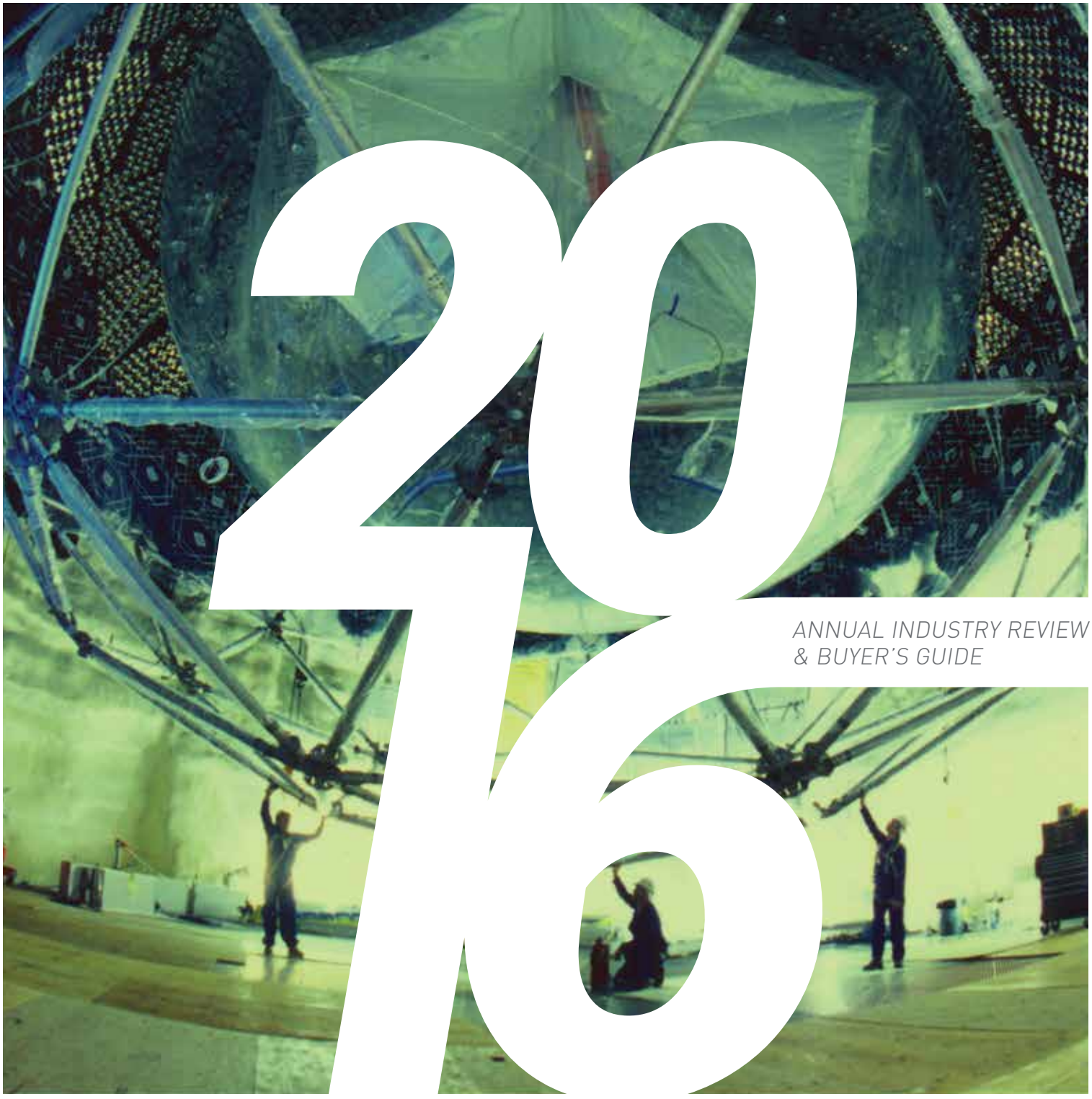

2016

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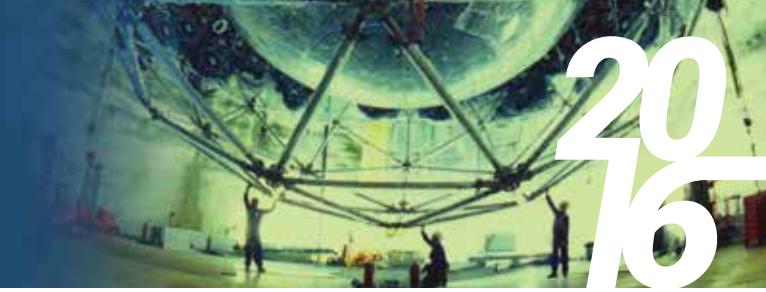
CNS President's Report

By Paul D. Thompson



Paul D. Thompson

Last year was an exciting year for the Canadian nuclear industry. It saw positive announcements with respect to the Bruce and Darlington refurbishment project decisions, the 70th anniversary of the Canadian Nuclear Safety Commission, and the discussion on the role of nuclear power in reducing greenhouse gas emissions following the COP21 conference. Likewise, it was an exciting year for the Canadian Nuclear Society.

To kick things off, we held the 35th annual CNS conference and the 39th CNS/CNA annual Student conference in Saint John, New Brunswick, last June. Thanks to the hard work of Jacques Plourde and his organizing committee, the conference was highly successful.

We also held a Fire Safety and Emergency Preparedness conference. Based on the very positive feedback from the participants, this conference will be repeated in 2017 and future years, opening up a new networking opportunity for our members, along with a new revenue stream for the society. Thanks go out to Tracy Lapping for her vision in establishing this new conference series, and her organizing team for making FSEP-2015 a success.

In fact last year was a banner year for conferences and courses. In addition to the two conferences discussed above, the following conferences and courses were also held:

- 17th International Conference on Environmental Degradation of Materials in Nuclear Power Plants
- 7th International Conference on Simulation Methods in Nuclear Engineering
- 2015 Canadian Workshop on Fusion Energy Science and Technology
- 2015 International Components Conference
- CANDU Fuel Technology Course
- CANDU Technology and Safety Course
- Nuclear 101

We extend our thanks to the many volunteers who helped organize these events and to the generous support of our sponsors in making these events a great success.

The various Branches were also very active this past year, putting on a variety of interesting technical seminars and lectures to our membership.

We have also continued our collaborations with sister nuclear societies in other countries, which open even more opportunities for the CNS and its members to participate in international nuclear events.

We also made a major upgrade to the CNS Website to improve security and user friendliness. Check out the new look if you have not done so already. Any suggestions to further improve and develop the website are welcomed by Adriaan Buijs and Mark Haldane, chairs of the internet committee, as well as Elmir Lekovic, our webmaster.

The CNS submitted interventions for the Bruce and Darlington Licence renewals and the CNL application to extend the duration of the NRU Operating Licence. All of these can be found on our website.

We also continue to get good feedback on our quarterly technical publication, the CNS Bulletin. Colin Hunt as publisher and Ric Fluke as editor-in-chief continue to do a great job in producing this high-quality publication that helps bring our membership together.

This past year also saw a good number of CNS members and non-members receiving awards at the CNS/CNA honours and awards ceremony held in conjunction with the annual conference. It is gratifying to see members of our Society recognizing the efforts and contributions of their peers in this great industry of ours.

In closing, I would like to note the fine work of our Council and all of our volunteers during the past year, and would like to recognize the nuclear companies that allow their employees to work on CNS activities and programs. It is through our volunteers' efforts that we remain an active and vigorous Society. The programs they help deliver provide vital services to our industry in ensuring the sharing of important technical information and experience through our conferences and courses. I also wish to congratulate incoming CNS President Peter Ozemoyah and wish him all the best, and offer to him my continuing support throughout the coming year. I know it will also be a great year!

The Darlington nuclear power station. (photo courtesy OPG)

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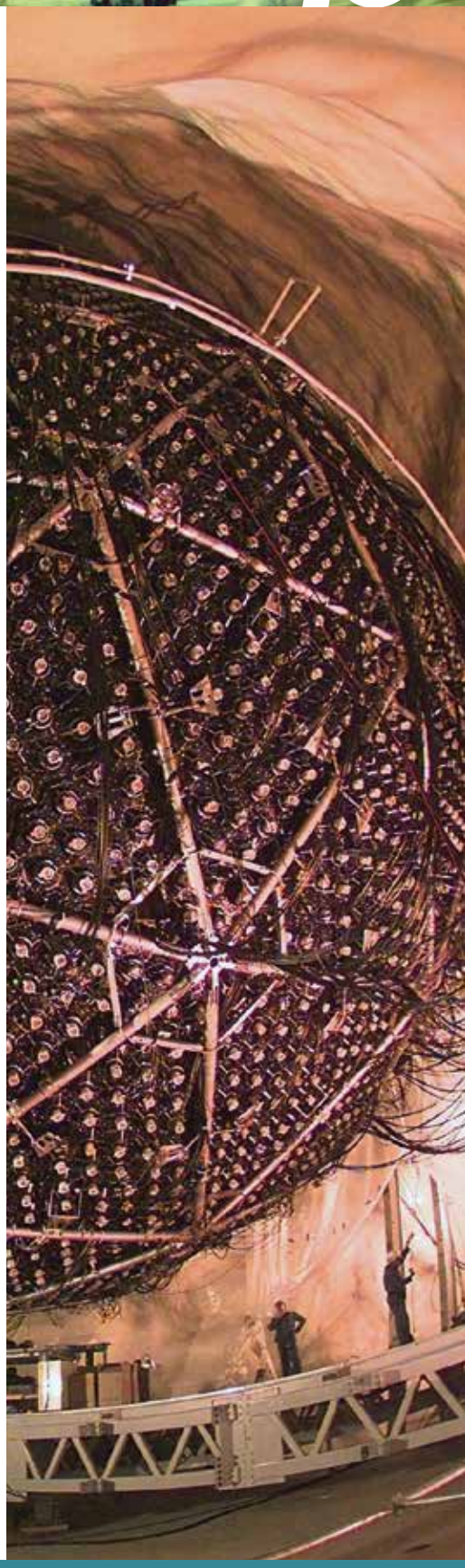

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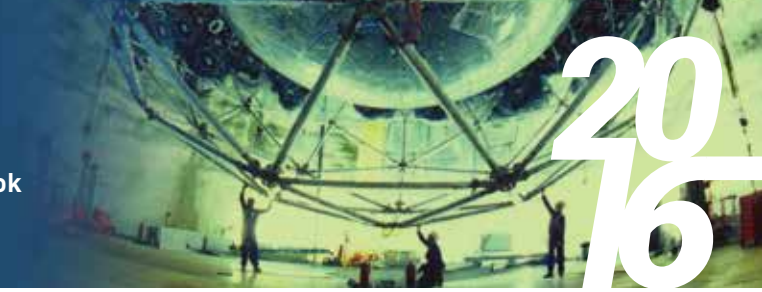
2015 Year in Review

By Colin Hunt, Publisher and Editor, Nuclear Canada Yearbook



Colin Hunt

Introduction

2015 has been a remarkable and successful year for Canada's nuclear industry. From power reactor operations, to nuclear physics, to government policy decision and implementation, Canada's nuclear industry has shown strong progress during the past year.

Beginning with nuclear physics, 2015 saw the award of the Nobel Prize for Physics to Dr. Arthur McDonald of Canada and Dr. Takaaki Kajita of Japan for "the discovery of neutrino oscillations, which shows that neutrinos have mass". By discovering the mass of the neutrino, Dr. McDonald's work has provided supporting evidence for the Standard Model of the Universe. As such he joins past illuminaries who have been awarded this prize such as Bertram Brockhouse, Wilhelm Roentgen, Henri Becquerel, Marie and Pierre Curie, Max Planck, Albert Einstein, Neils Bohr, James Chadwick, Enrico Fermi, John Cockcroft, and Richard Feynman (and of course – although the award was somewhat anomalously awarded in Chemistry – Ernest Rutherford).

The work of Dr. McDonald and the Sudbury Neutrino Laboratory (SNO) team is outlined in a feature article in this Yearbook, but it should be noted this work was uniquely possible in Canada because of the large amounts of heavy water required, loaned by AECL (now CNL).

CANDU 6 Nuclear Reactor Performance – 2015

Reactor	In Service	Capacity (MW)	Performance In 2015 (%)	Lifetime Performance (%)
Point Lepreau	1983	705	75.1	75.1
Wolsong 1	1983	679	90.4*	88.7
Wolsong 2	1987	678	92.9	93.3
Wolsong 3	1998	698	94.7	94.2
Wolsong 4	1999	703	87.7	94.6
Embalse	1983	648	12.5*	79.2
Cernavoda 1	1996	707	96.9	90.7
Cernavoda 2	2007	705	92.2	94.3
Qinshan 4	2002	700	80.7	90.9
Qinshan 5	2003	700	95.5	92.5
Average		20 691	89.4	89.4

COG CANDU/PHWR Performance Statistics, 2015.

Notes

1. Wolsong 1 capacity factor is since its return to service, June 20, 2015 after re-licencing.
2. Embalse was considered unavailable by grid control except during brief periods of high demand.
3. 2015 Fleet average excludes Wolsong 1 and Embalse.

Turning to nuclear power operations, for the first time since 1994, all of Canada's operating nuclear power reactors were on line simultaneously. In addition, the CANDU 6 reactor fleet completed another year of very strong performance with the highest fleet average reactor capacity of any technology in service.

With respect to the future of nuclear technology in Canada, the Province of Ontario made important decisions about the future of all three of Ontario's operating nuclear power stations: refurbishment for Bruce and Darlington, and continued operation beyond 2020 for Pickering. For the future of nuclear research and development in Canada, the federal government completed its reorganization of Atomic Energy of Canada Limited (AECL) with the transfer of operational control of AECL's research facilities into the hands of a private consortium.

2015 has also been a very successful year for the Canadian Nuclear Society (CNS). Some of these highlights are noted in the reports by the President of the CNS Paul Thompson, and by CNS Education and Communications Chair Ruxandra Dranga found in this Yearbook.

Nuclear Research in Canada

On June 26, 2015, the federal government announced that it had chosen the Canadian National Energy Alliance (CNEA) to operate Canadian Nuclear Laboratories (CNL). CNEA consists of a consortium of five companies: SNC-Lavalin Inc., CMH2 Hill Canada Ltd., Fluor Government Group Canada Inc., EnergySolutions Canada Group Inc., and Rolls-Royce Civil Nuclear Canada Inc.

