fax: +33 140 57 6559

International Radiation Protection Association (IRPA)
Route du Panorama
BP48-F92263
Fontenay-aux-Roses Cedex
France
Tel: +33 1 46 547 476
Fax: +33 1 40 849 034

(OECD) Organisation for Economic Cooperation and Development Nuclear Energy Agency (NEA)
Le Seine Saint-Germain
12, boulevard des les
F-92130 Issy-les-Moulineaux,
France
Tel. +33 (1) 45 24 82 00
Fax. +33 (1) 45 24 11 10

United Nations Scientific Committee on the Effects of Atomic Radiation (UNSCEAR)
P.O. Box 500
A-1400 Vienna, Austria
Tel: +43 1 211 31, ext. 4330

World Association of Nuclear Operators (WANO)
King's Buildings
16 Smith Square
London, United Kingdom SW1P 3HQ
Tel: +44 71 828 2111
Fax: +44 71 828 6691

World Council of Nuclear Workers
49 rue Lauriston
75116 Paris, France
Tel : +33 (0)1 53 70 88 99
Fax : +33 (0)1 53 70 01 08

World Energy Council (WEC)
5th Floor, Regency House
1-4 Warwick St.
London, United Kingdom SW1B 5LT
Tel: +44 20 7734 5996
Fax: +44 20 7734 5926

World Nuclear Association
12 Floor, Bowater House W.
114 Knightsbridge, London
SW1X 7LJ, UK
Tel: +44 20 7225 0303
Fax: +44 20 7225 0308

World Nuclear Transport Institute
Remo House
310-312 Regent Street
London, W1B 3AX
Tel: +44 (0) 207 580 1144
Fax: +44 (0) 207 580 5365
www.wnti.co.uk

Canada's Nuclear Facilities

This list contains, by licence type, power reactors, uranium mine/mill facilities, uranium refineries and fuel fabrication facilities, radioisotope management facilities, research reactors, particle accelerators and radioisotope uses licensed by the Canadian Nuclear Safety Commission in Canada.

Information is based upon Canadian Nuclear Safety Commission licensing information in 2006.

Power Reactor Licences

Facility and Location	Type and Number of Units/Capacity	Startup	Status
Pickering Nuclear Generating Station A Pickering, Ontario (OPG)	CANDU-PHW 2 x 500 MW(e)	1971	Shutdown
Pickering Nuclear Generating Station A Pickering, Ontario (OPG)	CANDU-PHW 2 x 500 MW(e)	1971	Operating
Bruce Nuclear Generating Station A Tiverton, Ontario (BP)	CANDU-PHW 2 x 750 MW(e)	1976	Reconstruction
Bruce Nuclear Generating Station A Tiverton, Ontario (BP)	CANDU-PHW 2 x 750 MW(e)	1976	Operating
Pickering Nuclear Generating Station B Pickering, Ontario (OPG)	CANDU-PHW 4 x 500 MW(e)	1982	Operating
Gentilly-2 Nuclear Generating Station Gentilly, Québec (Hydro-Québec)	CANDU-PHW 1 x 600 MW(e)	1982	Operating
Point Lepreau Generating Station Lepreau, New Brunswick (New Brunswick Power Corp.)	CANDU-PHW 1 x 600 MW(e)	1982	Reconstruction
Bruce Nuclear Generating Station B Tiverton, Ontario (BP)	CANDU-PHW 4 x 840 MW(e)	1984	Operating
Darlington Nuclear Generating Station Bowmanville, Ontario (OPG)	CANDU-PHW 4 x 850 MW(e)	1989	Operating

Non-Power Reactor Licences

Unit	Type	In Service	Status
University of Toronto, Toronto, Ontario	Subcritical Assembly	1958	Decommissioned
McMaster University Hamilton, Ontario	Pool-Type 5 MW(T)	1959	Operating
École polytechnique, Montréal, Québec	Subcritical Assembly	1974	Operating
University of Toronto, Toronto, Ontario	SLOWPOKE-2 20 kW(t)	1976	Decommissioned
École polytechnique, Montréal, Québec	SLOWPOKE-2 20 kW(t)	1976	Operating
Dalhousie University, Halifax, Nova Scotia	SLOWPOKE-2 20 kW(t)	1976	Decommissioned
University of Alberta, Edmonton, Alberta	SLOWPOKE-2 20 kW(t)	1977	Operating
Saskatchewan Research Council Saskatoon, Saskatchewan	SLOWPOKE-2 20 kW(t)	1981	Operating
Royal Military College, Kingston, Ontario	SLOWPOKE-2 20 kW(t)	1985	Operating
Atomic Energy Canada Ltd. Chalk River, Ontario	Maple 1 & 2 Reactors 10 MW(t)		Shutdown pending decommissioning

Nuclear Research and Test Establishment Licences

Unit	Type	Status
Chalk River Laboratories (AECL)		
NRX Reactor	42 MW(t)	Decommissioning
NRU Reactor	135 MW(t)	Operating
Recycle Fuel Fabrication Laboratories	Manufacture of small quantities of mixed oxide fuel for research and demonstration	Operating
PTR Reactor	100 W(t)	Shutdown pending decommissioning
ZED-2 Reactor	200 W(t)	Operating

Nuclear Research and Test Establishment Licences (cont'd)

Unit	Type	Status
Universal Cells	3 isolation cells for examining radioactive material	Operating
Molybdenum-99 Production Facility	Production of Mo-99 and Xe-133	Operating
Health Physics Neutron Generator	Electrostatic accelerator 150 KeV	Operating
Waste Treatment Centre and Associated Facilities	Treatment of solid and liquid waste	Operating
Fuels and Materials Cells	12 isolation cells for examining radioactive material	Operating
Waste Management Areas	Storage and handling of waste	Operating/Shutdown
Nuclear Fuel Fabrication Facility	Production of low enriched uranium fuel for research reactors	Operating
Nuclear Fuel Fabrication Facility	Production of low and high enriched uranium fuel targets for research reactors	Operating
Heavy Water Upgrading Facility	Upgrading of heavy water	Shutdown pending decommissioning
CECEUD Test Facility	Upgrade and detritiate heavy water	Shutdown pending decommissioning
Tritium Laboratory	Processing of tritium	Operating
Whiteshell Laboratories (AECL)		
WR-1 Reactor	Organically cooled experimental reactor	Decommissioning
WL Concrete Canister Storage Facilities	Storage of irradiated fuel	Operating
Van de Graaf Accelerator	Proton accelerator, >30 microamps	Decommissioned
14 MeV Neutron Generator		Decommissioned
Active Liquid Waste Treatment Centre	Treatment of liquid waste	Operating
WL Shielded Facilities	Post irradiated examination of fuels, reactor core components and other radioactive material	Decommissioning
WL Waste Management Area	Storage and handing of waste	Operating
SLOWPOKE Demonstration Reactor	2 MW pool-type reactor	Decommissioned

