One Artifact at a Time – Preserving Canada's Nuclear Heritage

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Abstract

Canada has a rich and varied history of nuclear science and technology, dating from the early twentieth century to the present. Examples include:

- Ernest Rutherford, Professor of Experimental Physics at McGill University from 1898 to 1907, established the theory of radioactive transmutation and was awarded the 1908 Nobel Prize in Chemistry for this work.

- Gilbert Labine, a prospector from Westmeath, Ontario, discovered uranium at Great Bear Lake in May 1930. His company, Eldorado Mining and Refining Limited, initially exploited pitchblende for its radium content to treat cancer, but later became a major provider of uranium for reactors around the world.

- The UK-Canada Montreal Laboratory of the National Research Council of Canada, established in 1943, evolved into Petawawa Works, the Chalk River Nuclear Laboratories, and Atomic Energy of Canada Limited in 1952. Canadian Nuclear Laboratories, Canadian universities and Canadian companies carry on this proud R&D tradition today.

The impressive list of Canadian-developed nuclear science and technology includes: cobalt treatment for cancer (two separate groups!) in 1951; research reactors, from ZEEP to SLOWPOKE; power reactors from NPD to CANDUs; radioactive waste management; medical radioisotope imaging; research and industrial accelerators; and neutron imaging (to name only a few).

Canada's nuclear history is described in a few books and web pages, and some museums and displays across the country devote space to specific aspects such as uranium mining, Co-60 cancer treatment, electrical generation, and nuclear safety. As early as 1959 attempts were made to create a comprehensive Canadian nuclear museum, but only in 2015 was a serious start made towards developing a national collection with related educational activities. In 2017 the Society for the Preservation of Canada's Nuclear Heritage was federally incorporated as a charitable organization. This paper describes the vision and journey to collect, preserve, archive and display Canada's past and ongoing nuclear story.

INTRODUCTION

One could say Canada's history of nuclear science and technology began on Christmas Day 1895, when Toulson Cunning was shot in the leg during a street brawl in Montreal. Only one and a half months earlier, Wilhelm Röntgen had discovered a strange new ray that

could penetrate opaque material and reveal bones still covered with flesh. Three days after Cunning was shot, Röntgen's paper "On a New Kind of Rays" (*Ueber eine neue Art von Strahlen*) was delivered to the President of the Physical Medical Society of Würzburg, and it appeared as a preliminary communication in the Annals of the Society. Röntgen described the new "x ray", but the English description did not appear until the January 23 1896 edition of *Nature*[1]. Scientists around the world eagerly replicated Röntgen's discovery, including Professor John Cox, Director of the Macdonald Physics Laboratory at McGill University. At the instigation of Doctor Robert Kilpatrick, Professor Cox took a 45-minute x-ray of Toulson Cunning's leg on February 7 1896. Despite being underexposed, the resulting x-ray was sufficient to reveal the whereabouts of the bullet, which surgeons removed and thus spared Cunning's leg. So began Canadian nuclear imaging. [2]

On the other hand, knowledge of Canadian uranium predated knowledge of ionizing radiation. Uranium and thorium were identified by John Le Conte in 1847, from specimens collected by B.A Stanard on the north shore of Lake Superior [3]. At the time, uranium was merely a scientific oddity, and no record was made of the exact location where the sample originated. However, one hundred years later prospector Robert Campbell rediscovered the uranium outcrop in the Alona Bay area; he had begun his search in a Toronto library, by examining historic reports including that of Le Conte [4].

These examples from nuclear history illustrate the value of accessible scientific and technical information. Röntgen's dramatic discovery was rapidly and widely disseminated, prompting further study and even utilization. In Campbell's case, an early discovery had been lost in obscurity due to its unimportance at the time; only diligent re-examination of old documents brought it once again to the light, leading to a more complete discovery now that its significance was recognized. These stories demonstrate that the preservation, presentation and study of history are relevant and can lead to further discovery.

This paper describes the ongoing work of the Society for the Preservation of Canada's Nuclear Heritage, a federally-incorporated charitable organization whose purpose is to collect, preserve, archive and display Canada's nuclear story – past, present and future. Who knows what treasures future generations may find within the Society's records?