The new management group formally assumed control of the former AECL facilities, principally including Chalk River Laboratories, Whiteshell Laboratories, Port Hope LLRWMO operations, and the CNER offices in Fredericton, in the fall of 2015. By the end of the year, the new team had unveiled its strategy for the future direction and operation of the nuclear labs. The plan includes extensive reconstruction and new facilities for the Chalk River site along with a diverse research and development mandate.

The Bruce A nuclear power station. (photo courtesy Bruce Power)

The mandate of CNL contains three principal elements: to manage Canada's radioactive waste and decommissioning responsibilities; to support the federal government in nuclear science and technology; and to provide to industry on a commercial basis its need for nuclear science and technology expertise.

The restructuring of AECL in 2014 is one in a series of policy decisions by the federal government over the past several years. In 2009, the federal government indicated its intent to restructure the company. In 2010, the government announced that Chalk River Laboratories would cease production of the medical radioisotope Molybdenum-99 in October 2016, and that it would start a process to select a private sector operator for AECL's operations. This was followed by the sale of AECL's reactor development division to SNC Lavalin as the new entity Candu Energy Inc.

CNEA remains committed to the shutdown of the NRU research reactor. But in 2015 it indicated its intention to seek an extension of its operating licence by 18 months (to March 2018) from the Canadian Nuclear Safety Commission (CNSC) – during which time CNL's Molybdenum-99 production would be maintained in hot standby mode.

The Future of Nuclear Power in Ontario

The Ontario government made a series of highly important decisions regarding the future of its nuclear reactor fleet. The first was the announcement of a commercial agreement with Bruce Power for the refurbishing and continued operation of all eight reactors at the Bruce station.

Starting in 2020, Bruce reactors 3 to 8 will sequentially undergo replacement and refurbishment of major systems in each of the six reactors. In total, the program will take approximately eight years and cost approximately $13 billion. Units 1 and 2 have already been successfully refurbished and restarted by Bruce Power.

In making this decision, the Province has ensured that the Bruce reactors will continue supplying Ontario with electricity past the mid-point of this century. In making the announcement, Ontario Energy Minister Bob Chiarelli stated that nuclear power provided the lowest cost, most reliable option for base load electricity in Ontario.

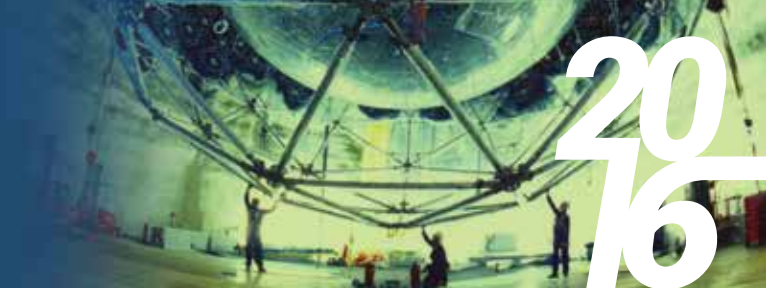
The future of Bruce Power's reactors is vital to Ontario's future electricity supply. In total, the Bruce complex supplies more than 30 per cent of the province's electrical energy. It is the largest operating nuclear facility in the world at this time.

Following closely upon the Bruce announcement, the Ontario government stated that it agreed with the proposal by Ontario Power Generation (OPG) to proceed with the full refurbishment of the Darlington nuclear power station. Refurbishment is scheduled to commence in the fall of 2016, with each of the four reactors being completed sequentially starting with Unit 2. As detailed in the 2014 edition of Nuclear Canada Yearbook, the project is expected to take approximately 10 years to complete work on all four reactors. Each of the reactors will be out of service for about three years each, and the total cost of the project is expected to be approximately $10 billion.

The importance of the Darlington refurbishment project cannot be understated. Its four reactors produce approximately 20 per cent of Ontario's total electricity supply, about 25-30 TWh annually. When completed, the Darlington reactors will be fit for an additional 30 years of service. As noted later on in this Yearbook, the Darlington reactors have run at consistently reliable performance since the startup of all reactors on the site in 1993.

The Province also made decisions about the Pickering nuclear generating station as well. Originally, the station was to close in 2020. However, the Province has indicated that it would prefer that the station continue operating until 2024. OPG will need to seek permission from the CNSC for continued operation beyond 2020.

A final factor affecting future nuclear operations in Ontario was a rates decision by the Independent Electricity Operator (IESO). Under the terms of the Green



Energy Act of 2009, renewables electricity sources such as wind and solar were given first access to the provincial electricity grid through a series of discounts applied to their generating costs. However, in the summer of 2015, IESO conducted a series of hearings on these discounts. At the end of 2015, the IESO announced that these discounts will largely be eliminated.

The effect of this change will be profound. By granting renewables first grid access, nuclear and hydraulic generation in Ontario was severely affected, with vented nuclear steam and spilled water being a consequence. The results of the IESO decision will mean higher levels of both nuclear and hydraulic production with many fewer reactor maneuvers than has been the case in the past number of years.

The consequence of all four of these policy decisions by Ontario means that the province will continue to receive over half of its electricity from nuclear power for at least the next 30 years. Together with another 25 per cent of the province's electricity coming from hydraulic generation, at least 90 per cent of Ontario's electricity will be supplied free of atmospheric emissions of any kind.

New Global Prospects for CANDU

The CANDU 6 fleet of reactors performed well in 2015. As shown in the accompanying table, the fleet had an average capacity factor for the year of just under 90 per cent. Its lifetime performance is also just under 90 per cent. Between lifetime performance and annual performance, CANDU 6 is the best performing power reactor technology in the world, a record it has sustained for more than a decade.

In recognition of this, new CANDU 6 reactors can be expected to commence construction elsewhere around the world. Romania has completed financial negotiations with China Nuclear Power Engineering Company (CNPEC) during 2015 for the construction of Cernavoda units 3 and 4. Candu Energy Inc. will have a large role in the construction of these two reactors resulting from the agreement between the two companies in 2014.

Also expected to emerge is a new CANDU 6 reactor in Argentina. Argentina came to financial terms with the China National Nuclear Corporation (CNNC) in 2014. In 2015, it was indicated that the new reactor will be built at Argentina's Atucha site, the third reactor to be located there. Again, based on Candu Energy Inc.'s agreement with CNNC signed in 2014, there will be a large Canadian component in this export reactor project as well.

In Closing

In the future, 2015 might be seen as the moment of decision for Canada's nuclear industry. The refurbishment decisions regarding Bruce and Darlington mean that Ontario will continue to get over half of its electricity from nuclear power past the mid-point of this century. For all practical purposes, that means the lifetime of the majority of Ontario's current citizens.

What is to come now is at least a decade of extensive construction work. Collectively, these projects will employ thousands of additional workers for at least a decade. Between the Ontario government and the private sector owners of Bruce Power, $23 billion will be invested in Ontario's nuclear reactors, making these the largest infrastructure projects in Canada and perhaps in North America.

What this means is that Canada will continue to have a strong and stable industrial base for its nuclear industry. This in turn will provide for continuation of Canadian reactor technology, for attracting new young talent into the industry, and for ensuring that Canadian nuclear technology remains a strong option for meeting the energy needs of the future.

Equally of great importance for Canada's nuclear future is the final implementation of the restructuring of the research assets of AECL into private sector management and operation. In 2016, CNEA will unveil its business plan for the five-year development of the Chalk River Laboratories site. When complete, the site will be transformed with the new investment into new facilities and new and broader research capabilities.

In 2015, the key decisions were taken about Canada's nuclear industry. In 2016, the work is about to commence.

Darlington NGS. (photo courtesy OPG)

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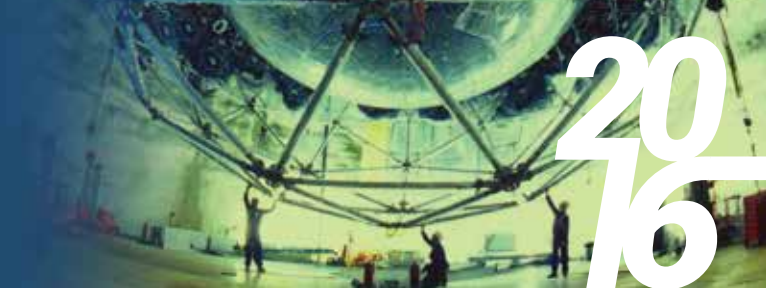
Nobel Prize winner returns home to tell a fascinating 'big science' story

By Clemente Angiolillo[1] and Ruxandra Dranga[2]



When the Royal Swedish Academy of Sciences announced Arthur (Art) McDonald as a co-winner of the 2015 Nobel Prize for physics for a discovery the committee said "changes our view of the universe," his former Atomic Energy of Canada Limited (AECL) colleagues and friends greeted the news with a smile and nostalgic reminisces of Art's days at Chalk River Laboratories (CRL). Among them are Davis Earle, a retired CRL physicist and resident of Deep River who started working with Art in 1973; and Bhaskar Sur, currently the Director of Canadian Nuclear Laboratories' (formerly AECL) Nuclear Science Division. Earle's early work with Art took place in the heady days of basic physics research when they paired up for experiments to study two-photon decay in neutron-proton capture using neutrons from the NRU reactor. Sur started working on the Sudbury Neutrino Observatory (SNO) experiment in 1989 when he was at Lawrence Berkeley National Laboratory in Berkeley, California and continued to work on SNO directly with Art at Queen's University and later with Davis Earle at CRL. Ultimately, under Art's leadership, SNO would make a major breakthrough on the study of the behavior of an elementary and enigmatic particle of the universe – the neutrino.

"This achievement is the result of the synthesis of over 30-years of work on particle physics, astrophysics and nuclear science that saw early germination at Chalk River Laboratories," says Sur. "Later on, preliminary SNO results led to a major leap forward on how to measure sub-atomic phenomena that were never used to this extent before and have also provided new insights into the 'Standard Model' of physics, and indeed in our fundamental understanding of the entire universe," Sur adds emphatically.

Even the Royal Swedish Academy of Sciences, which bestows the prize annually, acknowledged the 'earth shook' when it noted that the Standard Model of particle physics, which described the innermost workings of matter and resisted all experimental challenges for more than 20 years to this point, was now known to be incomplete. Neutrinos, produced in the core of stars by a fusion reaction, were described in the Standard Model as having zero-mass. Art's work showed that this assumption was incorrect and revealed that they do have mass as well as other amazing characteristics.

Pictured in 1986 in front of building 508 at Chalk River Laboratories, Nobel Prize winner Art McDonald, on the far right, and Davis Earle, on the far left, flank the Sudbury Neutrino Observatory's founding team. The initial spokesman for a solar neutrino experiment using Canadian heavy water was Professor Herb Chen (fifth from right), who proposed the concept in 1984 and tragically succumbed to cancer only a year after this photo was taken.

The neutrino, proposed to exist in 1936 to explain the apparent non-conservation of energy during beta decay, was first detected in 1956. This observation, which was actually of anti-neutrinos, was a measurement of a non-zero rate for inverse beta decay, a proton converting into a neutron, in a detector placed next to a nuclear reactor. Ten years later, neutrino detectors had improved to the point where the neutrinos produced in fusion reactions in the core of the sun were detectable and the solar neutrino problem was born. The neutrinos coming from the sun were essentially counting fusion reactions, and the heat from fusion in the sun being produced was in good agreement with both observation and theoretical models. However, the number of neutrinos coming from the sun pointed to a fusion rate which was approximately a third, certainly no more than a half, of what the models predicted. In the Standard Model of particle physics, particles were grouped into three 'families', each family containing two quarks, a lepton, and an associated neutrino. Matter in the universe is almost completely composed of the family having the lightest particles, the up and down quarks, the electron, and the electron-neutrino. The 'weak' nuclear interactions, which governed particle decay, apparently conserved the intrinsic 'flavour' of the lepton members of the family, "electronness" for the lowest mass family, with the result that the sum of the electrons and electron-neutrinos, minus the sum of their anti-particles was always constant. The neutrinos fit in the Standard Model best if their mass was zero. This was because their mass, if it existed, was anomalously low, outside the range of the other particles and there was no explanation for this. As well, all neutrinos observed had left-handed chirality (spin direction opposite to their momentum) and chirality is strictly conserved for particles traveling at the speed of light, but not otherwise. However, the earliest neutrino detectors were sensitive only to electron-neutrinos, and the only serious candidate theory for missing solar neutrinos was the theory of 'neutrino oscillation'. This can be described as the changing of neutrinos from one flavour (electron-ness) to another (muon-ness or tau-ness) and back again as they traveled from the core of the sun to the detector on Earth, resulting in a deficit of neutrinos of the right flavour to interact in the detectors. Over the next few decades, several experiments hinted at the existence of neutrino oscillation, but none settled the question by counting all the neutrinos coming from the sun.

The SNO experiments essentially re-wrote the balance sheet of the universe and have implications for its origins and nature. After the light-carrying particles known as photons, neutrinos are the most abundant particles in the universe as oceans of them are left over from the Big Bang, and many more are produced in stars and in nuclear reactors. They race through the earth and our own bodies like wind through a screen door and they also come in three different

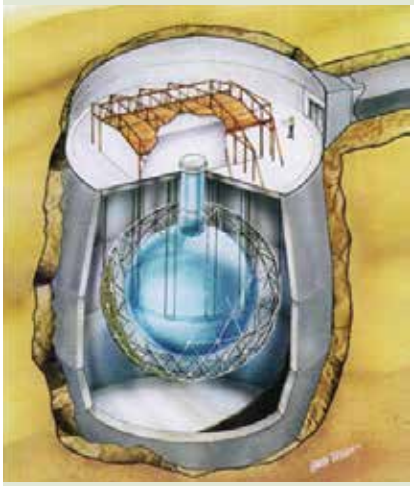
[1] Clemente Angiolillo, CNS Member
[2] Ruxandra Dranga, CNS Education and Communication Committee Chair

Nobel Prize winner returns home to tell a fascinating 'big science' story *continued from page 9*

identities, or "flavours," (a technical colloquialism) – which was the key to their eventual unmasking.