Uranium Mine and Mill Facility Licences

Facility	Activity	Status
Beaverlodge/Dubyna, Saskatchewan (Cameco Corporation)		Decommissioned
Cigar Lake Project, Saskatchewan (Cameco Corporation)	Development	Construction
Cluff Lake, Saskatchewan (Cogema Resources Inc.)		Decommissioning
Key Lake Operation Saskatchewan (Cameco Corporation)	Milling	Operating
McArthur River Project, Saskatchewan (Cameco Corporation)	Ore removal	Operating
McClean Lake Project, Saskatchewan (Cogema Resources Inc.)	Ore removal and milling	Operating
Midwest Joint Venture, Saskatchewan (Cogema Resources Inc.)	Care and maintenance	Siting license
Rabbit Lake Saskatchewan (Cameco Corporation)	Ore removal and milling	Operating
Denison Mines, Elliot Lake, Ontario (Denison Mines Ltd.)		Decommissioned
Stanrock, Elliot Lake, Ontario (Denison Mines)		Decommissioned
Madawaska Bancroft, Ontario (Madawaska Mines Ltd.)		Decommissioned

Canada's Nuclear Facilities

Refinery and Fuel Fabrication Facility Licences

Facility	Annual Licensed Production Limit	Status
GE Canada Inc., Toronto, Ontario	1,800 tonnes of uranium as UO2 pellets	Operating
GE Canada Inc., Peterborough, Ontario	1,800 tonnes of uranium as UO2 pellets in fuel bundles	Operating
Cameco Fuel Manufacturing Inc. Port Hope, Ontario	1,500 tonnes of uranium as UO2 pellets in fuel bundles	Operating
Cameco Corporation, Blind River, Ontario	18,000 tonnes of uranium as UO3	Operating
Cameco Corporation, Port Hope, Ontario	12,500 tonnes of uranium as UF6	Operating
	2,800 tonnes of uranium as UO2	Operating
	1,000 tonnes of uranium as ADU	Operating
	2,000 tonnes of depleted uranium metals and alloys	Non-operational
Earth Sciences Extraction Co. Calgary, Alberta	70 tonnes of uranium as U3O8	Non-operational since 1987

Waste Management Licences

Facility	Activity	Status
Radioactive Waste Operations Site 1, Tiverton, Ontario (OPG)	Storage of old solid wastes from Douglas Point nuclear station, no new waste accepted	Storage with surveillance
Western Waste Management Facility Tiverton, Ontario (OPG)	Incineration, compaction and storage of low and intermediate waste, and storage of spent fuel from Bruce NGS	Operating
Pickering Waste Management Facility Pickering, Ontario (OPG)	Storage of spent fuel and retube components from Pickering NGS	Operating
Bruce Heavy Water Plant Tiverton, Ontario (OPG)	Demolition of the heavy water plant and remediation of the site	Decommissioning
Douglas Point Radioactive Waste Storage Facility Tiverton, Ontario (AECL)	Storage of solid waste from Douglas Point Generating Station, spent fuel storage, no new waste accepted	Storage with surveillance
Gentilly-1 Radioactive Waste Storage Facility Gentilly, Quebec (AECL)	Storage of solid waste from Gentilly-1 NGS, spent fuel storage, no new waste accepted	Storage with surveillance
Gentilly-2 Radioactive Waste Storage Facility Gentilly, Quebec (Hydro-Quebec)	Storage of solid waste and spent fuel storage from Gentilly-2 NGS	Operating
Point Lepreau Solid Radioactive WMF Point Lepreau, New Brunswick (NB Power Nuclear Corporation)	Storage of solid waste and spent fuel storage from Point Lepreau NGS	Operating
Darlington Used Fuel Dry Storage Facility Bowmanville, Ontario (OPG)	Construction of a waste management facility for spent fuel at the Darlington NGS	Under construction
University of Toronto WMF Toronto, Ontario (University of Toronto)	Storage, handling and compaction of waste from university	Operating
Central Maintenance and Laundry Facility Tiverton, Ontario (Bruce Power)	Managing waste from decontamination activities	Operating
Monserco WMF Brampton, Ontario (Monserco Ltd.)	Storage, handling and compaction of waste from Ontario and Quebec	Operating
Nuclear Power Demonstration WMF Rolphton, Ontario (AECL)	Storage of solid waste from the partial decommissioning of NPD NGS, no new waste accepted	Storage with surveillance
Port Granby WMF Clarington, Ontario (Cameco Corporation)	Storage of historic waste and chemical treatment of drainage and run-off, no new waste accepted	Storage with surveillance
Welcome WMF Port Hope, Ontario (Cameco Corporation)	Storage of historic waste and treatment of drainage and run-off, no new waste accepted	Storage with surveillance

Waste Management Licences (cont'd)

Facility	Activity	Status
Elliot Lake WMF Elliot Lake, Ontario (Rio Algom Ltd.)	Multiple tailings management site, chemical treatment of effluent, no new waste accepted	Storage with surveillance
Port Hope PSE TSS Port Hope, Ontario (Low-Level Radioactive Waste Management Office)	Storage of historic waste, no new waste accepted	Storage with surveillance
Port Hope WMF Port Hope, Ontario (Low-Level Radioactive Waste Management Office, Pine St. Extension Temporary Storage Site)	Storage of historic waste	Operating
Roving Locations (Low-Level Radioactive Waste Management Office, decontamination projects)	Possession of historic waste on an as requested basis	Operating
Agnew Lake Idle Mine Site Nairn Centre, Ontario (Ministry of Northern Development and Mines Canada)	Above-ground tailings	Storage with surveillance
Dyno Idle Mine Site Bancroft, Ontario (EnCana West Ltd.)	Above-ground tailings	Storage with surveillance
Rayrock Idle Mine Site Northwest Territories (Ministry of Indian and Northern Affairs Canada)	Above-ground tailings	Storage with surveillance