CANADIAN NUCLEAR HISTORY - A BRIEF OVERVIEW

Canada has a long and significant history of nuclear science and technology that is difficult to summarize in a few paragraphs. It began, in earnest one might say, with the 1898 appointment of Rutherford as Professor of Experimental Physics at McGill University, thanks to the recommendation of Sir Joseph John Thomson, Cavendish Professor of Physics at the University of Cambridge [5]. They were heady days - atomic and subatomic physics was expanding in great leaps with the discoveries of: x-rays (Röntgen, 1895); radioactivity (Becquerel, 1896); the electron (Thomson, 1897); and polonium and radium (Curies, 1898). Adding to this, Rutherford discovered radon, the radioactive half-life, radioactive transmutation, and alpha and beta radiation. Unfortunately for Canada, Rutherford returned to the United Kingdom in 1908 to become the chair of physics at the University of Manchester, and that same year he received the Nobel Prize in Chemistry based on his work

at McGill. Thankfully much of his laboratory equipment has been preserved, at the Rutherford Museum of the McGill Physics Department [6].

After such a strong start, Canada was largely left behind in the rapidly expanding world of nuclear physics. The single largest effort was by a small group within the Division of Physics and Electrical Engineering at the National Research Council (NRC) in Ottawa. The division director was Robert W. Boyle, and the senior member was George C. Laurence; both men had studied under Rutherford – Boyle at McGill and Laurence at Cambridge. Following the discovery of nuclear fission, announced on January 16, 1939 in a letter to *Nature* by Meitner and Frisch, Laurence began studies with natural uranium and graphite moderation. This could be considered the beginning of the continuous Canadian nuclear story, as suggested by Wilfrid Eggleston in his comprehensive classic, *Canada's Nuclear Story* [7].

Canadian nuclear knowledge expanded enormously because of World War II and Canada's involvement in the British Tube Alloys Project (atomic weapons research); British and European scientists moved from the Cavendish Laboratories at Cambridge to join Canadian scientists at the Montreal Laboratories under the jurisdiction of the NRC. From this point Canada's nuclear history becomes far too large and broad to be described in this paper. Suffice it to list a few of the subsequent highlights:

WWII: Montreal Laboratories evolves into Chalk River Nuclear Laboratories (CRNL); Trail heavy water production; decision for Canada to specialize in heavy water technology; ZEEP, first reactor outside USA; Eldorado Mining and Refining, major development of Canada's uranium mining and refining industry.

1940s: Establishment of non-weapons nuclear research program at CRNL; National Research X-perimental (NRX), world's largest and most powerful research reactor for many years; first radioisotope shipments from NRX.

1950s: Evolution of CRNL project into Atomic Energy of Canada Limited; radioisotope applications; Co-60 cancer treatment (U Saskatchewan and U of Western Ontario); neutron scattering (B. Brockhouse 1994 Nobel Prize in Physics); NRX accident, rebuild and restart; power reactor development began - Nuclear Power Demonstration (NPD) reactor (re)designed; National Research Universal (NRU) built, largest research reactor in Canada; McMaster University reactor built (still operating).

1960s: NPD starts operation (Canadian General Electric + AECL + Ontario Hydro-Electric Power Commission); Power Projects Division established at Sheridan Park, Mississauga; Douglas Point - first commercial-sized CANDU; Whiteshell Nuclear Research Establishment built as sister AECL research site, including WR-1 organic-cooled research reactor; first international Canadian reactor (CIRUS); food irradiation research and application; AECL Commercial Products Division, Kanata, became world-leading isotope producer; studies for the ING (Intense Neutron Generator) super-neutron source.

1970s: SLOWPOKE research reactor; Gentilly-1 boiling water reactor, Québec; Pickering A; CANDU 6 designed; Soviet COSMOS-954 crash; Bruce A; TRIUMF cyclotron operational; secure heavy water supply at Cape Breton and Bruce plants.

1980s: Tandem Accelerator Superconducting Cyclotron (TASCC); Canadian Nuclear Fuel Waste Management Program (CNFWMP) begins, including Underground Research Laboratory; Pickering accident, subsequent retube; Pickering B; Bruce B; first four CANDU 6 reactors built – New Brunswick, Argentina, Korea, Québec; Eldorado Nuclear privatized; formation of CANDU Owners Group (COG).