On October 16, 2015, Art McDonald returned home to Deep River's Mackenzie Community School where former colleagues and current CNL staff packed the Childs Auditorium to the rafters to hear Art talk about the SNO experiment that would define his long career. The focus of his talk was the amazing story of an ambitious, risk-laden project for which McDonald served as Director since 1989, which required the building of the most sensitive neutrino detector created to date. Overall, the project is a remarkable engineering achievement in its own right; a massive construction project that resulted in the creation of an ultra-clean, 10-storey-high cavity, two kilometers underground in INCO Ltd's Creighton nickel mine in Sudbury. In the centre of the cavity was a 12-meter diameter acrylic vessel containing 1,000 tons of heavy water (worth $300 million and on loan from AECL). If that doesn't sound ambitious enough, SNO would be the first neutrino detector with the ability to detect all three flavours of neutrinos (electron, muon, and tau) and distinguish electron neutrinos from the other two. The depth of the detector's location was essential to the study as it reduced interference from cosmic rays by many orders of magnitude. Additional steps were required to minimize interference from other sources of radiation and, in fact, the levels of radiation at the centre of the vessel are believed to be the lowest on earth. Once the facility was established, the rest is history. Although the road to the Nobel Prize was laden with challenges and missteps along the way, the project would yield tremendous results to the team's knowledge of the universe. For CNL, which has been a forerunner in the establishment of the global nuclear industry since World War II and continues to be on the vanguard of nuclear science and technology, it illustrates how history reaches forward and supports the organization's brand today. Art and many former AECL employees, like Davis Earle, made incredible contributions to the SNO experiment, and it is difficult to conceive of the experiment's success without those contributions and time spent at Chalk River Laboratories.

Almost three decades after posing for the grainy, black and white photo with the SNO group, Art would return to Deep River to tell his amazing story of discovery that would define his career and earn him the Nobel Prize.



Above is a schematic diagram of the Sudbury Neutrino Observatory (SNO). It was located underground to eliminate interference by cosmic radiation. Its core was a 12-metre in diameter container filled with 1,000 tons of heavy water, surrounded by detectors.

Bolstering Canada's 'big science' brand

Malcolm Harvey, a former Director of Physics at CRL who worked with Art, recounts a memorable conversation he had with McDonald in the early 1970's when Art came into his office and hinted at the 'big science' work that he wanted to pursue. After settling into a chair in Harvey's office, Art confided something to Malcolm that he has never forgotten to this day: "I don't want to do run-of-the-mill physics," he uttered in a plain-spoken, unanimated tone, "I want to do something memorable."

Harvey recounts that moment with Art with a sense of pride and as if the conversation happened yesterday. Personal achievement and professional admiration aside, the Noble Prize is also a win for 'big science' in Canada, whose representative institutions are very few and far between in the nation, and would include CNL's Chalk River Laboratories; TRIUMF in British Columbia; Saskatoon's Canadian Light Source; and of course SNO, which was initially a grand experiment and more recently has spun-off SNOLAB. For CNL specifically, Art's win is a shining reminder that some of Canada's, indeed the world's, greatest scientific minds have strode through its doors, and CNL can proudly claim to have employed four of the world's Nobel laureates for extended periods: John Cockcroft, CRL's first Director when CRL was still under the auspices of the National Research Council of Canada; Geoffrey Wilkinson, a chemist who was at CRL in its early days; Bertram Brockhouse, who did his pioneering work at the NRX and NRU reactors and devised an ingenious method and technologies to probe the crystal structure of materials; and now of course Art McDonald for SNO.

'Big science' is a big investment: Davis Earle reflects on the early days

Art came to Chalk River in 1969 as a postdoctoral fellow and progressed to Senior Research Officer prior to his departure

in 1982, and although Davis Earle is not familiar with Art's early work, he vividly recalls the latter years of his career at CRL. They collaborated on a number of experiments culminating in a search for parity violation in deuterium using the electron accelerator at Chalk River. At the time, the Russians were actively pursuing this line of study and their initial conclusions contradicting the Standard Model turned out to be in error according to Earle as he reflects on the early days of the project.

"Although we were unable to get the statistical sensitivity required, we were realizing what it takes to look for very small signals, and it was just at this time that a suggestion by Professor Herb Chen from the University of California, Irving of a solar neutrino experiment using Canadian D_2O and an existing Sudbury mine arrived on our doorstop. At the time we thought 'this is just the kind of basic research we were looking to pursue' and we jumped at the opportunity," Earle exclaims. "I basically turned to it full time as I was doing basic research from the day I walked into CRL, essentially curiosity driven work that contributes to knowledge as opposed to applied research work for industry. By 1984, Art was at Princeton and in addition to teaching he invested considerable time into the Sudbury experiment. Other university professors also quickly came on board as advocates and as early contributors to the project. To get it going, we had to convince funding agencies that: a) it is a good idea with potential; and b) we can do it – that essentially it is worth the investment and the results would contribute to our knowledge. That took another six years and it wasn't easy as we were competing with other good ideas for the same scarce dollars. But because we had a good idea, and the heavy water – compliments of AECL – as well as the availability of the existing Creighton mine, we felt we had a leg up on the competition for funding dollars and the other experiments we were competing with had to admit our idea was also a worthy one to support."

Ultimately the team got the money to build and early data revelations were an amazing journey for Art, Davis and company. Earle says one important lesson learned from the experience was that funding agencies sometimes don't always appreciate that it is not enough to simply fund such big projects. Once you commit to funding 'big science' research projects that are breaking new ground in construction and installation, you also have to be prepared to add funds when there are setbacks. "We were 'boldly going where no one had gone before' and cost overruns are a reality," he adds. "In addition, these projects are not-for-profit with no source of income, thus operating funds must also be provided."

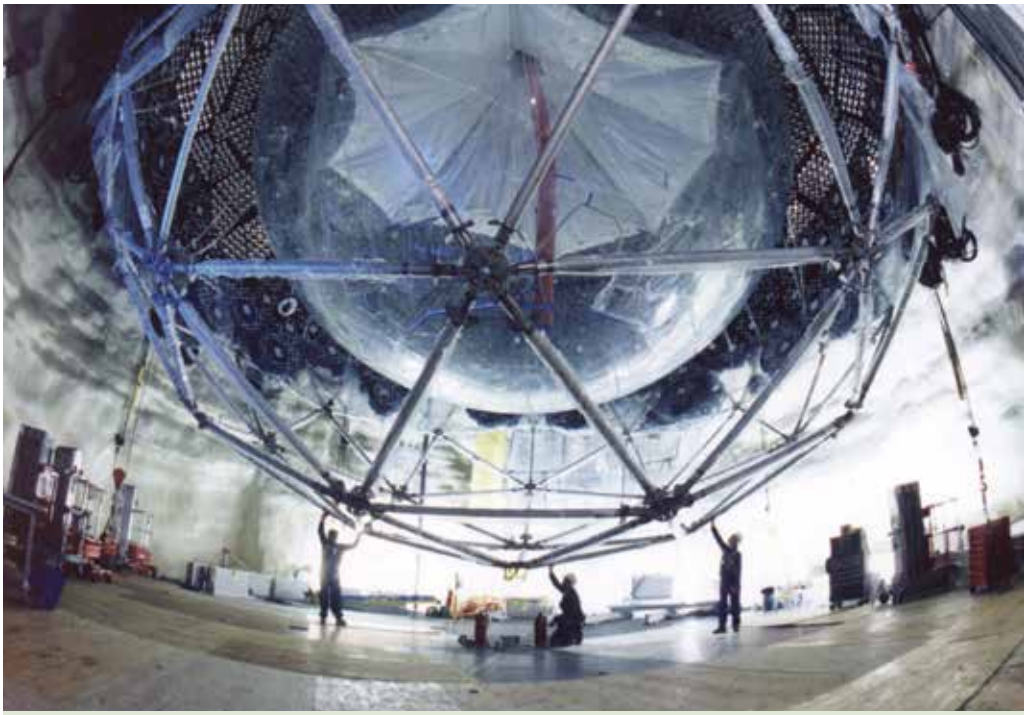
> "I don't want to do run-of-the-mill physics, I want to do something memorable."
>
> Art McDonald, circa 1970

Great science and great scientists enrich us all. They enable technologies that ease our lives, or, as in Art's case, they show us what's beyond our horizons and the disciplines that ask the biggest questions and find the deepest explanations are the fundamental sciences. Looking back on Art's work serves as a testament to what is possible when you set high ambitions, work hard to build support for an intrepid project and assemble the right people as part of a team. It takes drive and dedication to convince groups to support a project with such obvious risk, much less challenge existing scientific knowledge and to make breakthrough discoveries, or what Art framed as wanting to "do something memorable" and not "run-of-the-mill."

Surrounded by family and friends, young and older, on that night Art seemed larger than life among former colleagues and the assembled crowd, and his story of true discovery brought another reward his way – the admiration of peers who are proud to see one of their own achieve such a pinnacle.

Acknowledgements

The authors would like to acknowledge the contributions of Davis Earle, Bhaskar Sur, Malcolm Harvey and Geoffrey Edwards.



Located two kilometers below the earth's surface the depth of the detector's location was essential to the study as it reduced interference from cosmic rays by many orders of magnitude. Additional steps were required to minimize interference from other sources of radiation and the levels of radiation at the centre of the vessel are believed to be the lowest on earth.

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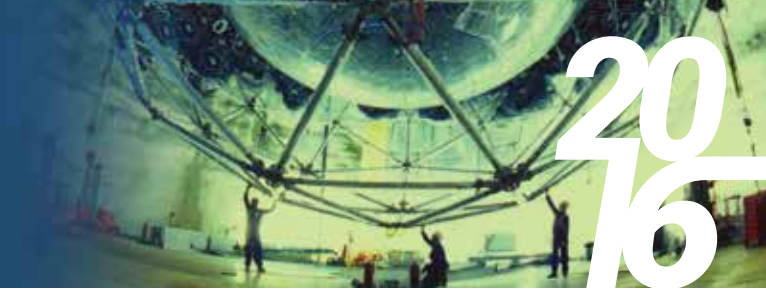
Canadian Nuclear Association (CNA) President's Report

By Dr. John Barrett, President and CEO, CNA



Canada's nuclear industry has a number of reasons to be optimistic about the future.

Final approval has been given to Ontario's refurbishment projects – one of the largest clean energy investments currently being made in North America, if not worldwide. No other jurisdiction can boast of an investment of this size in ensuring that citizens have safe, reliable clean electricity and clean air for years to come.

The COP21 meeting in Paris last December, along with the decisions taken there, has put the challenge of climate change squarely on the agenda of many countries. Although the leaders did not exactly embrace nuclear energy at COP21, there is increasing recognition among concerned environmentalists, energy specialists and climate scientists that, if we want real de-carbonisation now, nuclear technology provides the only near-term proven solution.

One can add the growing interest in small and advanced reactor designs as a means of replacing use of fossil fuels as sources of power in remote and off-grid applications as well as for on-grid electricity generation. More and more, we are hearing SMRs being spoken of not in terms of "if" but of "when" – and the next decade is stated as the goal for deployment. And the advanced fuel reactor that SNC-Lavalin Nuclear's advanced fuel CANDU reactor has garnered considerable interest in China, with the company on the cusp of other significant opportunities in Romania, the UK and Argentina.

So the promising signs are there. The question is, are we ready to take advantage of the opportunities and enter a period of reinvigoration and real growth?

Well, first we have to start getting the message out – to the federal government, provincial governments, publics and stakeholders. We need to pick up the pen, open the desktop, pull out the smart phone, get on the media – both social and traditional (radio, TV and print) – to tell people about our industry and what it can do for you and your community.

Only a few countries match Canada's world-leading profile in the nuclear sphere. We're a country that mines uranium, fabricates fuel, designs and maintains reactors, generates carbon-free electricity, advances nuclear medicine and innovative manufacturing, improves nutrition through irradiation, mitigates its environmental impacts, and shares its scientific and technological expertise with the world.

Nuclear improves the day-to-day lives of Canadians with many benefits, including cleaner air, better medical treatment, long-term highly skilled employment, high-quality research and development, the competitive advantage that nuclear provides in the knowledge economy, and the numerous opportunities available in the global nuclear marketplace.

For those who think globally about foreign affairs and Canada's role in the world, nuclear is also a global strategic asset for Canada. How so? The answer is that we have a stronger, more influential and credible voice in international relations and in multilateral diplomacy because of our nuclear expertise and experience. When it comes to important nuclear-related issues, the world does not listen to us just because our nameplate says "Canada". It listens because of internationally renowned Chalk River nuclear laboratories, the four decades of safe and successful power generation, the prominence of our uranium mining and extractive technologies.

Is this true, you ask? Yes, as Canada's Ambassador and Permanent Representative to the International Atomic Energy Agency and the Comprehensive Nuclear Test Ban Treaty Organization, I saw the attention paid to Canada when we had something to say on nuclear non-proliferation or safety and security. And I knew where that credibility was built. It's time more people recognized this contribution to our foreign policy by our nuclear industry.

That there is a high regard internationally for Canada's expertise is shown in other ways. In 2015, when we put together a Canadian nuclear industry delegation to the IAEA's General Conference, it was very well received. The idea was to enable CNA member companies to develop contacts in the IAEA technical secretariat and with its member countries, notably China, India, France, Argentina, United Arab Emirates, and the USA. We also wanted to convey a basic message at such a pre-eminent international gathering: Canada is back on the global nuclear stage.

Back home, the decision to invest $25 billion to refurbish ten of Ontario's reactors at Darlington and Bruce substantially is not just a decision to replace major components – important as that obviously is to reactor life extension. It was also a decision in favour of economic growth, climate-change mitigation, and a better quality of life for people in the host communities and across Ontario.

Refurbishment will provide a stable, low-carbon foundation for Ontario's electricity system for decades. It will also create thousands of jobs in Ontario. According to the Conference Board of Canada, OPG's Darlington refurbishment will boost Ontario's GDP by $14.8 billion from 2010 to 2026 and create an average of 8,800 jobs over the same period.

Meanwhile, Bruce Power's program will secure an estimated 18,000 jobs directly and indirectly from operations, as well as 3,000-5,000 additional jobs annually throughout the investment program. A 2014 economic study noted that "there is no single, well-established project, facility or infrastructure project in Ontario that will have such a significant economic impact."

The proof of the pudding is in the eating. As the refurbishment program goes forward, the industry has an opportunity to show in real, tangible ways how the life extension work is not only successfully executed, but that it makes use of innovative advanced technologies to get the job done.

It is the innovative part of our industry that may be the best music to the ears of the federal government, particularly if innovation

continued on page 15...

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...Canadian Nuclear Association (CNA) President's Report *continued from page 13*

is tied closely with clean energy (which it most definitely is) and reduced environmental and waste impact. Both at COP21 and, most recently in the March federal budget, Prime Minister Trudeau pledged significantly increased federal funding of research and innovation in low-carbon, clean technologies. We need to ensure that the government understands and supports the role of nuclear technology is achieving these high-priority policy objectives.

That is why the industry is working on proposals such as the creation of a Nuclear Innovation Council. In Canada, we have considerable infrastructure and facilities to carry out advanced R&D and innovation in clean energy and commercial spinoffs.