Particle Accelerator Licences

Facility	Type	Status
Provincial Health Services Authority Charlottetown, Prince Edward Island	1 linac	Operating
Region 2 Hospital Corporation Saint John, New Brunswick	1 linac	Operating
Complexe hospitalier de la Sagamie Chicoutimi, Québec	1 linac	Operating
Centre universitaire de santé McGill Montréal, Québec	4 linacs	Operating
Hôpital Maisonneuve-Rosemont Montréal, Québec	3 linacs	Operating
The Board of Governors of the Kingston Hospital, Kingston, Ontario	3 linacs	Operating
Thunder Bay Regional Health Sciences Centre, Thunder Bay, Ontario	2 linacs	Operating
Windsor Regional Hospital Windsor, Ontario	3 linacs	Operating
Cancer Care Manitoba Winnipeg, Manitoba	5 linacs	Operating
Saskatchewan Cancer Foundation Regina, Saskatchewan	3 linacs	Operating
Saskatchewan Cancer Foundation Saskatoon, Saskatchewan	3 linacs	Operating
Alberta Cancer Board Calgary, Alberta	6 linacs	Operating
Alberta Cancer Board Edmonton, Alberta	5 linacs	Operating
Hôpital Général Juif Montréal, Québec	2 linacs	Operating
Centre hospitalier régional de Rimouski Rimouski, Québec	2 linacs	Operating

Canada's Nuclear Facilities

Particle Accelerator Licences (cont'd)

Facility	Type	Status
Cape Breton District Health Authority Sydney, Nova Scotia	1 linac	Operating
Régie régionale de la santé (Beauséjour) Moncton, New Brunswick	2 linacs	Operating
British Columbia Cancer Agency Kelowna, British Columbia	2 linacs	Operating
British Columbia Cancer Agency Victoria, British Columbia	5 linacs	Operating
British Columbia Cancer Agency Surrey, British Columbia	4 linacs	Operating
British Columbia Cancer Agency Vancouver, British Columbia	5 linacs	Operating
The Credit Valley Hospital Mississauga, Ontario	3 linacs	Operating
Newfoundland Cancer Treatment and Research St. John's, Newfoundland	1 linac	Operating
Centre hospitalier universitaire de Sherbrooke Sherbrooke, Québec	2 linacs	Operating
Centre hospitalier universitaire de Québec Québec, Québec	5 linacs	Operating
Capital District Health Authority Halifax, Nova Scotia	5 linacs	Operating
Hamilton Health Sciences Corporation Hamilton, Ontario	8 linacs	Operating
Centre hospitalier de l'Université de Montréal Montréal, Québec	8 linacs	Operating
Centre hospitalier régional Trois-Rivières, Québec	2 linacs	Operating
Hôpital régional de Sudbury Sudbury, Ontario	5 linacs	Operating
The Ottawa Hospital Ottawa, Ontario	6 linacs	Operating
Sunnybrook and Women's College Health Sciences Centre Toronto, Ontario	9 linacs	Operating
Centre hospitalier des vallées de l'Outaouais Gatineau, Québec	1 linac	Operating
University Health Network Toronto, Ontario	16 linacs	Operating
Grand River Hospital Corporation Kitchener, Ontario	4 linacs	Operating
London Health Sciences Centre London, Ontario	8 linacs	Operating
McMaster University Hamilton, Ontario	1 tandetron accelerator	Operating
McMaster University Hamilton, Ontario	1 tandetron accelerator	Operating
McMaster University Hamilton, Ontario	2 Van de Graaff	Operating

Particle Accelerator Licences (cont'd)

Facility	Type	Status
University of Guelph Guelph, Ontario	1 Pelletron accelerator	Operating
University of Western Ontario London, Ontario	1 tandetron accelerator 1 Van de Graaff	Operating Operating
Queen's University at Kingston Kingston, Ontario	1 particle accelerator	Operating
Université de Montréal Montréal, Québec	1 Van de Graaff tandem accelerator 1 tandetron accelerator	Operating Operating
Université Laval Ste-Foy, Québec	1 Van de Graaff tandem accelerator	Operating
Acsion Industries Incorporated Pinawa, Manitoba	1 particle accelerator	Operating
National Research Council Canada Ottawa, Ontario	1 Elekta Philips Precise 1 Vickers Electron Linear Accelerator	Operating Operating
Inco Limited Toronto, Ontario	Neutron Generator	Operating
Schlumberger Canada Limited Calgary, Alberta	Neutron Generator	Operating
Precision Drilling Technology Services Inc. Calgary, Alberta	Neutron Generator	Operating
Baker Hughes Canada Company Calgary, Alberta	Neutron Generator	Operating
Scientific Drilling International (Canada) Calgary, Alberta	Neutron Generator	Operating
Hotwell Canada Ltd. Calgary, Alberta	Neutron Generator	Operating
Montreal Neurological Institute and Hospital Montreal, Quebec	1 Cyclotron	Operating
Alberta Cancer Board Edmonton, Alberta	1 Cyclotron	Operating
Centre for Addiction and Mental Health Toronto, Ontario	1 Cyclotron	Operating
Centre hospitalier universitaire de Sherbrooke Sherbrooke, Québec	1 Cyclotron	Operating
Hamilton Health Sciences Corporation Hamilton, Ontario	1 Cyclotron	Operating
University of Ottawa Heart Institute Ottawa, Ontario	1 Cyclotron	Operating

Nuclear Substance Processing Facility Licences

Facility	Type	Status
New Processing Facility Chalk River Laboratories Chalk River, Ontario	Production and processing	Operating
MDS Nordion Ottawa, Ontario	Production and processing	Operating
SRB Technologies	Processing	Operating
Shield Source Inc.	Processing	Operating