1990s: Darlington; Wolsong 2 – 4 built, Korea; Sudbury Neutrino Observatory (A. McDonald 2015 Nobel Prize in Physics); AECL radiochemical company privatized; formation of business incubators such as the Accelerator Business Unit and Bubble Technology; Cernavoda -1 CANDU 6 operational.

2000s: CANDU refurbishments; Canadian Light Source operational, Saskatoon; Cernavoda - 2 operational; privatization of AECL reactor design company; Mixed-oxide fuel research; Qinshan-1 and 2 CANDU 6, China.

2010s: Small Modular Reactor research; AECL research company privatized; Cigar Lake mine operation.

CANADIAN NUCLEAR HISTORY – BOOKS AND INTERNET RESOURCES

Given such a rich and broad history of Canadian nuclear science and technology, some books have appeared over the years, including:

W. Eggleston, *Canada's Nuclear Story*, Clarke, Irwin & Company Limited, 1965.

G. Sims, *A History of the Atomic Energy Control Board*, AECB INFO-0026, 1980.

R. Bothwell, *Eldorado: Canada's National Uranium Company*, University of Toronto Press, 1984.

R. Bothwell, *Nucleus: The history of Atomic Energy of Canada Limited*, University of Toronto Press, 1988.

R. Fawcett, *Nuclear Pursuits: The Scientific Biography of Wilfrid Bennett Lewis*, McGill-Queen's University Press, 1994.

D.G. Hurst (ed.), *Canada Enters the Nuclear Age: a technical history of Atomic Energy of Canada Limited as seen from its research laboratories*, McGill-Queen's University Press, 1997.

P. Litt, *Isotopes and Innovation: MDS Nordion's First Fifty Years, 1946 – 1996*, McGill-Queen's University Press, 2000.

K. Krenz, *Deep Waters: The Ottawa River and Canada's Nuclear Adventure*, McGill-Queen's University Press, 2004.

D. Bratt, *The Politics of CANDU Exports*, University of Toronto Press, 2006.

C. Saunders, *Whiteshell Laboratories: A Legacy to Nuclear Science and Engineering in Canada*, Pinawa Foundation, 2017.

With the rise of the internet over the past two decades, a huge number of nuclear history resources have arisen. Sites with significant amounts of Canadian nuclear history include:

1. The Canadian Nuclear Society cns-snc.ca/cns/history has a large number of historical and history documents including a *Canadian Nuclear Chronology*, the 1989 CNS Conference Special Symposium *50 Years of Nuclear Fission in Review*, George Lawrence's *Early Years of Nuclear Energy Research in Canada*, *On the Trail of Drum T-7*, and *An History of the WR-1 Reactor at Whiteshell Laboratories*, to name a few. Several historical articles have appeared in the CNS Bulletin (e.g., *The Eldorado Radium Silver Express*).
2. The CANTEACH project canteach.candu.org offers the reader a comprehensive set of documents related to the CANDU reactor, shared by partners such as the CANDU Owners Group, AECL, utilities and universities.
3. The Canadian Nuclear Safety Commission (CNSC) nuclearsafety.gc.ca has a Timeline of Presidents, focused on the history of nuclear safety in Canada.

CANADIAN NUCLEAR HISTORY - MUSEUMS

There are a few Canadian nuclear history displays across the country:

- The Rutherford Museum at McGill University, Montreal.
- The CNSC history display, including a model of an early CANDU, at its public entrance in Ottawa.
- NPD reactor artifacts and models at the Schoolhouse Museum in Laurentian Hills, Ontario.
- The Elliot Lake Nuclear and Mining Museum.
- The ZEEP reactor at the Canadian Museum of Science and Technology, Ottawa.
- The Co-60 beam therapy unit at the Western Development Museum in Saskatoon
- Bruce Power Visitors Centre in Tiverton, Ontario
- Ontario Power Generation Nuclear Information Centres at Pickering and Darlington stations

SOCIETY FOR THE PRESERVATION OF CANADA'S NUCLEAR HERITAGE

Given the breadth and depth of Canadian nuclear science and technology, not a great deal of its history is readily accessible to the public, despite the few books, web sites and displays mentioned earlier. Is there a better way to preserve and promote Canada's proud and significant nuclear heritage?