Moreover, we could use these facilities and assets for greater international collaboration under the auspices of a "Climate Change Innovation Council", bringing scientists from around the world to research together the technologies needed to stabilize the climate.

Such an initiative would provide real evidence that Canada is ready to play an international leadership role on climate change. It would be an initiative worthy of Canada's great history as an innovator of ideas that serve a global purpose beyond national interest alone.

On behalf of the CNA and Canada's nuclear industry, let me thank the Canadian Nuclear Society for continuing the publication of this excellent Yearbook, which highlights so much what our industry brings to Canadians and to the world.

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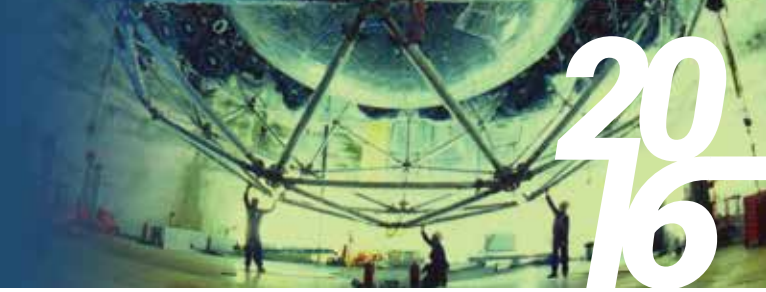
Canada

Organization of Canadian Nuclear Industries (OCI), President's Report

By Ron Oberth, President & CEO
Organization of Canadian Nuclear Industries (OCI)



OCI's achievements over the last year aligned with OCI's four strategic focus areas:

- Strengthening linkages between suppliers and utilities;
- Increasing supplier readiness for refurbishment projects;
- Assisting suppliers to develop international opportunities;
- Proactively advocating for nuclear power with both government and the public.

OCI organized successful Suppliers' Days at Bruce Power, Ontario Power Generation (OPG), NB Power and SNC-Lavalin–Candu Energy. OCI workshops and seminars informed members about emerging industry issues such CFSI (Counterfeit and Suspect Items) (in conjunction with COG in December 2015) and refurbishment planning with OPG in May 2015. The Annual OCI Christmas Lunch and Golf Tournament brought members and customers together for lighter discussion and comradery.

OCI signed an MOU in July with the Romanian suppliers' group ROMATOM similar to that signed with the Korea suppliers' group KAIF the previous year. This was followed by the signing of an MOU with the Nuclear Industry Association of Turkey (NIATR) in January 2016 that will enhance collaboration among Canadian and Turkish nuclear suppliers.

Encouraged by the expansion of the nuclear supply base in Asia, OCI led trade missions to South Korea (April 2015), India (October 2015). The potential CANDU new-build projects in Argentina and Romania were focus of an OCI trade mission to Romania in July and an incoming trade mission of Argentine suppliers in November.

OCI hosted a Networking Luncheon in February 2016 with OPG President and CEO, Jeffrey Lyash. The event attracted a strong turnout and provided an opportunity for the supply chain to hear about the future plans for the Darlington refurbishment project.

OCI, in collaboration with the CANDU Owner's Group (COG) held a Refurbishment Forum Workshop in March 2016 to discuss the future state of the supplier-utility relationship. The Bruce Power Major Components Replacement program announcement and the Government of Ontario approval of the Darlington refurbishment project will bring significant work for OCI suppliers.

Keeping the economic and environmental benefits of the nuclear industry top of mind with elected officials in Ottawa and at Queen's Park was a priority for OCI this year. OCI, in collaboration with CNA, exhibited at the Globe Conference in Vancouver in March 2016 to speak to the benefits of nuclear energy in combating of climate change. The conference was highly attended by politicians and energy industry leaders.

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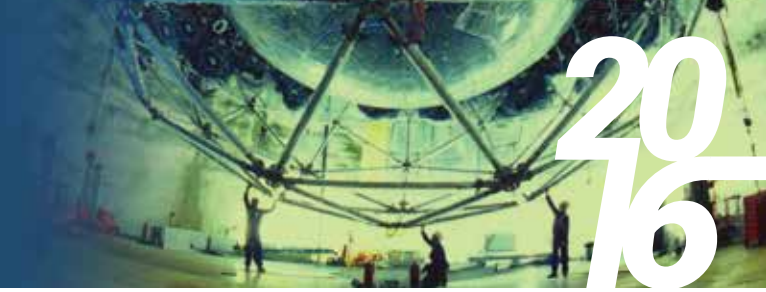
Women in Nuclear (WiN) Canada President's Report

By Heather Kleb, President WiN-Canada



At its inception in 2004, Women in Nuclear (WiN) Canada had 12 members. By 2015, we had more than 1,500 members and six Chapters across the country. Today, WiN-Canada is the premier networking organization for women working in all aspects of nuclear energy, science, trades and technology. Through our efforts to promote the careers of women, we have become a strong, credible voice in the nuclear industry.

WiN-Canada is proud of the many accomplishments achieved through the dedication of its members and the support of its industry sponsors. Without the support of companies like Bruce Power and Ontario Power Generation it would not be possible to offer the wide variety of activities we offer today. This report highlights how these activities have enabled us to achieve WiN-Canada's goals.

Promoting the Industry and Women in Nuclear-Related Occupations

Continuing in our tradition of connecting with women in the industry across Canada and around the globe, WiN-Canada attended the WiN-Global conference in Vienna, Austria in August. We have always played an active role in the WiN-Global community and we continue to hold a seat on the WiN-Global Board of Directors and Executive Committee.

Closer to home, WiN-Canada contributed to a number of industry initiatives and committees including the Canadian Nuclear Leadership Forum, the Electricity Human Resources Canada Connected Women Steering Committee, the CNS Council and subcommittees and the Canadian Nuclear Association's (CNA's) legislative day at Queen's Park in October.

In November, over 190 participants from 40 different organizations enjoyed the hospitality of the WiN-Durham Chapter and Ontario Power Generation, who hosted our 12th WiN-Canada Annual Conference in Ajax, Ontario. The theme of the 2015 conference, *Linking the Nuclear Family: Past, Present and Future* allowed WiNners to gain a sense of where the industry began, where it is headed and how to flourish in a changing environment.

The conference was coupled with our Annual General Assembly where we ratified our new President and Board of Directors. Our new Board includes representatives from Bruce Power, Cameco Corporation, Canadian Nuclear Laboratories, Kinectrics, Lee Hecht Harrison Knightsbridge, New Brunswick Power, Ontario Power Generation, the Organization for Canadian Nuclear Industries (OCI), and SNC Lavalin.

Our Six WiN-Canada chapters continued to organize quarterly meetings over the year, providing opportunities for professional development and networking. We also connected with a number of WiNners and recruited new members at our WiN booth during CNA, CNS, and OCI conferences and events.

WIN's Role in Increasing Public Awareness

WiN Leadership and members continue to participate and to represent WiN at industry events, public forums, hearings and government panels, as well as relevant conferences and local community platforms. Adding our voice to the public hearing process, WiN-Canada was given an opportunity to speak at the CNSC hearings on the Bruce Power licence renewal in Kincardine, ON, and the Darlington licence renewal and refurbishment licence application in Ajax, ON.

Promoting Nuclear Careers for Women and Young People

The continued success of WiN is reflected in the dedication and commitment shown by our members and Chapter leaders across Canada. WiN has done extremely well in volunteering and running science camps for youth, both independently and in conjunction with other sponsored organizations in order to foster an interest in Skilled Trades and the STEM (Science, Technology, Engineering and Mathematics) subjects.

In 2015, WiN chapters participated in a number of activities mentoring young people:

- Skills Work! For Women Networking dinners
- Skills Canada-Ontario Young Women's Conference
- Skills Canada-Ontario Technological Skills competition
- STEM camps (summer camps, March break program and PD Days)

While it is always interesting to look back on the many WiN-Canada accomplishments over the past year, it is more exciting to look forward to a successful future. In 2015 the WiN-Canada Board of Directors worked to implement the 5 year Strategic Plan that was launched earlier in the year and posted on the WiN-Canada website.

In keeping with the Strategic Plan, we are extending our reach to other women's organizations by becoming involved with women's groups, such as Nature Canada's *Women for Nature* initiative, and offering them presentations on a range of topics through our newly established Speaker's Clearinghouse. The industry can expect to see more of our members speaking at multi-industry events, women's clubs and private schools for girls, in the coming year.

To see a schedule of these speaking engagements or learn more about our goals and objectives you can visit us online at:
www.wincanada.org
www.facebook.com/womeninnuclear.canada
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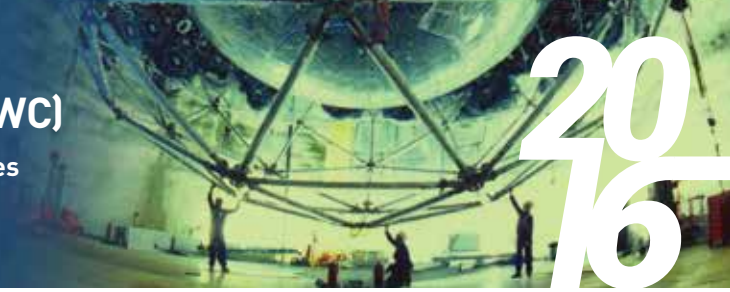
Canadian Nuclear Workers Council (CNWC)

The collective voice of organized labour in the nuclear industries
By David Shier, President and CEO, CNWC



The Canadian Nuclear Workers Council (CNWC) is an umbrella organization of Unions representing workers in all sectors of the Canadian nuclear industry. Founded in 1993, it represents sectors including electric power utilities, uranium mining and processing, radioisotope production for medical and industrial purposes, nuclear research, construction and trades in Ontario and labour councils in host communities.

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 2015, several presentations and briefs were made on behalf of the membership. The CNWC made a presentation to the CNSC on April 16th and collaborated with other stakeholders on an on-line petition in support of the renewal of the operating license for the Bruce Power Nuclear complex. In June the CNWC submitted a letter of support to the CNSC regarding the mid-term operating license for the Western Waste Management Facility. In August, a presentation to the CNSC was made in support of the renewal of OPG's operating license for the Darlington Nuclear plant. As well, the CNWC made an oral presentation at the CNSC's public hearing in November. In August, the CNWC submitted a letter of support and appeared at the Ottawa hearing regarding the NPP Oversight Report. Similar actions were taken in October in support of the CNSC's 2014 report on the performance of uranium and nuclear substance processing facilities and uranium mine and mill facilities. The CNWC monitored other relevant CNSC hearings and meetings and regulatory documents e.g. OPG's DGR project and draft CNSC Regulatory Documents affecting workers. The CNWC organized the Annual Meeting of the Nuclear Power Plant representatives in Ottawa at the CNSC offices on August 25th.

The CNWC's 2015 education and outreach activities included attendance (with our display booth) at the Canadian Nuclear Association's 2015 Annual Conference, and participation in a CNA Queen's Park Day in September. In November, the Council was represented at the CUPE National Convention in Vancouver and the Ontario Federation of Labour conference in Toronto.

Public communications included four newsletters issued quarterly. The CNWC's website was also updated and a new brochure describing the CNWC and the organization's views on key nuclear issues was developed.

The CNWC's Annual Convention was held September 19th to 22nd in Saskatoon, which included tours of the Key Lake Mill and McArthur River Uranium Mine. Delegates reviewed the CNWC's Constitution, Executive Board structure and strategy. Agreement was reached to restructure the executive board and to expand the membership to include the supply chain and construction sectors.

In 2016, CNWC education and outreach activities will focus on: expansion of the membership from nuclear supply chain companies, construction union, and local labour councils; support for the Canadian Nuclear Laboratories license extension; Bruce Power's and OPG's refurbishment projects; the CNSC's Fitness for Duty Regulation; OPG's DGR facility; Nuclear Waste Management Organizations process; continued participation in the Nuclear Leadership Forum; and the hosting of more nuclear facility tours for labour leaders. Leadership changes in these groups create the need for the new leadership to be updated about current and emerging nuclear industry issues and opportunities. The CNWC will continue to engage provincial officials and will also pursue meetings with relevant federal ministers and members of Parliament during the year.

The CNSC has developed a 101 program to provide an overview of the regulator and its processes. The CNWC will coordinate program presentations to the union membership. The CNWC will publish four editions of the Nuclear Worker, develop a new information booklet, update the website and continue with its display booth activities in 2016. The CNWC will represent its membership at several upcoming conventions/conferences – Provincial Federation of Labour Conventions, and the Annual INWUN meeting, which will be held Kiev, Ukraine. This convention will mark the 30th anniversary of the accident at Chernobyl. The CNWC will also participate along with member Unions in the annual meeting with the CNSC. The CNWC's Annual Convention is planned for October 15th to 19th in Toronto.

CNWC Member Unions:

- District Labour Councils (Grey/Bruce, Durham, Northumberland)
- International Association of Firefighters
- International Federation of Professional & Technical Engineers (160 & 164)
- International Association of Machinists & Aerospace Workers (608)
- International Brotherhood of Electrical Workers (37)
- International Union of Operating Engineers (772)
- Construction & Building Trades Council of Ontario
- Power Workers' Union
- Professional Institute of the Public Service of Canada (PIPS)
- CRPEG, WRPEG, & WTPEG
- Society of Energy Professionals Union
- UNIFOR (254, 48S, 252, 524)
- United Steel Workers (14193, 13173, 8562, 8914, 7806, 4096, 1568)

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- Keeps billions of dollars here in Canada
- Contributes to affordable electricity prices
- Delivers tax revenues for governments
- Supports high value-added innovation
- Provides a low-carbon electricity competitive advantage for our businesses

Exporting Canada's nuclear technology and expertise can deliver even more economic and environmental benefits for Canadians.

Canada's nuclear energy coupled with another low-carbon advantage, hydropower, provides a clear path for our nation to grow as a GHG emission-free electricity powerhouse.

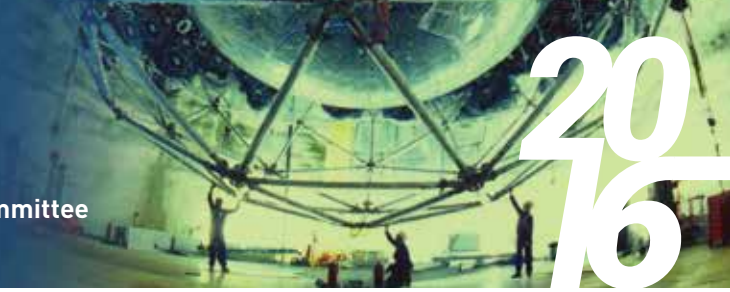
For more information please go to: www.pwu.ca

FROM THE MEN AND WOMEN WHO HELP KEEP THE LIGHTS ON.