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Fuel Cycle Components
Cameco Corporation .....IBC

Fuel Element Cladding
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Fuel, Research Reactors
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Glass, Radiation Shielding
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Suppliers' Addresses and Contacts

Aecon Industrial
150 Sheldon Dr.
Cambridge, Ontario
N1R 7K9
Canada
Contact:
James Gandhi
Business Development Manager – Nuclear
Tel: 519-653-3200
Fax: 519-621-8430
E-mail: jgandhi@aecon.com

Aerofin Corporation
4621 Murray Place
Lynchburg, Virginia
24502
USA
Contact:
Brian C. Elliott
V.P. – Engineering
Tel: 434-845-7081
Fax: 434-528-6242
E-mail: sales@aerofin.com
www.aerofin.com

Alexander Vacuum Research, Inc.
P.O. Box 589
Greenfield, Massachusetts
01302-0589
USA
Contact:
Daniel Carson
General Manager
Tel: 413-498-9924
Fax: 413-498-9926
E-mail: avr_inc@verizon.net

AMEC NCL 22
700 University Avenue, 4th Floor
Toronto, Ontario
M5G 1X6
Canada
Contact:
Walter Thompson
Commercial Director
Tel: 416-592-4349
Fax: 416-592-8284
E-mail:
walter.thompson@amec.com
www.amecncl.com

AMEC NSS 22
700 University Ave., 4th Floor
Toronto, Ontario
M5G 1X6
Canada
Contact:
Walter Thompson
V.P. Commercial Operations
Tel: 416-592-4349
Fax: 416-592-8284
E-mail:
walter.thompson@amec.com
www.amecnss.com

ANRIC Enterprises Inc.
202 – 701 Evans Ave.
Toronto, Ontario
M9C 1A3
Canada
Contact:
Anne Barnes
Manager
Tel: 416-253-9459, ext. 104
Fax: 416-252-5335
E-mail: afbarnes@anric.com

AREVA NP Canada Ltd. 4
925 Brock Road
Pickering, Ontario
L1W 2X9
Canada
Contact:
Michael Ruysseveldt
Director, Business Development
Tel: 905-421-2738
Fax: 905-421-2605
www.canada.areva.com

Armour Valve Ltd.
126 Milner Ave.
Toronto, Ontario
M1S 3R2
Canada
Contact:
Jennifer Jones
Tel: 416-299-0780, ext. 461
Fax: 416-299-0394
E-mail: sales@armourvalve.com

Asco Numatics
P.O. Box 160, 17 Airport Rd.
Brantford, Ontario
N3T 5M8
Canada
Contact:
Darren Salmon
Tel: 519-758-2700
Fax: 519-758-5540
E-mail: asconumaticscanada@emerson.com
www.ascovalve.ca

ATC Nuclear
588 Broadway
Schnectady, New Jersey
12305
USA
Contact:
Brendan Kelly
Tel: 518-612-8945
Fax: 518-382-0283
E-mail: bkelly@argoturbo.com
www.argoturbo.com
Representative(s):
Hank Rasanen
Henry Controls Inc.
32 Heslop Court
Georgetown, Ontario
L7G 4J4
Canada
Tel: 905-877-8786
Fax: 905-877-0428
Cell: 416-931-6108
E-mail: hank@henrycontrols.com
www.henrycontrols.com

ATI Nuclear Energy
1600 NE Old Salem Road
P.O. Box 460
Albany, Oregon
97321
USA
Contact:
Customer Service
Tel: 1-877-777-5140
Fax: 541-967-6977
E-mail: nuclearenergyinquiries@atimetals.com

Atlantic Nuclear Services Inc.
P.O. Box 1268, Station A
Fredericton, New Brunswick
E3B 5C8
Canada
Contact:
Keith Scott
President
Tel: 506-458-9552
Fax: 506-451-0525
E-mail: kscott@ansl.ca
www.ansl.ca

Avensys Solutions
422 Consumers Road
Toronto, Ontario
M2J 1P8
Canada
Contact:
Jennifer Loeffler
Tel: 416-499-4421
Fax: 416-499-0816
E-mail: jloeffler@avensys.com
www.avensyssolutions.com

Axiom NDT Corporation 2
380 Sheldon Dr., Unit 8
Cambridge, Ontario
N1T 2C2
Canada
Contact:
Gordon Walker
President
Tel: 519-621-5665
Fax: 519-621-2062
E-mail:
gordon.walker@kinectrius.com

B.C. Instruments
41 Proctor Road
Schomberg, Ontario
L0G 1T0
Canada
Contact:
Harshad P. Patel, P.Eng
Director/Section Manager
Tel: 905-939-7323, ext. 354
Fax: 905-939-8206
E-mail:
harshadp@bc-instruments.com
www.bc-instruments.com

Suppliers' Addresses and Contacts

Babcock & Wilcox.....76

581 Coronation Blvd.
Cambridge, Ontario
N1R 5V3
Canada
Contact:
Jun Tang
Director Nuclear Sales
and Marketing
Tel: 519-621-2130
Fax: 519-621-2310
E-mail: jtang@babcock.com
www.babcock.com/bwc

Biron Engineering Ltd.

101-1710 Hickey Road
Building 5
Saint John, New Brunswick
E2J 3S6
Canada
Contact:
Ken Biron, MASc, P.Eng
President
Tel: 506-696-1440
Fax: 506-696-1442
E-mail: bironeng@rogers.com

Brent Packaging & Logistics Ltd.