In 2015 an informal committee first met in Deep River, Ontario ("Home of Canada's Nuclear Pioneers") to explore the possibility of preserving some of the nation's nuclear history. Naturally, first thoughts were of the collections of artifacts in local basements and personal libraries, since so many people had been employed by Atomic Energy of Canada Limited and its successor Canadian Nuclear Laboratories. There were stories of households being downsized, with dumpsters of interesting historical tidbits ending up in the local landfill.

This was by no means the first attempt to create a nuclear museum – it was first proposed in the spring and summer of 1961. In March 1968 a committee was formed at Chalk River Nuclear Laboratories, with the support of AECL Vice-President Les Haywood, to create a historical artifact collection. In 1988 a consultant to the Town of Deep River recommended the development of "a nuclear museum and historical site". Finally, in 2014 the town of Deep River, AECL and the local chamber of commerce proposed establishing a museum. Unfortunately all these efforts fizzled, for various reasons. The 2015 committee wanted to avoid such an end!

A community meeting was held in the Fall of 2015; the level of support was good, and a group of eight to ten people began to meet monthly at the Canadian Clock Museum in Deep River. Governance documents were drafted and scrutinized, and enquiries made into the next steps, especially incorporation.

The first Meeting of Members of the Society took place on August 29, 2017, at which time the first board of directors was elected. The following day an application for federal incorporation was filed, and the Society for the Preservation of Canada's Nuclear Heritage Incorporated (SPCNHI) came into being on August 30. We had hoped for a snappier name, with a short acronym (e.g., CNHS - Canadian Nuclear Heritage Society), but Corporations Canada was concerned about the similarities to other organizations (CNS? CNSC?). However, we are also known as Nuclear Heritage. Following incorporation, the Society was also granted charitable status by the Canada Revenue Agency.

The purposes of the SPCNHI are:

- To collect, archive, preserve, and protect artifacts related to Canada's nuclear research and development history, and
- To carry out activities ancillary and incidental to the attainment of the above charitable purpose.

There were questions as to whether the Society should have formed under the umbrella of another organization, the Canadian Nuclear Society being one suggestion. Essentially, a separate organization with a single mandate is easier to run and can deal directly with the many stakeholders (e.g., individuals, Canadian Department of Heritage, AECL, Canadian Nuclear Laboratories, Ontario Power Generation, Bruce Power, New Brunswick Power, universities, CANDU Owners Group, municipalities, researchers, school children, etc.) An example is our two-year lease with AECL for the Interim Storage Facility in Deep River (Figure 1) – the Society could make such business and legal arrangements only after incorporation. In addition, incorporation allowed the Society to obtain charitable status, which is necessary for granting receipts for financial and artifact donations.

The Society currently has eight directors, who are co-authors of this paper; six are retirees from AECL / CNL, and two are employees of CNL. This current mix is admittedly Chalk River-centric, although two directors also spent several years at Whiteshell Laboratories in Manitoba; this board make-up was not intentional, just practical given the size of our country and limited resources. The directors come from a variety of employment backgrounds such as accelerator technology, archiving, reactor operations, waste management, and reactor safety. The Society membership is currently small, approximately 30, but some members live outside Ontario.

It is the intention of the SPCNHI to be national in scope, to reflect the diversity of nuclear development, technology and innovation in Canada, from mines to medicine to reactors. Much of the current collection reflects the research and development work of AECL and CNL, but major artifacts have been received from outside Ontario, including the console of the decommissioned University of Alberta SLOWPOKE (Figure 2).

During the first one and one half years of its existence, the SPCNHI has:

- Created Articles of Incorporation & By-Laws; become federally incorporated; obtained charitable status; contracted General Liability and Directors' & Officers' insurance.

- Leased AECL's 51 Poplar Street in Deep River as an interim storage facility, maintained by CNL. Society members have revitalized the garden and made the property more attractive.

- Collected furniture, storage shelving and cabinets; purchased a computer, and installed a security system

- Produced a five-year Strategic Plan and a five-year Business Plan

- Issued several procedures for managing artifacts and books. Received advice from a professional archivist, and from the Canada Revenue Agency.