POWER WORKERS' UNION

2015 – Education and Communications Committee Report

By Ruxandra Dranga, Chair Education and Communications Committee



In 2015 the Education and Communications Committee (ECC) continued to be a key contributor towards the CNS's core objectives, through a number of activities and programs that encourage education in, and knowledge about nuclear science and technology, increase members' involvement in public educational programs, and facilitate the exchange of information between CNS members and the general public.

Geiger Kits to High Schools across Canada

The Geiger Program was primarily in "maintenance mode" in 2015. Bryan White, who is the single point of contact between the CNS and high schools across Canada that have a Geiger kit, has been providing technical support for science teachers. Three Geiger kits have been requested by the Town of Blind River in 2015 to be owned by the town and made available for loan to science teachers and members of the community. These kits have been purchased by the CNS and funded by the Nuclear Waste Management Organization.

An additional important component of the Geiger Program is the Ionising Radiation Workshop, which demonstrates the use of the detector in a classroom setting. A version of this workshop, which is tailored to students, has been organized as part of the Deep River Science Academy Summer Science Immersion in 2015, to educate high school students participating in the 1month long program about ionizing radiation. Geiger kit demonstrations were also performed during the Science Teacher's Association of Ontario Conference, which was attended last year in collaboration with the Foundation for Student Science and Technology (FSST).

"Nuclear 101" Course

2015-2016 was once again a very successful year for the "Nuclear 101" course, with two organized courses, one offered in Ottawa in March 2015 and one offered in Toronto in May 2016. The "Nuclear 101" course was specifically design for individuals with or without a technical background who are part of the nuclear science and technology community and who find themselves interacting with the public. The course has been very popular amongst individuals in the nuclear community (both technical and non-technical) and received excellent reviews from all participants.

A three-hour seminar version of the "Nuclear 101" course, titled "Nuclear for Everyone", which has been first introduced in 2014 for individuals who do not directly work in the nuclear industry, but who collaborate and interact with organizations which are part of the nuclear community, was organized as an embedded seminar in the Technical Program for the 2015 CNS Annual Conference in New Brunswick. The seminar was very well attended (approximately 100 attendees) and received positive feedback. As a result, one other seminar was presented during an NWMO Council of Elders meeting in July 2015 (by request), and another embedded seminar will be organized during the 2016 CNS Annual Conference in Toronto.

Collaborations

In 2015, an MOU was signed off between CNS (ECC) and the Foundation for Student Science and Technology, which details some of the collaborative activities that the two not-for-profit groups will undertake to increase our mutual reach to students and teachers and further advance public education in nuclear science and technology.

Public Advocacy

The CNS participated as an intervenor in the Bruce relicensing hearing in April 2015, and the Darlington relicensing hearing in November 2015 – in both cases making oral and written submissions in support of the proponent. The CNS continues to engage in public advocacy in 2016, including a written submission to the CRL licence amendment hearing in April 2016.

Further Information

For further information on the CNS' activities in Education and Communication, contact Ruxandra Dranga (Chair, CNS Education and Communication Committee) at **ECC@cns-snc.ca**

2016 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**

2016 May 16 – May 17
Nuclear 101
Fairfield Inn & Suites, Toronto Airport
Organized by CNS
Contact: Canadian Nuclear Society Office
Email: cns-snc@on.aibn.com

2016 June 19 – June 22
36th Annual CNS Conference,
40th CNS/CNA Student Conference
Marriott Toronto Eaton Centre Hotel
Organized by CNS
Contact: Canadian Nuclear Society Office
Email: cns-snc@on.aibn.com

2016 August 15 – August 18
13th International Conference
on CANDU Fuel
Holiday Inn Waterfront Hotel, Kingston, ON
Organized by CNS
Contact: Paul Chan
Email: Paul.Chan@rmc.ca

2016 September 11 – September 14
3rd Canadian Conference on
Nuclear Waste Management,
Decommissioning and
Environmental Restoration
Marriott Hotel, Ottawa, ON
Organized by CNS
Contact: Ms. Parva Alavi
Email: Parva.alavi@ewmconsulting.net

2016 November 2 – November 4
4th International Technical Meeting
on Small Reactors (ITMSR-4)
Delta City Centre, Ottawa, ON
Organized by CNS
Contact: Canadian Nuclear Society Office
Email: cns-snc@on.aibn.com

2017 May 7 – May 11
CANDU Maintenance and Nuclear
Components Conference
Toronto, ON
Organized by CNS
Contact: Canadian Nuclear Society Office
Email: cns-snc@on.aibn.com

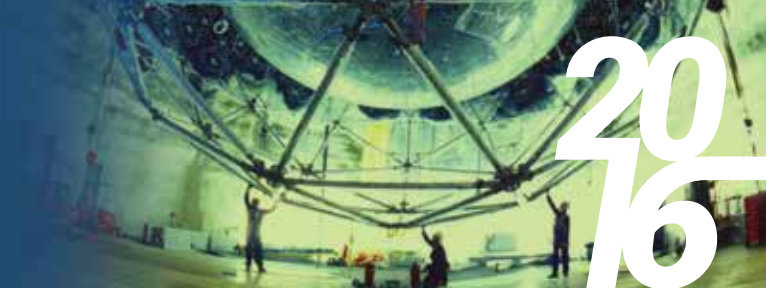
2017 June 04 – June 07
37th Annual CNS Conference,
41st CNS/CNA Student Conference
Niagara Falls, ON
Organized by CNS
Contact: Canadian Nuclear Society Office
Email: cns-snc@on.aibn.com

2017 July 31 – August 4
13th International Topical Meeting
on Nuclear Applications of
Accelerators, AccApp'17
Quebec, QC
Organized by CNS
Contact: Canadian Nuclear Society Office
Email: cns-snc@on.aibn.com

2017 September 17 – September 21
2nd International Technical Meeting
on Fire Safety and Emergency
Preparedness for the Nuclear Industry
(FSEP 2017)
Marriott Toronto Eaton Centre Hotel
Organized by CNS
Contact: Tracy Lapping
Email: tlapping@saddlehills.ab.ca

Rotor replacement Bruce Unit 2. (photo courtesy Bruce Power)

The Top 25



World Reactor Performance

Top 25 units for 2015 by capacity factor, December 31, 2015

Rank	Country	Plant	Type	Capacity (MW)	Capacity (%)
1	US	Peach Bottom 2	BWR	1182	105.95
2	Russia	Balakovo 4	PWR	1000	104.88
3	US	Calvert Cliffs 1	PWR	890	103.85
4	India	Kaiga 3	PHWR	220	103.71
5	US	Dresden 3	BWR	920	103.52
6	Taiwan	Kuosheng 2	BWR	985	103.01
7	US	Fitzpatrick	BWR	849	102.41
8	US	North Anna 2	PWR	994	102.35
9	US	Ginna	PWR	597	101.79
10	US	Comanche Peak 1	PWR	1250	101.32
11	US	Vogtle 2	PWR	1205	100.38
12	**Canada**	**Bruce 2**	**PHWR**	**904**	**100.21**
13	Korea	Hanul 3	PWR	1050	99.93
14	US	Palo Verde 1	PWR	1402	99.69
15	Korea	Hanul 2	PWR	1012	99.65
16	US	Millstone 3	PWR	1276	99.42
17	Korea	Hanul 5	PWR	1051	99.40
18	Russia	Smolensk 3	LWGR	1000	99.40
19	US	Dresden 2	BWR	925	99.36
20	US	Lasalle 1	BWR	1207	99.35
21	China	Ling Ao 1	PWR	990	99.29
22	India	Kaiga 1	PHWR	220	98.84
23	Russia	Balakovo 3	PWR	1000	98.78
24	India	Rajasthan 5	PHWR	925	98.73
25	Russia	Kalininin 4	PWR	1000	98.42

All figures taken from Nucleonics Week, 02/11/16. All numbers have been rounded.
No monthly results reported from Great Britain, France, Ukraine, Slovakia, Only partial results reported from China.

The Bruce B nuclear power station, and just to the north, the Douglas Point prototype reactor. (photo courtesy Bruce Power)

CANDU Nuclear Reactor Performance and World Uranium Production

CANDU Nuclear Reactor Performance – 2015

Reactor	In Service	Capacity (MW)	Performance In 2015 (%)	Lifetime Performance (%)
Point Lepreau	1983	705	75.1	75.9
Wolsong 1*	1983	679	90.4*	88.7
Wolsong 2	1987	678	92.9	93.3
Wolsong 3	1998	698	94.7	94.2
Wolsong 4	1999	703	87.7	94.6
Embalse	1983	648	12.5*	79.2
Cernavoda 1	1996	707	96.9	90.7
Cernavoda 2	2007	705	92.2	94.3
Qinshan 4	2002	700	80.7	90.9
Qinshan 5	2003	700	95.5	92.5
Pickering 1	1971	542	57.7	64.1
Pickering 4	1973	542	94.7	67.0
Pickering 5	1983	540	65.4	73.9
Pickering 6	1984	540	67.6	78.2
Pickering 7	1985	540	92.9	78.4
Pickering 8	1986	540	95.3	76.7
Bruce 1	1977	825	88.2	83.2
Bruce 2	1978	825	99.5	87.8
Bruce 3	1978	825	89.0	65.3
Bruce 4	1979	825	69.0	65.3
Bruce 5	1985	872	86.4	84.5
Bruce 6	1984	872	74.6	81.6
Bruce 7	1986	872	88.4	84.8
Bruce 8	1987	872	87.9	83.1
Darlington 1	1992	934	71.5	84.6
Darlington 2	1990	934	83.6	79.7
Darlington 3	1993	934	65.1	86.5
Darlington 4	1993	934	85.2	86.3
Total/Average		**20 691**	**83.8**	**83.3**

COG CANDU/PHWR Performance Statistics, 2015.

Notes

1. Wolsong 1 capacity factor is since its return to service, June 20, 2015 after re-licencing.
2. Embalse was considered unavailable by grid control except during brief periods of high demand.
3. 2015 Fleet average excludes Wolsong 1 and Embalse.

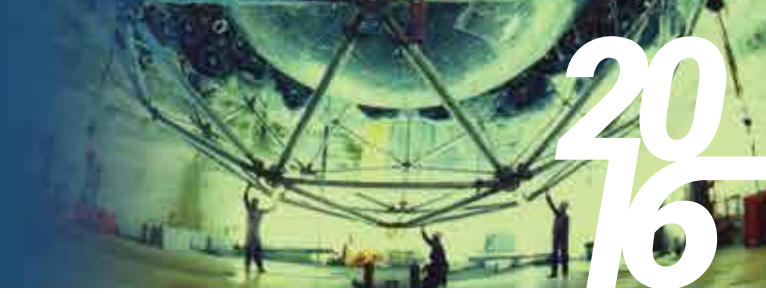
World Uranium Production – 2014

Country or area	Production (tU)				
	2010	**2011**	**2012**	**2013**	**2014**
Australia	5900	5983	6991	6350	5001
Brazil	148	265	231	198	231
Canada	9783	9145	8999	9332	9134
China*	827	1599	1500	1450	1500
Czech Rep	254	229	228	225	193
France	7	6	3	0	3
Germany	-	52	50	27	33
India*	400	400	385	400	385
Kazakhstan	17 803	19 451	21 317	22 567	23 127
Malawi	670	846	1101	1132	369
Namibia	4496	3259	4495	4315	3255
Niger*	4198	4351	4667	4528	4057
Pakistan*	45	45	45	45	45
Romania*	77	77	90	80	77
Russia	3562	2993	2872	3135	2990
South Africa	583	582	465	540	573
Ukraine*	850	890	960	1075	962
USA	1660	1537	1596	1835	1919
Uzbekistan*	2400	3000	2400	2400	2400
Total	**53 671**	**53 493**	**58 394**	**59 673**	**56 252**

*WNA estimate

All figures taken from the World Nuclear Association.

World Reactor Capacity



World Reactor Capacity – 2016

Country	Operating		Planned or Under Construction 03/01/16		Electricity Generation 2016	
	No	MW	No	MW	%	TWh
Argentina	3	1627	5	3277	4	5.3
Armenia	1	376	1	1060	30.7	2.3
Bangladesh			2	2400		
Belarus			4	4788		
Belgium	7	5943			47.5	32.1
Brazil	2	1901	5	5405	2.9	14.5
Bulgaria	2	1926	1	950	31.8	15
Canada	19	13553			16.8	98.6
Chile			4	4400		
China	30	26849	202	231215	2.4	123.8
Czech Rep.	6	3904	3	3600	35.8	28.6
Egypt			4	4800		
Finland	4	2741	3	4400	34.6	22.6
France	58	63130	2	3500	76.9	418
Germany	8	10728			15.8	91.8
Hungary	4	1889	2	2400	53.6	14.8
India	21	5302	66	69800	3.5	33.2
Indonesia			5	4030		
Iran	1	915	9	8300	1.5	3.7
Israel			1	1200		
Italy						
Japan	43	40480	15	20128	0	0
Jordan			2	2000		
Kazakhstan			4	1200		
Korea (N)			1	950		
Korea (S)	25	23017	11	15800	30.4	149.2
Lithuania			1	1350		
Malaysia			2	2000		
Mexico	2	1600	2	2000	5.6	9.3
Netherlands	1	485	1	1000	3.9	4
Pakistan	3	725	4	2980	4.3	4.6
Poland			6	6000		
Romania	2	1310	3	1965	18.5	10.8
Russia	35	26053	56	57659	18.6	169.1
Saudi Arabia			16	17000		
Slovakia	4	1816	3	2142	56.8	14.4
Slovenia	1	696	1	1000	37.2	6.1
South Africa	2	1830	8	9600	6.2	14.8
Spain	7	7121			20.4	54.9
Sweden	9	8849			41.5	62.3
Switzerland	5	3333	3	4000	37.9	26.5
Taiwan	6	4927	2	2700	na	na
Thailand			5	5000		
Turkey			8	9300		
Ukraine	15	13107	13	13900	49.4	83.1
UAE			14	20000		
UK	15	8883	13	17900	17.2	57.9
USA	99	98990	47	40530	19.5	798.6
Vietnam			10	10700		
World	**440**	**384006**	**570**	**624329**		**2369.9**

Notes
All figures taken from the World Nuclear Association, March 1, 2016.