5491 Timberlea Blvd.
Mississauga, Ontario
L4W 2T6
Canada
Contact:
Stephen W. Warwick
President
Tel: 905-624-8898
Fax: 905-624-3655
E-mail:
swarwick@brentpackaging.com
www.brentpackaging.com
Representative(s):
Alison Warwick-Fernandes
Sales Representative
Tel: 416-618-0024

Cameco Corporation ...IBC

2121 – 11th Street West
Saskatoon, Saskatchewan
S7M 1J3
Canada
Contact:
Gord Struthers
Director, External
Communications
Tel: 306-956-6340
Fax: 306-956-6318
www.cameco.com

Cameco Fuel Manufacturing..... IBC

200 Dorset Street East
Port Hope, Ontario
L1A 3V4
Canada
Contact:
Doug Burton
Manager Marketing, Zirconium
& Reactor Components
Tel: 905-885-4537, ext. 3300
Fax: 905-372-3748
E-mail:
doug_burton@cameco.com
www.cameco.com
Representative(s):
Celeste Pendlebury
Marketing Manager
Tel: 289-251-2601
Fax: 905-372-3748
E-mail:
celeste_pendlebury@cameco.com

Canadian Nuclear Society 8, 40

655 Bay St., 17th Floor
Toronto, Ontario
M5G 2K4
Canada
Contact:
Denise Rouben
Tel: 416-977-7620
Fax: 416-663-3504
E-mail: cns-snc@on.aibn.com
www.cns-snc.ca

Canadian Nuclear Workers' Council

244 Eglinton Ave. E.
Toronto, Ontario
M4P 1K2
Canada
Contact:
David Shier
President
Tel: 416-481-4491
Fax: 416-481-7115
Cell: 416-725-5776
E-mail: dshier@pwu.ca
www.cnwc-cctn.ca

Canadian Power Utility Services Limited

Unit 4, KR 230, 800 Kipling Ave.
Toronto, Ontario
M8Z 6C4
Canada
Contact:
Derek Mori
Vice President
Tel: 416-231-9559, ext. 222
Fax: 416-231-9230
E-mail: dmori@cpusl.com

Canberra Co.

West – 50B Caldari Rd.
Concord, Ontario
L4K 4N8
Canada
Contact:
Jim Outos
Sr. Account Manager
Tel: 905-660-5373, ext. 231
Fax: 905-660-9693
Toll-Free: 1-866-660-5373
E-mail: joutos@canberra.com
www.canberra.com
Representative(s):
Vincent Pitre
Account Manager
Tel: 905-660-5373, ext. 263
Fax: 905-660-9693
E-mail: vpitre@canberra.com
Jessica Laciak
Account Manager
Tel: 905-660-5373, ext. 267
Fax: 905-660-9693
E-mail: jlaciak@canberra.com
Linda Ostrowski
VP, Sales & Service, AMERICAS
Canberra Co.
107 Union Valley Road
Oak Ridge, Tennessee
37830
USA
Tel: 865-220-6354
E-mail: lostrowski@canberra.com

Candesco.....2

230 Richmond St. West,
10th Floor
Toronto, Ontario
M5V 1V6
Canada
Contact:
Peter Blahnik
Manager, Business Development
& Marketing
Tel: 416-585-2552, ext. 225
Fax: 416-585-9559
E-mail: pblahnik@candesco.com
www.candesco.com

Candu Energy Inc.

2285 Speakman Drive
Mississauga, Ontario
L5K 1B2
Canada
Contact:
Scott Malcolm
Candu Services
Tel: 905-823-9040
E-mail:
scott.malcolm@candu.com
www.candu.com

Chempump Division of Teikoku USA

959 Mearns Road
Warminster, Pennsylvania
18974
USA
Contact:
James McDaniel
Contract Administrator
Tel: 267-486-1010
Fax: 267-486-1037
E-mail:
jmcdaniel@chempump.com
www.chempump.com

Comstock Canada Ltd.
3455 Landmark Road
Burlington, Ontario
L7M 1T4
Canada
Contact:
Bob Kilmartin
Tel: 905-335-3333
Fax: 905-332-5680
E-mail:
bkilmartin@comstockcanada.com

Container Products Corporation
P.O. Box 3767
Wilmington, North Carolina
28406
USA
Contact:
Kenneth N. Beyma
Tel: (910) 392-6100
Fax: (910) 392-6778
E-mail: sales@c-p-c.com

Copes-Vulcan, An SPX Brand.....32
5620 West Road
McKean, Pennsylvania
16426
USA
Contact:
Dave Martin
Tel: 814-476-5800
Fax: 814-476-5848
E-mail: david.martin@spx.com
www.spxft.com

Cuttler & Associates Inc.
1781 Medallion Court
Mississauga, Ontario
L5J 2L6
Canada
Contact:
Jerry M. Cuttler
Tel: 416-837-8865
E-mail: jerrycuttler@rogers.com

Denison Mines Corp.
595 Bay St., Suite 402
Toronto, Ontario
M5G 2C2
Canada
Contact:
Ron Hochstein
President & CEO
Tel: 416-979-1991
Fax: 416-979-5893
E-mail:
rhochstein@denisonmines.com

E.S. Fox Limited 16
9127 Montrose Road
Niagara Falls, Ontario
L2E 7J9
Canada
Contact:
E.A. Downes
V.P. Business Development
Tel: 905-354-3700, ext. 344
Fax: 905-354-5599
E-mail: ernie.downes@esfox.com
www.esfox.com
Representative(s):
Zed Janakovic
Sales Vice President
E.S. Fox Limited
9127 Montrose Road
Niagara Falls, Ontario
L2E 7J9
Canada
Tel: 905-354-3700, ext. 262
Fax: 905-354-5599
E-mail: zed.janakovic@esfox.com
www.esfox.com

Eaton-Yale Company..28
6175 Kenway Drive
Mississauga, Ontario
L5T 2L3
Canada
Contact:
Gordon Thompson
Tel: 905-364-2908
Fax: 905-542-2321
E-mail:
gordthompson@eaton.com

Eclipse Scientific.....33
97 Randall Drive
Waterloo, Ontario
N2V 1C5
Canada
Contact:
Robert Ginzel
Tel: 519-886-6717
Fax: 519-886-1102
E-mail:
info@eclipsescientific.com

EcoMetrix Incorporated
6800 Campobello Rd.
Mississauga, Ontario
L5N 2L8
Canada
Contact:
Don Hart
Tel: 905-794-2325, ext. 236
Fax: 905-794-2338
E-mail: dhart@ecometrix.ca
Representative(s):
Al Shpyth
Innovation Place
Suite 303, 111 Research Drive
Saskatoon, Saskatchewan
S7N 3R2
Canada
Tel: 306-933-3939
Fax: 306-933-3943
E-mail: ashpyth@ecometrix.ca