- Collected over 260 artifacts, 450 books, and over 10 m of documents (Figures 3 to 10). Catalogued these items, including making indices of articles in *AECL Review* and its descendants.

- Established a website (www.nuclearheritage.ca) and virtual museum.

- Signed Memoranda of Understanding with a fundraising organization and with a design company.

- Made presentations to local municipality councils, clubs, the Canadian Nuclear Society; attended numerous local events with a display table; issued two newsletters; published articles in the North Renfrew Times and CNL Voyageur.

- Established formal points of contact with AECL and CNL. Visited Chalk River Laboratories several times to survey buildings to be demolished, and request items.

- Held an Open House in November 2018, hosting over 75 people. Tours are available by appointment.

- Received grant from the Deep River and District Community Foundation. Applications made for Canadian Museum of History and Ontario Trillium grants.

The future holds both promise and challenges, as this year the Society seeks a more permanent facility that can regularly open to the public. The timeline towards a national Nuclear Heritage Museum is outlined as follows, from the Society's Five year Business Plan:

2019 Permanent building decided; plans in place to move (if necessary) by end of year; contingency plan executed if permanent museum found not possible. Operations established in permanent building; visits begin

2020 Sustainable routine operations well-established; regular education activities begin

2021 Innovations introduced (e.g., video showings, online presentations)

2022 Museum fully operational and sustainable

Canada has a long, rich and productive history of nuclear research, engineering, resource development and technical accomplishment, covering the entire broad span of nuclear science. The Society for the Preservation of Canada's Nuclear Heritage purpose is to collect, preserve, archive and display some of that history – not only to celebrate past accomplishments, but also to herald the ongoing story.

REFERENCES

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3. J.L. LeConte, *On Coracite, a New Ore of Uranium*, The American Journal of Science and Arts, Vol. III, Article XIX, pp 173 – 175, May 1847,
4. *'49 Uranium Rush*, Popular Mechanics, February 1949, Vol. 91, No. 2, pp 89.
5. J. Campbell, *Rutherford: Scientist Supreme*, AAS Publications, New Zealand, 1999.
6. Rutherford Museum, McGill University, www.physics.mcgill.ca/museum/rutherford_museum.htm
7. W. Eggleston, *Canada's Nuclear Story*, Clarke, Irwin & Company Limited, 1965.

Figure 1: The SPCNHI Interim Storage Facility in Deep River, owned by AECL and formerly a day care and before that a laboratory. SPCNHI logo created by J. Whitlock.

Figure 2: The console from the University of Alberta SLOWPOKE reactor.

Figure 3: Some of the artifact collection.

Figure 4: A portion of the book and document collection. The red volumes are W.B. Lewis' bound copies of AECL public domain papers.

Figure 5: ZED-2 model given as a retirement gift

Figure 6: Precision analytical balance from AECL

Figure 7: Datatron Computer Console – CRNL's first Electronic Computer

Figure 8: Datatron rescue crew

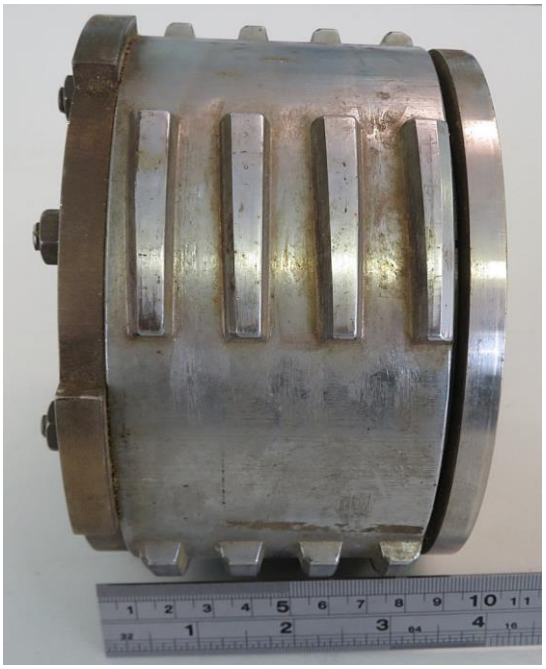

Figure 9: NPD end fitting plug

Figure 10: W.B. Lewis hood from U. Victoria, 1975