CNS Council and Staff

CNS Executive

Paul Thompson
President

Peter Ozemoyah
1st Vice-President

Dan Gammage
2nd Vice-President

Jacques Plourde
Past President

Mohamed Younis
Treasurer

Colin Hunt
Secretary

Benjamin Rouben
Executive Director

Ken Smith
Financial Administrator

Jeremy Whitlock
Communications Director

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 1997, 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. The elected Council consists of six Officers plus up to 30 Members-at-Large – all volunteers. Various members of Council are appointed to Chair Committees that look after specific issues. The Council is supported by a full time Office Manager, and by other part-time specialists.

Elected Executive for June 2015 to June 2016:

Paul Thompson	**Peter Ozemoyah**	**Dan Gammage**	**Colin Hunt**	**Mohamed Younis**	**Jacques Plourde**
President	1st V-P	2nd V-P	Secretary	Treasurer	Past President

Part-time Specialists and Office Staff:

Ben Rouben	**Ken Smith**	**Brian Blosser**	**Amanda Blosser**	**Bob O'Sullivan**	**Jeremy Whitlock**
Executive Director	Financial Administrator	Accountant	Bookkeeper	Office Manager	Communications Director

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.

Members of the CNS Council and staff are listed on the next page.

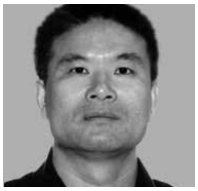
An outline of the activities of the CNS, including a list of upcoming conferences and courses, is provided elsewhere in this Yearbook.

CNS Council Members at Large


Parva Alavi


John Barrett
President and CEO, CNA


Fred Boyd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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 *continued from page 31*

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

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) 589-2085

CNL Chalk River Laboratories
Chalk River ON K0J 1J0
Tel: 1-866-513-2325

CNL Low-level Radioactive Waste Management
National Office
Suite 200
1900 City Park Drive
Ottawa ON K1J 1A3
Tel: 1-866-513-2325

CNL Whiteshell Laboratories
P.O. Box 550
Pinawa MB R0E 1L0
Tel: 1-866-513-2325

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

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

National Energy Board
444 Seventh Ave. S.W.
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)
22 St. Clair Avenue East
Sixth Floor
Toronto ON M4T 2S3
Tel: 416-934-9814
Fax: 416.934.9526

PROVINCIAL ORGANIZATIONS

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

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) 592-2555

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 420
Ottawa ON K1P 5G4
Tel: (613) 236-0569

Association of Major Power Consumers of Ontario (AMPCO)
65 Queen Street West
Suite 1510
Toronto ON M5H 2M5
Tel: (416) 260-0280
Fax: (416) 260-0442

Canadian Association of Medical Radiation Technologists
85 Albert St., Suite 1501
Ottawa ON K1P 6A4
Tel: (613) 234-0012

Canadian Association of Radiologists
600 – 294 Albert Street
Ottawa ON K1P 6E6
Tel.: 613 860-3111
Fax: 613 860-3112

Canadian Electricity Association
275 Slater Street, Suite 1500
Ottawa ON K1P 5H9
Tel: (613) 230-9263
Fax: (613) 230-9326

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
3700 Steeles Ave. W.
Woodbridge ON L4L 8K8
Tel: (905) 265-5300

Institute de Recherche
d'Hydro-Québec (IREQ)
1800, boul. Lionel-Boulet
Varennes QC J3X 1S1
Tel: (450) 652-8011

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

Guide to Nuclear-Related Organizations *continued from page 33*

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)
700 University Avenue
4th floor
Toronto ON M5G 1X6
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, S.W.
Calgary AB T2R 0C5
Tel: (403) 263-7722

Organization of Canadian Nuclear Industries (OCI)
1730 McPherson Court Unit 2
P:ickering ON L1W 3E6
Tel: (905) 839-0073

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)
Tower House
10 Southampton Street
London, United Kingdom
WC2E 7HA
Tel: +44 (0)20 7451 1520

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 2013.

Power Reactor Licences

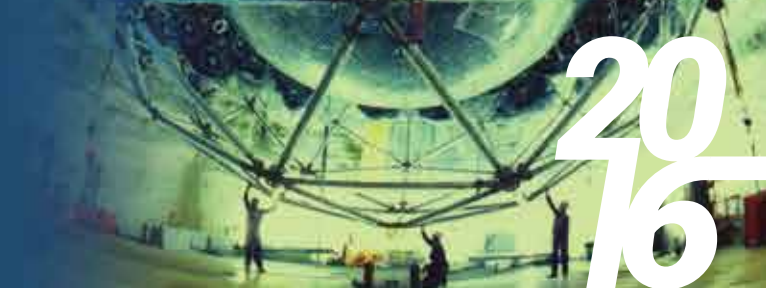
Facility and Location	Type and Number of Units/Capacity	Startup	Status
Pickering Nuclear Generating Station A Pickering, Ontario (Ontario Power Generation)	CANDU-PHW 2 x 500 MW(e)	1971	Operating
Pickering Nuclear Generating Station A Pickering, Ontario (Ontario Power Generation)	CANDU-PHW 2 x 500 MW(e)	1971	Shutdown To be decommissioned
Pickering Nuclear Generating Station B Pickering, Ontario (Ontario Power Generation)	CANDU-PHW 4 x 500 MW(e)	1983	Operating
Darlington Nuclear Generating Station Bowmanville, Ontario (Ontario Power Generation)	CANDU-PHW 4 x 850 MW(e)	1989	Operating
Bruce Nuclear Generating Station A Tiverton, Ontario (Bruce Power)	CANDU-PHW 4 x 750 MW(e)	1976	Operating
Bruce Nuclear Generating Station B Tiverton, Ontario (Bruce Power)	CANDU-PHW 4 x 840 MW(e)	1984	Operating
Gentilly-2 Nuclear Generating Station Gentilly, Québec (Hydro-Québec)	CANDU-PHW 1 x 600 MW(e)	1983	Shutdown To be decommissioned
Point Lepreau Generating Station Lepreau, New Brunswick (New Brunswick Power Corp.)	CANDU-PHW 1 x 600 MW(e)	1982	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 of 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)	Decommissioned and released
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
Gamma Beam Irradiator GC60	Irradiation Facility	Operating
Gamma Beam 150 C Irradiation Facility	Irradiation Facility	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	Dcommissioning
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	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, Saskatchewan (Cameco Corporation)	Long-term monitoring	Decommissioned
Cigar Lake Project, Saskatchewan (Cameco Corporation)	Mining	Operating
Cluff Lake, Saskatchewan (AREVA Resources Canada Inc.)	Long-term monitoring	Decommissioned
Key Lake Operation Saskatchewan (Cameco Corporation)	Milling	Operating
McArthur River Project, Saskatchewan (Cameco Corporation)	Mining	Operating
McClean Lake Project, Saskatchewan (AREVA Resources Canada Inc.)	Milling	Operating
Rabbit Lake Saskatchewan (Cameco Corporation)	Mining and milling	Operating
Denison Mines, Elliot Lake, Ontario (Denison Mines Ltd.)	Above-ground tailings	Decommissioned
Stanrock, Elliot Lake, Ontario (Denison Mines)	Above-ground tailings	Decommissioned
Madawaska Bancroft, Ontario (Madawaska Mines Ltd.)	Long-term monitoring	Decommissioned

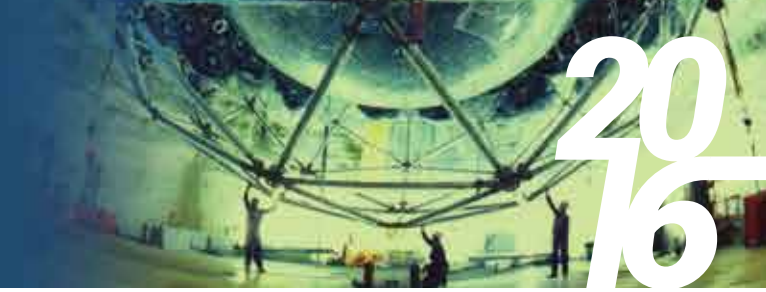
Canada's Nuclear Facilities *continued from page 37*

Refinery and Fuel Fabrication Facility Licences

Facility	Annual Licensed Production Limit	Status
GE Hitachi Nuclear Energy Canada Inc., Toronto, Ontario	1,800 tonnes of uranium	Operating
GE Hitachi Nuclear Energy Canada Inc., Peterborough, Ontario	1,800 tonnes of uranium	Operating
Port Hope Fuel Manufacturing Facility, Port Hope, Ontario (Cameco)	125 tonnes of UO2	Operating
Blind River Uranium Refinery, Blind River, Ontario (Cameco)	24,000 tonnes of uranium as UO3	Operating
Port Hope Uranium Converstion Facility, Port Hope, Onatario (Cameco)	12,500 tonnes of uranium as uranium hexaflouride 3,800 tonnes of uranium as UO2 1,000 tonnes of uranium as ammonium diuranate 2,000 tonnes of uranium metals	Operating

Waste Management Licences

Facility	Activity	Status
Radioactive Waste Operations Site 1 Tiverton, Ontario (OPG)	Storage of intermediate level radioactive waste from the Douglas Point nuclear reactor in in-ground concrete trenches and tile holes. The licence was amended in July 2006 to include the Spent Solvent Treatment Facility as minor amounts of nuclear substances remain in the facility from the past processing of spent solvents Contaminated with nuclear substances. No new radioactive waste is accepted at the facility.	Storage with surveillance
Western Waste Management Facility, Tiverton, Ontario (OPG)	Processing and/or storage of low level radioactive waste and storage of intermediate level radioactive waste, and processing and storage of spent nuclear fuel from the Bruce NGS	Operating
Pickering Waste Management Facility Pickering, Ontario (OPG)	Processing and storage of spent nuclear fuel from the Pickering NGS and storage of retube components from the Pickering NGS	Operating
Bruce Heavy Water Plant Tiverton, Ontario (OPG)	Decommissioning 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 radioactive waste is 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 Waste Management Facility Bowmanville, Ontario (OPG)	Processing and storage of spent nuclear fuel from the Darlington NGS	Operating
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 (slightly radioactive clothing materials) from decontamination activities	Operating
Energy Solutions WMF Brampton, Ontario (Energy Solutions Canada)	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 Long-term (LT) WMF Clarington, Ontario (AECL)	Storage of historic waste and chemical treatment of drainage and run-off. No new waste is accepted. Currently undergoing construction.	Storage with surveillance and remediation
Port Hope Long-term (LT) WMF Port Hope, Ontario (AECL)	Storage of historic waste and treatment of drainage and run-off. No new waste is accepted. Currently undergoing construction.	Storage with surveillance and remediation



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.	Decommissioned
Port Hope PSE TSS Port Hope, Ontario (Low-Level Radioactive Waste Management Office)	Storage of historic waste	Operating
Port Hope WMF Port Hope, Ontario (Low-Level Radioactive Waste Management Office, Pine St. Extension Temporary Storage Site)	Storage of historic waste no new waste accepted	Storage with surveillance
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 (Ontario Ministry of Northern Development and Mines)	Above-ground tailings	Decommissioned
Dyno Idle Mine Site Bancroft, Ontario (EWL Management Ltd)	Above-ground tailings	Decommissioned
Rayrock Idle Mine Site Northwest Territories (Department of Indian Affairs and Northern Development)	Above-ground tailings	Decommissioned
Port Radium Idle Mine Site Northwest Territories (Department of Indian Affairs and Northern Development)	Above-ground tailings	Decommissioned
Madawaska Bancroft, Ontario (EWL Management Ltd.)	Above-ground tailings	Decommissioned
Bicroft Tailings Storage Facility Bancroft, Ontario (Barrick Gold Corporation)	Above-ground tailings	Decommissioned

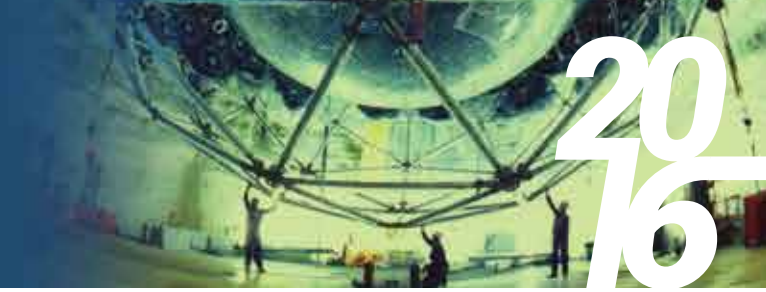
Particle Accelerator Licences

Facility	Type	Status
Health PEI Charlottetown, Prince Edward Island	2 linacs	Operating
Region Health Authority B Saint John, New Brunswick	3 linacs	Operating
Centre de santé et de services sociaux de Chicoutimi Chicoutimi, Québec	3 linacs	Operating
Centre universitaire de santé McGill Montréal, Québec	3 linacs	Operating
Hospital Maisonneuve-Rosemont Montréal, Québec	6 linacs	Operating
The Board of Governors of the Kingston General Hospital, Kingston, Ontario	4 linacs	Operating
Thunder Bay Regional Health Sciences Centre Thunder Bay, Ontario	3 linacs	Operating
Windsor Regional Hospital Windsor, Ontario	3 linacs	Operating
Cancer Care Manitoba Winnipeg, Manitoba	7 linacs	Operating
Saskatchewan Cancer Agency Regina, Saskatchewan	3 linacs	Operating
Saskatchewan Cancer Agency Saskatoon, Saskatchewan	3 linacs	Operating
Alberta Health Services Calgary, Alberta	6 linacs	Operating
Alberta Health Services Edmonton, Alberta	5 linacs	Operating
Alerta Health Services Lethbridge, Alberta	2 linacs	Operating
Hôpital Général Juif Montréal, Québec	3 linacs	Operating

Canada's Nuclear Facilities *continued from page 39*

Particle Accelerator Licences (cont'd)