Ellwood Quality Steels Company
700 Moravia Street
New Castle, Pennsylvania
16101
USA
Contact:
Gregory J. Manzo
Tel: 724-658-6507
Fax: 724-658-6802
E-mail: gmanzo@elwd.com

Suppliers' Addresses and Contacts

EnergySolutions Canada Monserco Ltd. 14

190 Wilkinson Rd., Unit #2
Brampton, Ontario
L63 4W3
Canada
Contact:
Vik Tathe
Tel: 905-450-3507
Fax: 905-450-8523
E-mail:
vlrobinson@energysolutions.com
www.energysolutions.com
Representative(s):
Celia Figel
Tel: 905-450-3507
Fax: 905-450-8523
E-mail:
vlrobinson@energysolutions.com

Ezeflow Inc.

905 Andre Line
Granby, Quebec
J2J 1J6
Canada
Contact:
Jacques Latendresse
President
Tel: 450-375-3575
Fax: 450-375-3772
Toll-Free: 1-800-363-6310
E-mail: info@ezeflow.com
www.ezeflow.com

Flowserve Flow Control

1900 South Saunders Street
Raleigh, North Carolina
27603
USA
Contact:
Floyd Bensinger
Sales and Contracts
Tel: 919-831-3200
Fax: 919-831-3369
E-mail:
fbensinger@flowserve.com
www.flowserve.com
Representative(s):
Richard B. Granstrand
Area Sales Manager
Flowserve Corp, FCD, Power Generation Group Sales
12 Moose Horn Road
P.O. Box 318
West Granby, Connecticut
6090
USA
Tel: 860-653-6407
E-mail:
rgranstrand@flowserve.com
www.flowserve.com

GE Hitachi Nuclear Energy Canada Inc... IFC

1160 Monaghan Rd.
Peterborough, Ontario
K9J 7B5
Canada
Contact:
Mike Gabbani
VP Sales
Tel: 705-748-7944
Fax: 705-748-7338
Cell: 705-760-1288
E-mail: Mike.Gabbani@ge.com
www.ge.com
Representative(s):
Dale Cosh
Nuclear Sales Manager
Tel: 705-748-7946
Cell: 705-930-3681
E-mail: Dale.Cosh@ge.com
Edward Genge
Parts Sales Manager
Nuclear Services
Tel: 705-748-7039
Fax: 705-748-7076
Cell: 705-875-8045
E-mail: edward.genge@ge.com

Hatch-Sargent & Lundy (HSL)

2800 Speakman Drive
Sheridon Science and Tech Park
Mississauga, Ontario
L5K 2R7
Canada
Contact:
Alan O'brien
Global Director
Tel: 905-357-6993
Fax: 905-855-8270
E-mail: aobrien@hatch.ca

Henry Controls Inc.

32 Heslop Court
Georgetown, Ontario
L7G 4J4
Canada
Contact:
Hank Rasanen
P. Eng.
Tel: 905-877-8786
Fax: 905-877-0428
Cell: 416-931-6108
E-mail: hank@henrycontrols.com
www.henrycontrols.com

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301-5750 Explorer Dr.
Mississauga, Ontario
L4W 0A9
Canada
Contact:
Paul Eric Marko
Manager, I&C Systems
Tel: 905-629-9300, ext. 2970
Fax: 905-290-0141
Toll-Free: 1-800-906-4482, ext. 2970
E-mail:
pauleric.marko@hitachi.ca
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General Manager
Tel: 403-276-1881, ext. 5265
Fax: 403-278-1810
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Jeremy Rasmussen
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Canada
Contact:
Rae A. Watson
Manager, Technical Sales
Tel: 519-623-4880 x210
Fax: 519-623-4686
Cell: 519-497-8340
E-mail: rwatson@mirion.com
www.mirion.com

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Etobicoke, Ontario
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Canada
Contact:
Ron Stewart
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(CAN & USA)
E-mail: info@kesl.com
www.kesl.com

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800 Kipling Ave.
Toronto, Ontario
M8Z 6C4
Canada
Contact:
Cheryl Tasker-Shaw
Marketing Manager
Tel: 416-207-6000, ext. 5970
Fax: 416-207-6532
E-mail: cheryl.tasker-shaw@
kinectrics.com
www.kinectrics.com

Laker Energy Products Ltd.
3435 Landmart Road
Burlington, Ontario
L7M 1T4
Canada
Contact:
Mariana Rogalo
Tel: 905-332-3231
Fax: 905-332-7151
Toll-Free: 1-888-375-2537
E-mail:
rogalom@lakerenergy.com
www.lakerenergy.com

Lakeside Process Controls Ltd.
5250 Orbitor Drive
Mississauga, Ontario
L4W 5G7
Canada
Contact:
Eddie Saab
Sales Manager
Tel: 905-629-9340
Fax: 905-629-7185
E-mail:
eddie.saab@lakesidecontrols.com
www.lakesidecontrols.com

LND Inc. 68, 79

3230 Lawson Blvd.
Oceanside, New York
11572
USA
Contact:
William J. Lehnert
Tel: 516-678-6141
Fax: 516-678-6704
E-mail: info@lndinc.com
www.lndinc.com

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1-1016C Sutton Drive
Burlington, Ontario
L7L 6B8
Canada
Contact:
Ron Bake
Tel: 905-332-1172
Fax: 905-332-1668
E-mail: rbake@marshinst.com
www.marshinst.com

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4140 Morris Drive
Burlington, Ontario
L7L 5L6
Canada
Contact:
David Holden
Sales Manager
Tel: 1-905-637-3862
Fax: 905-637-8841
Toll-Free: 1-800-381-5335
E-mail: dholden@marsmetal.com

Marubeni Canada Ltd.
40 University Ave., Suite 600
Toronto, Ontario
M5J 1T1
Canada
Contact:
Yasuo Hasebe
Vice President, Machinery &
Energy Group
Tel: 416-368-1171, ext. 233
Fax: 416-947-9004
E-mail:
hasebe-y@na.marubeni.com