Facility	Type	Status
Cape Breton District Health Authority Sydney, Nova Scotia	2 linacs	Operating
Régie régionale de la santé (Beauséjour) Moncton, New Brunswick	3 linacs	Operating
British Columbia Cancer Agency Kelowna, British Columbia	3 linacs	Operating
British Columbia Cancer Agency Victoria, British Columbia	3 linacs	Operating
British Columbia Cancer Agency Prince George, British Columbia	2 linacs	Operating
British Columbia Cancer Agency Abbotsford, British Columbia	4 linacs	Operating
Cancer Care Ontario St. Catherines, Ontario	3 linacs	Operating
British Columbia Cancer Agency Vancouver, British Columbia	9 linacs	Operating
Eastern Regional Integrated Health Authority (Eastern Health) St. John's, Newfoundland	4 linacs	Operating
Centre hospitalier universitaire de Sherbrooke Sherbrooke, Québec	1 linac	Operating
Centre hospitalier universitaire de Sherbrooke Fleurimont, Québec	3 linacs	Operating
Centre hospitalier universitaire de Québec Québec, Québec	4 linacs	Operating
Capital District Health Authority Halifax, Nova Scotia	3 linacs	Operating
Hamilton Health Sciences Corporation Hamilton, Ontario	10 linacs	Operating
Centre hospitalier de l'Université de Montréal Montréal, Québec	7 linacs	Operating
Centre de sante et services sociaux Champlain-Charles-Le-Moyne Greenfield Park, Québec	4 linacs	Operating
Hôpital régional de Sudbury Sudbury, Ontario	6 linacs	Operating
The Ottawa Hospital Ottawa, Ontario	9 linacs	Operating
Sunnybrook Health Sciences Centre Toronto, Ontario	10 Cyclotron	Operating
Sunnybrook Health Sciences Centre Barrie, Ontario	3 linacs	Operating
Ciment Québec Inc. Saint-Basile, Québec	2 Neutron Generator	Operating
General Fusion Inc. Burnaby, British Columbia	1 Plasma Injector	Operating
Hilliburton Group Canada Inc. Nisku, Alberta	1 Neutron Generator	Operating
Hunter Well Science Ltd. Calgary, Alberta	1 Neutron Generator	Operating
Centre de sante et de services sociaux de Gatineau Gatineau, Québec	3 linacs	Operating
University Health Network Toronto, Ontario	20 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



Particle Accelerator Licences (cont'd)

Facility	Type	Status
McMaster University Hamilton, Ontario	1 cyclotron	Operating
McMaster University Hamilton, Ontario	1 Van de Graaff	Operating
University of Guelph Guelph, Ontario	1 linac	Operating
University of Western Ontario London, Ontario	1 tandetron accelerator	Operating
Queen's University at Kingston Kingston, Ontario	2 Neutron Generator	Operating
Université de Montréal Montréal, Québec	1 Van de Graaff tandem accelerator 1 tandetron accelerator	Operating Operating
Centre de santé et services sociaux de Laval Laval, Québec	2 linacs	Operating
National Research Council Canada Ottawa, Ontario	2 linacs	Operating
Schlumberger Canada Limited Calgary, Alberta	1 Neutron Generator	Operating
Scientific Drilling International (Canada) Calgary, Alberta	1 Neutron Generator	Operating
Hotwell Canada Ltd. Calgary, Alberta	1 Neutron Generator	Operating
Montreal Neurological Institute and Hospital Montreal, Quebec	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
Mervex Corporation Stittsville, Ontario	1 linac	Operating
Lakeridge Health Oshawa, Ontario	6 linacs	Operating
PharamaLogic P.E.T. Services of Montreal Company Lachine, Québec	1 Cyclotron	Operating
Southlake Regional Health Centre Newmarket, Ontario	3 linacs	Operating
St. Joseph's Health Care London, Ontario	1 linac	Operating
Vancouver Cancer Centre Vancouver, British Columbia	1 Cyclotron	Operating
Weatherford Canada Ltd. Edmonton, Alberta	1 Neutron Generator	Operating
Winnipeg Regional Health Authority Winnipeg, Manitoba	1 Cyclotron	Operating

Nuclear Substance Processing Facility Licences

Facility	Type	Status
New Processing Facility Chalk River Laboratories Chalk River, Ontario	Production and processing	Operating
Nordion (Canada) Inc., Ottawa, Ontario	Production and processing	Operating
SRB Technologies, Pembroke, Ontario	Processing	Operating
Shield Source Inc., Peterborough, Ontario	Processing	Shutdown

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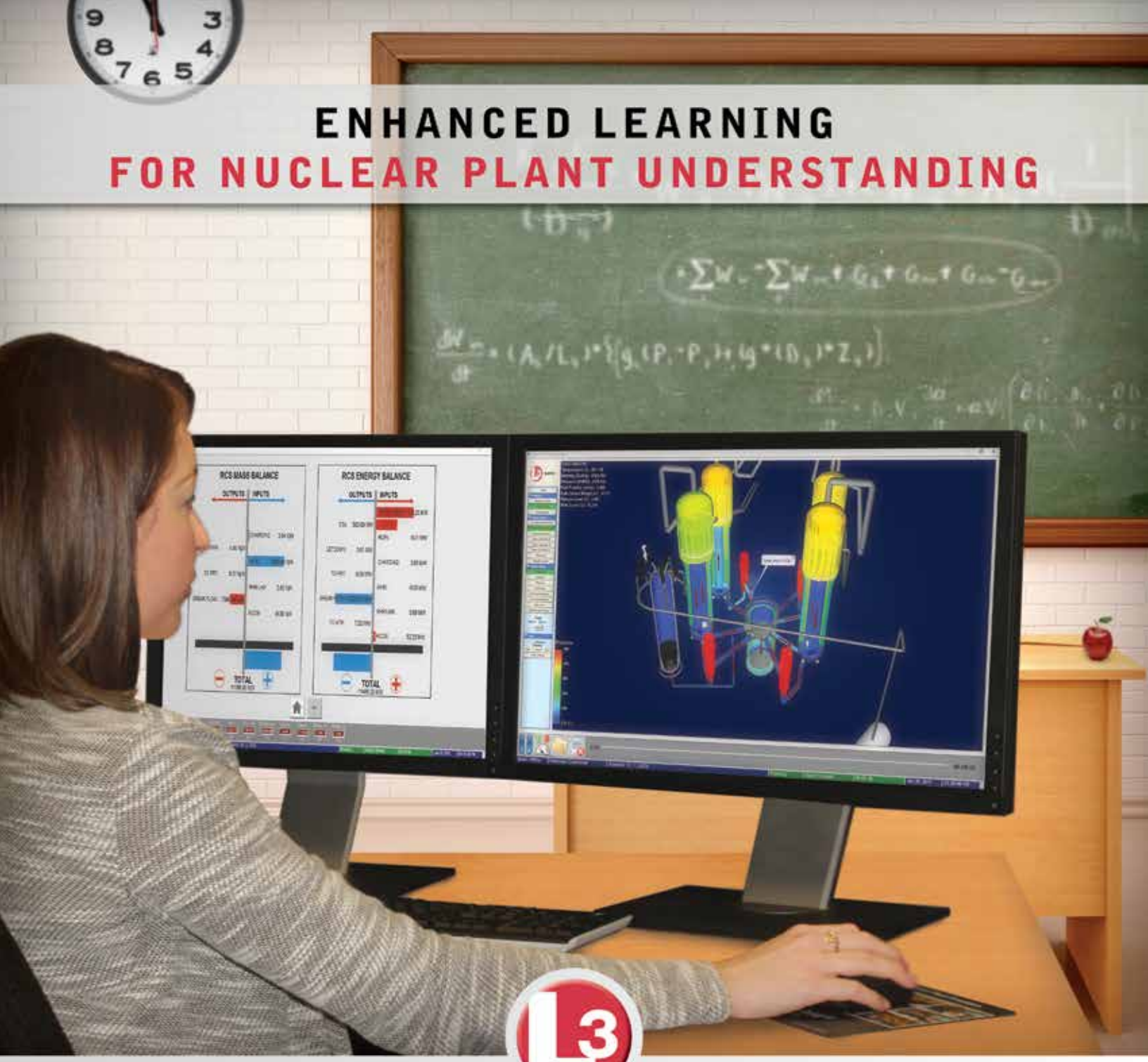

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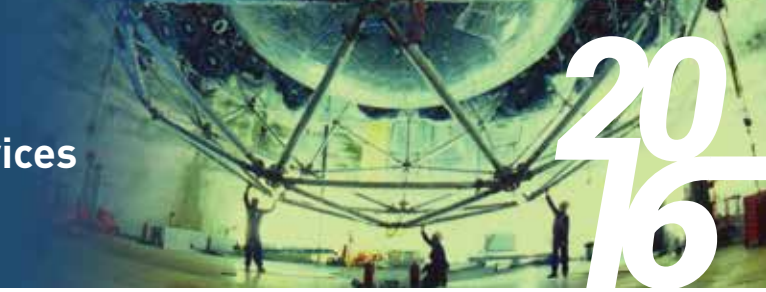
Nuclear Products, Materials and Services



A

Air Filtration Systems
CCI Thermal Technologies Inc.

Air Headers
Special Electronics and Designs Inc.

Airlocks, Reactor
RCM Technologies Canada Corp. 18
SNC-Lavalin Inc. 15

Alarm Systems
SNC-Lavalin Inc. 15

Alpha Spectroscopy
Canberra Co.

Analyzers
Avensys Solutions

Architects, Engineers
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Assay Equipment and Services, Uranium
McMaster Nuclear Reactor

Associations – Guide to Nuclear Related Organizations
Ontario Society of Professional Engineers

B

Base Listing Fee
Canadian Nuclear Workers' Council
Power Workers' Union 22

Bellows, Metal
Thorburn Flex Inc. 14, 58

C

Cable Assemblies, Radiation Resistant
Kanata Electronic Services Limited
Mirion Technologies (IST Canada) Inc. ..... OBC
Promation Nuclear Ltd.

Calandrias, Reactor
Thorburn Flex Inc. 14, 58

Calibration Services
Marsh Instrumentation Ltd.

Castings, Nuclear Quality
ATI
Nuclear Logistics Inc. 42

Chambers, Fission
Cameco Fuel Manufacturing 17
LND Inc. 51
Mirion Technologies (IST Canada) Inc. ..... OBC
SNC-Lavalin Inc. 15

Chambers, Ionization
Cameco Fuel Manufacturing 17
LND Inc. 51
Mirion Technologies (IST Canada) Inc. ..... OBC
SNC-Lavalin Inc. 15

Clothing, Protective
UniTech Services Group ... 35

Coatings, Protective
Metal Improvement Company LLC, a business unit of Curtiss-Wright Surface Technologies

Combined Communication Air Hoses
Special Electronics and Designs Inc.

Commercial Grade Dedication
Canadian Power Utility S ervices Limited
Kinectrics Inc. 2
Nuclear Logistics Inc. 42

Communications Equipment
Marsh Instrumentation Ltd.
Special Electronics and Designs Inc.

Compactors, Box and Drum
Container Products Corporation

Compressors, Gas
Thorburn Flex Inc. 14, 58

Computer Software Development & Maintenance
SWI Systemware

Computers, Reactor Control
Marsh Instrumentation Ltd.
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Configuration Management
BWXT Canada Ltd.
Canadian Power Utility Services Limited
GE Hitachi Nuclear Energy Canada Inc. ..... IFC
Hatch Ltd. 53
RCM Technologies Canada Corp. 18
SNC-Lavalin Inc. 15
SWI Systemware

Confined Space Communications
Special Electronics and Designs Inc.

Connectors, Electrical, Radiation Resistant
Kanata Electronic Services Limited

Construction Management
BWXT Canada Ltd.
E.S. Fox Limited 4
Hatch Ltd. 53

Construction, Modular
E.S. Fox Limited 4

Consultant, Waste and Decommissioning Planning
Arcadis Canada Inc.
Candesco 2
Tetra Tech Wei Inc. 20

Consultants, Business
Strategic Insights Inc.

Consultants, Design
BWXT Canada Ltd.
Canadian Power Utility Services Limited
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RCM Technologies Canada Corp. 18
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SWI Systemware
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Strategic Insights Inc.

Consultants, Engineering
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Canadian Power Utility Services Limited
Marsh Instrumentation Ltd.
NA Engineering Associates Inc.
RCM Technologies Canada Corp. 18
Rolls-Royce Civil Nuclear Canada Ltd.
SNC-Lavalin Inc. 15
Structural Integrity Associates Inc
Tetra Tech Wei Inc. 20

Consultants, Environmental
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EcoMetrix Incorporated
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Consultants, Geotechnical
SNC-Lavalin Inc. 15

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Strategic Insights Inc.
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Consultants, Materials
RCM Technologies Canada Corp. 18

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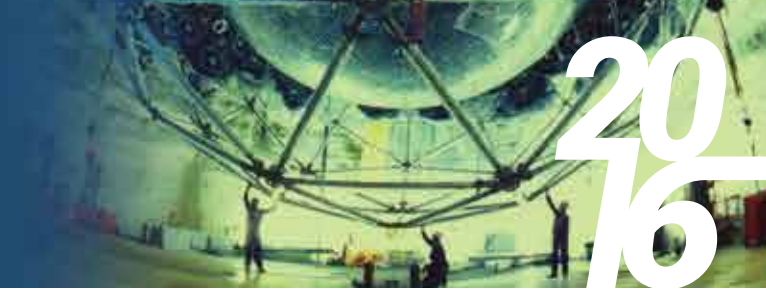

F

Fabrication, Pipe, Nuclear
Canadian Power Utility Services Limited
E.S. Fox Limited 4
Niagara Energy Products 52
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Fabrication, Pipe, Nuclear
BWXT Canada Ltd.
CCI Thermal Technologies Inc.
GE Hitachi Nuclear Energy Canada Inc. ..... IFC
Promation Nuclear Ltd.
Thorburn Flex Inc. 14, 58

Fasteners, Nuclear Quality
Laker Energy Products Ltd.
Niagara Fasteners Inc.

Feeder Services
BWXT Canada Ltd.

Filter Baskets
CCI Thermal Technologies Inc.

Filters, Air
CCI Thermal Technologies Inc.

Filters, Gland Injection and Monitor
CCI Thermal Technologies Inc.

Filters, Water, Nuclear
CCI Thermal Technologies Inc.

Fire Protection
Canadian Power Utility Services Limited
Hatch Ltd. 53
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Flasks, Shielding
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Promation Nuclear Ltd.

Flow Meters
Advanced Measurement and Analysis Group Inc. (AMAG Inc.)
Avensys Solutions
Lakeside Process Controls Ltd.
Marsh Instrumentation Ltd.
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Flow Switches
Avensys Solutions
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Flux Monitor Components
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RPC Radiy
SNC-Lavalin Inc. 15

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Niagara Energy Products 52
Niagara Fasteners Inc.