Suppliers' Addresses and Contacts

McMaster Nuclear Reactor
1280 Main Street West
NRB G101
Hamilton, Ontario
L8S 4K1
Canada
Contact:
C. Heysel
Director, Nuclear Operations and Facilities
Tel: 905-525-9140, ext. 23278
Fax: 905-524-3994
E-mail: heyselc@mcmaster.ca
www.mcmaster.ca

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Brampton, Ontario
L6T 4K3
Canada
Contact:
Sheamus Doherty
Technical Service Manager, MICAN
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Fax: 905-791-4490
E-mail: sheamus.doherty@cwst.com
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Niagara Energy Products Corp.
4749 Buttrey Street
Niagara Falls, Ontario
L2E 7K7
Canada
Contact:
Robert Dimitrieff
Vice President
Tel: 905-371-2500, ext. 228
Fax: 905-371-2235

Niagara Fasteners Inc. 42
6095 Progress Street
P.O. Box 148
Niagara Falls, Ontario
L2E 6S8
Canada
Contact:
Dean Zaniol
General Manager
Tel: 905-356-6887
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Toll-Free: 1-800-263-3602 (CAN & US)
E-mail: nfsales@niagara.com
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18001 Sheldon Road
Middleburg Heights, Ohio
44130
USA
Contact:
Claire Dinkel
Tel: 216-496-3162
E-mail: cdinkel@curtisswright.com
nova.cwfc.com
Representative(s):
Dan Harnett
Regional Manager
Toronto, Ontario
Canada
Tel: 416-787-8539
Fax: 416-787-8746
E-mail: dharnett@curtisswright.com
nova.cwfc.com
Chris Hoose
Account Executive
Nova Machine Products
18001 Sheldon Road
Middleburg Heights, Ohio
44130
USA
Tel: 216-898-8020
Cell: 440-840-8338
E-mail: choose@curtisswright.com
nova.cwfc.com

Nucleonix Systems Pvt Ltd.
Plot 162 A&B, IDA, PH II,
Cherlapally
Hyderabad, AP
500051
India
Contact:
J Nishanth Reddy
Head, International Business Division
Tel: +91-40-27263701
Fax: +91-40-27262146
Email: info@nucleonix.com

Nuclear Canada Yearbook
655 Bay St., 17th Floor
Toronto, Ontario
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Canada
Contact:
Colin Hunt
Publisher and Editor
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Fax: 416-977-8131
Cell: 613-220-7607
E-mail: colin.hunt@rogers.com
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Representative(s):
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Advertising Sales Manager
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Canada
Tel: 416-482-5511
Fax: 416-482-5512
E-mail: thomasmcna@aol.com

Nuclear Logistics, Inc. 60
7410 Pebble Drive
Forth Worth, Texas
76118
USA
Contact:
Gerry Waterhouse
Tel: 905-623-1235
Toll-Free: 1-800-448-4124
E-mail: gerry.waterhouse@nuclearlogistics.com
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Nuvia Canada 53
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Canada
Contact:
Arkell Farr
Business Development Manager
Tel: 647-864-6428
Fax: 416-900-6058
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Canada
Contact:
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V.P. Business Development
Tel: 519-758-8100
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244 Eglinton Avenue East
Toronto, Ontario
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Canada
Contact:
Don MacKinnon
President
Tel: 416-481-4491
Fax: 416-322-2454
E-mail: pwu@pwu.ca
www.pwu.ca

Promation Nuclear Ltd.
2767 Brighton Rd.
Oakville, Ontario
L6H 3J4
Canada
Contact:
Narinder Bains
Vice-President
Tel: 416-453-8835
Fax: 905-625-6910
E-mail: bains.n@promation.com

Radiation Safety Institute of Canada
165 Ave. Road, Suite 300
Toronto, Ontario
M5R 3S4
Canada
Contact:
Natalia Mozayani
Director of Development and Marketing
Tel: 416-650-9090, ext. 28
Fax: 416-650-9920
E-mail: nmozayani@radiationsafety.ca
www.radiationsafety.ca

RCM Technologies Canada Corp. 18
895 Brock Road South
Pickering, Ontario
L1W 3C1
Canada
Contact:
Geoff Davies
V.P. Power Services
Tel: 905-837-8333, ext. 2145
Fax: 905-837-8248
Cell: 416-938-2014
E-mail: geoff.davies@rcmt.com
www.rcmt.ca

Rolls-Royce Civil, Nuclear Canada LTD
678 Neal Drive, Box 1776
Peterborough, Ontario
K9J 7X6
Canada
Contact:
Glen Crawford
Director of Marketing
Tel: 705-743-2708
Fax: 705-743-3216
E-mail: glen.crawford@rolls-royce.com
www.rolls-royce.com

RSB LOGISTIC INC.
219 Cardinal Cres.
Saskatoon, Saskatchewan
S7L 7K8
Canada
Contact:
Mark Muench
Manager Key Accounts, Nuclear Transportation, Management
Tel: 306-242-8300
Fax: 306-242-2311
E-mail: rsb@rsblogistic.com
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Seal Master Corporation 80
368 Martinel Drive
Kent, Ohio
44240-4368
USA
Contact:
Marc Cardarelli
Sales Manager
Tel: 330-673-8410
Fax: 330-673-8242
Toll-Free: 1-800-477-8436
E-mail: info@sealmaster.com
www.sealmaster.com

SENES Consultants Limited
121 Granton Drive, Unit #12
Richmond Hill, Ontario
L4B 3N4
Canada
Contact:
Leo Lowe
Ph.D., P.Phys., Principal, Senior Health and Environmental Physicist
Tel: 905-764-9380
Fax: 905-764-9386
E-mail: llowe@senes.ca
www.senes.ca
Representative(s):
Douglas Chambers
Ph.D., Vice-President, Director of Risk and Radioactivity Studies
Tel: 905-764-9380
Fax: 905-764-9386
E-mail: dchambers@senes.ca
www.senes.ca

SIHI Pumps Limited
225 Speedvale Ave. W.
P.O. Box 728
Guelph, Ontario
N1H 6L8
Canada
Contact:
Guy Loken
P. Eng., Project Manager
Tel: 519-824-4600
Fax: 519-824-7250
E-mail: mail@sihi.com
www.sihi-pumps.com

Stantec Consulting Ltd.
845 Prospect St.
Fredericton, New Brunswick
E3B 5B4
Canada
Contact:
Marc Voisine
Tel: 506-452-7000, ext. 1219
Fax: 506-452-0112
E-mail: marc.voisine@stantec.com

SWI Systemware
2300 Yonge St., Suite 1800
P.O. Box 2418
Toronto, Ontario
M4P 1E4
Canada
Contact:
David Tremaine
Tel: 416-932-4653
Fax: 416-932-4710
E-mail: info@swi.com

Tetra Tech Wei Inc. 30
1055 Squires Beach Road
Pickering, Ontario
L1W 4A6
Canada
Contact:
Sanjay Krishnan
Business Development
Tel: 905-686-2810, ext. 481
Fax: 905-686-8560
Cell: 905-599-3939
E-mail: commnuclear@tetratech.com
www.tetratech.com

Thorburn Equipment Inc. 24, 34
173 Oneida Drive
Pointe-Claire, Quebec
H9R 1A9
Canada
Contact:
Robert Thorburn
President
Tel: 514-695-8714
Fax: 514-695-8716
Toll-Free: 1-800-363-6613x306
E-mail: sales@thorburnflex.com
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Tyne Engineering Inc.
2333 Wyecroft Road, Unit #9
Oakville, Ontario
L6L 6L4
Canada
Contact:
John Robinson
Tel: 905-825-0697
Fax: 905-825-0716
E-mail: jr@tyne-engineering.com
www.tyne-engineering.com

Suppliers' Addresses and Contacts

Ultra Electronics, Nuclear Sensors & Process Instruments
707 Jeffrey Way, P.O. Box 300
Round Rock, Texas
78680-0300
USA
Contact:
David Robertson
Tel: 512-434-2950
Fax: 512-434-2951
E-mail: nuclear@ultra-nspi.com
www.ultra-nspi.com
Representative(s):
Hank Rasanen
Henry Controls Inc.
32 Heslop Court
Georgetown, Ontario
L7G 4J4
Canada
Tel: 905-877-8786
Fax: 905-877-0428
Cell: 416-931-6108
E-mail: hank@henrycontrols.com
www.henrycontrols.com

Wyle Laboratories Inc.
7800 Highway 20 West
P.O. Box 077777
Huntsville, Alabama
35807-7777
USA
Contact:
Greg Mason
Tel: 256-716-4283
Fax: 256-837-3363
E-mail: greg.mason@wyle.com
www.wyle.com
Representative(s):
Hank Rasanen
Henry Controls Inc.
32 Heslop Court
Georgetown, Ontario
L7G 4J4
Canada
Tel: 905-877-8786
Fax: 905-877-0428
Cell: 416-931-6108
E-mail: hank@henrycontrols.com
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Zetec Inc.....65
875 Boulevard Charest Ouest,
Suite 100
Quebec, Quebec
G1N 2C9
Canada
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Eric Rochefort
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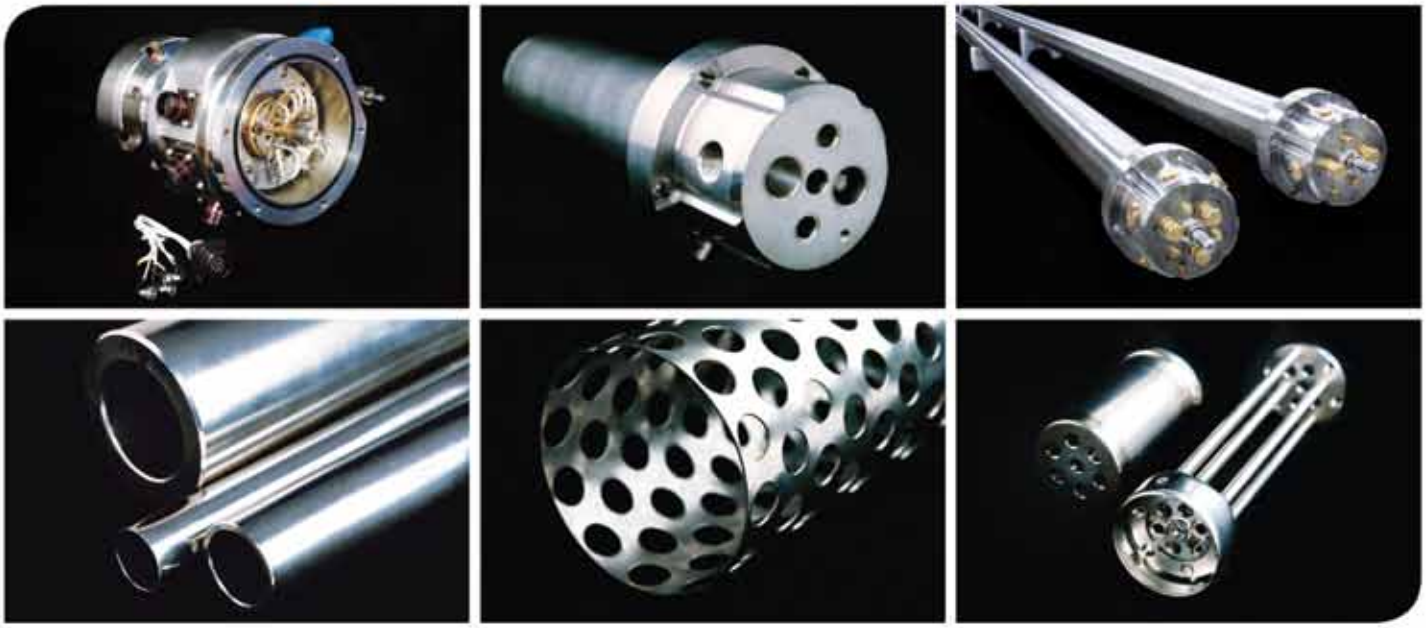

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