Fuel Channel Components
ATI
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GE Hitachi Nuclear Energy Canada Inc. ..... IFC
Laker Energy Products Ltd.
Promation Nuclear Ltd.
SNC-Lavalin Inc. 15

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Cameco Fuel Manufacturing 17

Fuel Fabrication
Cameco Fuel Manufacturing 17
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B.C. Instruments
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Marsh Instrumentation Ltd.
Promation Nuclear Ltd.
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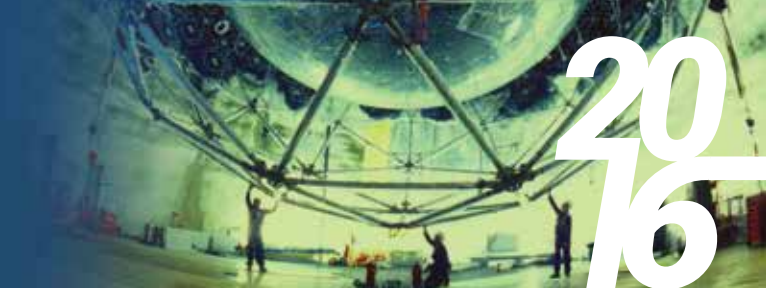

Gamma Flux Mapping Systems
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Ice Plugs Control and Monitoring Systems
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RPC Radiy

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Nuclear Insurance Association of Canada

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CCI Thermal Technologies Inc.
GE Hitachi Nuclear Energy Canada Inc. ..... IFC

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SWI Systemware

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Rolls-Royce Civil Nuclear Canada Ltd.

Piping, Nuclear Grade
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Canadian Power Utility Services Limited
Laker Energy Products Ltd.
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Pneumatic Control Systems
IMI NH/CCI – IMI Critical Engineering
Marsh Instrumentation Ltd.

Post-Accident Radiation Monitoring Systems
Mirion Technologies (IST Canada) Inc. ..... OBC

Power Plants, Nuclear
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Nuvia Canada

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Mirion Technologies (IST Canada) Inc. .....OBC

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Canberra Co.
LND Inc. 51
Mirion Technologies (IST Canada) Inc. .....OBC

Radioactive Sources, Calibration/Check
Canberra Co.

Radioactive Waste Management Equipment
Canberra Co.
Nuvia Canada
Rolls-Royce Civil Nuclear Canada Ltd.
SNC-Lavalin Inc. 15

Radioactive Waste Management Services
Arcadis Canada Inc.
EnergySolutions Canada
Kinectrics Inc. 2
Nuvia Canada
SNC-Lavalin Inc. 15
UniTech Services Group ... 35

Radiochemicals
McMaster Nuclear Reactor

Radioisotopes
McMaster Nuclear Reactor

Reactor Safety Analysis
Candesco 2
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Reactor Services
BWXT Canada Ltd.

Reactor Vessel Inspection
SNC-Lavalin Inc. 15

Reactor, Pressure Vessel Replacements
BWXT Canada Ltd.

Reactors, Power
SNC-Lavalin Inc. 15

Reactors, Research
SNC-Lavalin Inc. 15

Recombiners and Flame Arrestors
Rolls-Royce Civil Nuclear Canada Ltd.
SNC-Lavalin Inc. 15

Recorders
Nuclear Logistics Inc. 42

Recruitment and Placement Services
Canadian Power Utility Services Limited

Refuelling Equipment, Reactor
SNC-Lavalin Inc. 15

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Canadian Power Utility Services Limited
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Kinectrics Inc. 2
Lakeside Process Controls Ltd.
RCM Technologies Canada Corp. 18
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Remote Handling
Promation Nuclear Ltd.
Rolls-Royce Civil Nuclear Canada Ltd.
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Research and Development
Advanced Measurement and Analysis Group Inc. (AMAG Inc.)
BWXT Canada Ltd.
McMaster Nuclear Reactor
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Resistance Temperature Detectors
Henry Controls Inc.
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RdF Corporation

Respiratory Equipment
UniTech Services Group

Restraints, Seismic
Nuclear Logistics Inc. 42

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EcoMetrix Incorporated
Kinectrics Inc. 2
SNC-Lavalin Inc. 15
Structural Integrity Associates Inc
Tetra Tech Wei Inc. 20

Risk Management
Candesco 2
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Robotics, Remote Handling
ASI Group Ltd.
BWXT Canada Ltd.
Promation Nuclear Ltd.
SNC-Lavalin Inc. 15

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Kinectrics Inc. 2

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Canadian Power Utility Services Limited
Candesco 2
RCM Technologies Canada Corp. 18
SNC-Lavalin Inc. 15
Tetra Tech Wei Inc. 20

Seals, Nuclear Quality
Kanata Electronic Services Limited
SNC-Lavalin Inc. 15

Security Systems
Canadian Power Utility Services Limited
Tetra Tech Wei Inc. 20

Seismic Analysis & Testing
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Siting Analysis
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Staffing Services
Adventis Nuclear Personnel Inc.
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Marsh Instrumentation Ltd.

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Structural Analysis
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Support Systems, Assessment
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System Integration
Marsh Instrumentation Ltd.
SWI Systemware

T

Tanks, Active Liquid Waste
E.S. Fox Limited 4

Television Systems, Nuclear Application
Mirion Technologies (IST Canada) Inc. .....OBC

Temperature Alarm Logic Controllers
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Thermal Aging
BWXT Canada Ltd.
Kinectrics Inc. 2
Marsh Instrumentation Ltd.
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Thermocouples
Henry Controls Inc.
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RdF Corporation

Third Party Qualifications
Canadian Power Utility Services Limited
Kinectrics Inc. 2
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Tritium Handling
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SNC-Lavalin Inc. 15

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Kinectrics Inc. 2
SNC-Lavalin Inc. 15

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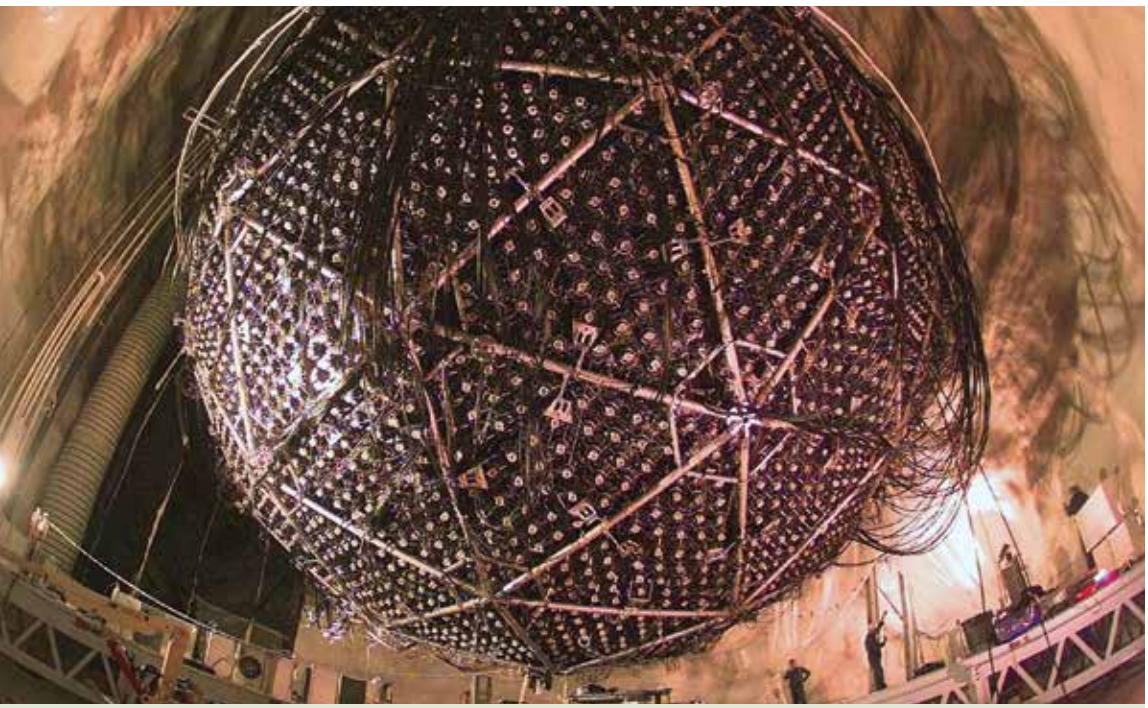
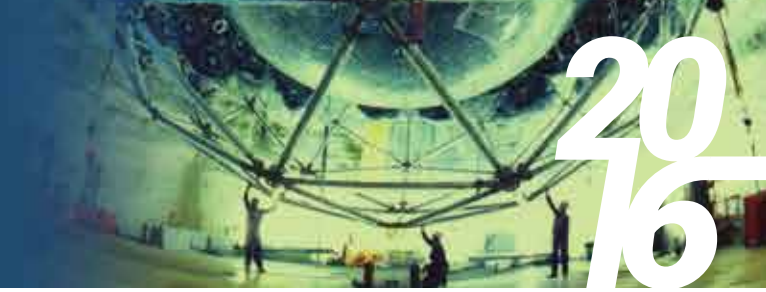
Tubes, Pressure
GE Hitachi Nuclear Energy Canada Inc. ..... IFC
Thorburn Flex Inc. 14, 58

Tubes, Testing
BWXT Canada Ltd.



Twelve metres in diameter, the spherical container filled with 1,000 tons of heavy water is surrounded by detectors.



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University Network of Excellence in Nuclear Engineering
Réseau d'Excellence Universitaire en Génie Nucléaire

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- A Master's of Engineering Degree from one of the five member universities (McMaster University, Queen's University, University of Waterloo, University of Western Ontario, and University of Ontario Institute of Technology).
- Courses are tailored to individuals already working in the nuclear industry, and are delivered on weekends in Whitby, so as not to conflict with core working hours.
- For the degree 10 courses, or 8 courses and an industrial research project, must be successfully completed over a period of 5 years.
- A nuclear engineering diploma (in final approval)*. The diploma is a four-course subset of the M.Eng.
- A student can take just one or a few courses rather than the full program.
- Students must be registered as graduate students in one of the participating universities.
- The courses are also offered using Distance Education tools for sites remote from the GTA.

The courses comprise:

- ☐ Nuclear Plant Systems and Operations
- ☐ Reactor Physics
- ☐ Heat Transport System Design
- ☐ Nuclear Reactor Safety Design
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- ☐ Control, Instrumentation and Electrical Systems in CANDU Power Plants
- ☐ Engineering Risk and Reliability
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The University Network of Excellence in Nuclear Engineering (UNENE) is an alliance of universities, nuclear power utilities, research and regulatory agencies for the support & development of nuclear education, research and development capability in Canadian universities.

The purpose of UNENE is to assure a sustainable supply of qualified nuclear engineers and scientists to meet the current and future needs of the Canadian nuclear industry.

For more information, please:

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- Wolsong South Korea (4 Units)
- Embalse Argentina (1 Unit)

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- GE Canada
- SNC-Nuclear
- CANDU Energy
- AREVA

Products:
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- Bellows for snout indexing mechanism & loop liner tube
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- Containment passage expansion joints
- Pressure balanced crossover expansion joints
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- ASME NCA4000 NQA-1 NPT Stamp (In Progress)
- ISO 9001:2008
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Quality Systems

Annulus seal bellows for calandria fuel channel


Fueling machine head separator assemblies


Bellows for snout indexing mechanism


Miniature bellows for fuel rod flask limit switch & rod cup seal


Loop liner tube bellows assemblies


Pressure balanced crossover expansion joints


Containment passage rectangular expansion joints


Main steam penetration gimbal expansion joints


In-line pressure balanced rubber expansion joints

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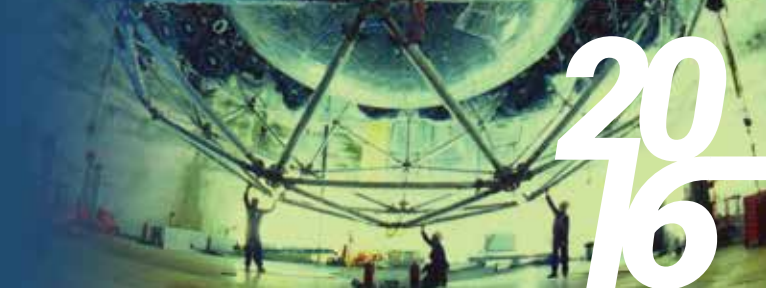

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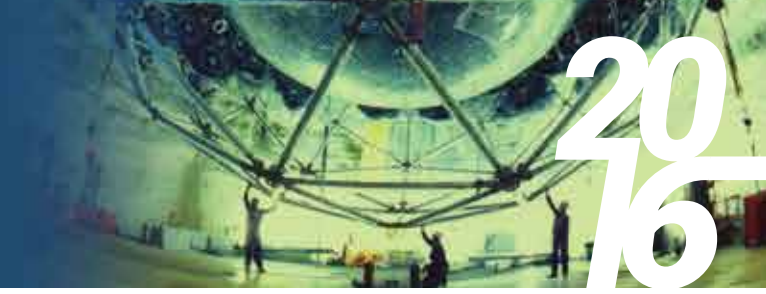

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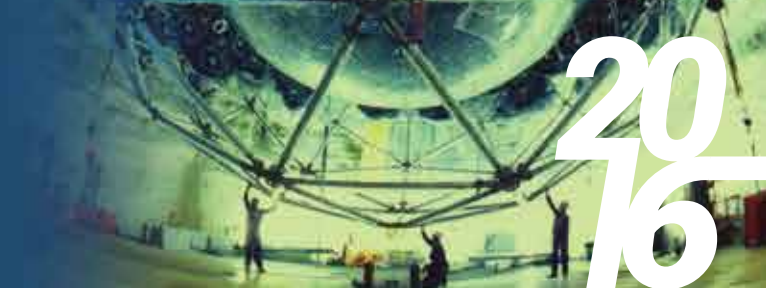

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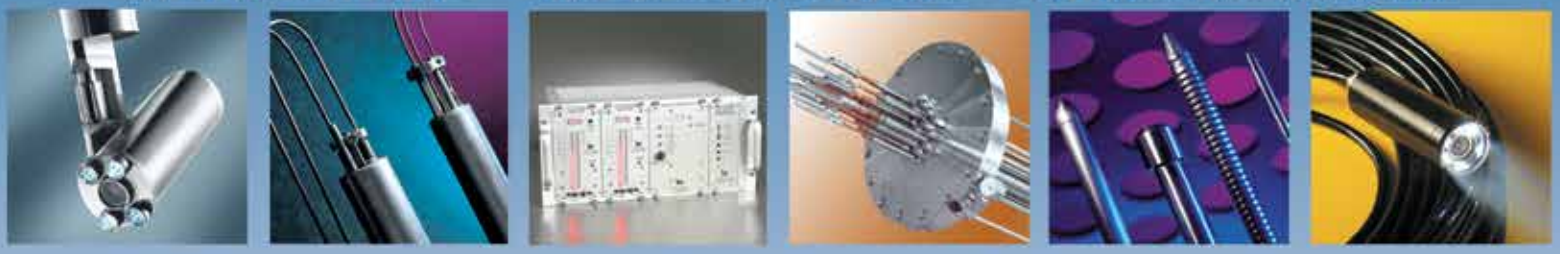

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