50 Years of Nuclear-Electric Power in Canada: The Privilege of Serving as a Public Servant of Canada - Challenges and Opportunities

Jon Jennekens

July 27, 2012 - Speech by Jon Jennekens

Preamble

Knowledge > Rationality > Understanding > Wisdom

Introduction

The invitation by the Canadian Nuclear Safety Commission for me to make a presentation to the staff of the Commission and its invited guests in the context of the 50th anniversary of nuclear-electric power in Canada was compelling. After 25 years of service with the Atomic Energy Control Board, the precursor of the CNSC, how could I decline?

Clare Cattrysse of the CNSC was aware that I had been invited by the University of Ontario Institute of Technology branch of the Canadian Nuclear Society to participate in a seminar at the UOIT earlier this year in celebration of the start-up of the NPD Generating Station of Ontario Hydro on April 11, 1962 and its connection to the Ontario power grid on June 4, 1962. I will endeavour to minimize repetition of the remarks that I made at UOIT on March 21, 2012.

I must hasten to note that the UOIT is a very impressive institution of higher learning and in my view its nuclear engineering and science program is a vitally essential component of the engineering and science programs conducted by Canadian universities and colleges which must

continue if Canada is to maintain its current internationally recognized status arising from its nuclear research and applied science contributions to the World Community.

In beginning my March 21, 2012 presentation at UOIT (which I entitled "Persons Who Persevered") I stated that the design, manufacturing, construction and commissioning of the NPD Generating Station was an outstanding example of how hundreds of Canadian companies working under the combined leadership of AECL, Canadian General Electric and Ontario Hydro demonstrated by scientific and engineering ingenuity, determination, drive, close cooperation and mutual understanding and respect the inherent characteristics and abilities of Canadians.

My purpose was to recognize and to pay tribute to the thousands of men and women who contributed to the success of NPD.

I also wished to name two persons among the many whose contributions to NPD and to Canada's nuclear research and development programs may not have received the accolades of those of brighter plumage. I named:

1. John Wesley (Jack) Beaver, an Ojibwa Indian, a descendent of generations of Chiefs of a Mississauga Band that moved from the Bay of Quinte in 1837 to 3,000 acres of land south of Rice Lake. In 1939, having graduated from high school in Campbellford, Ontario at 19, and married shortly thereafter, Jack was recruited by a Royal Air Force team that was visiting Canada in search of young volunteers. Jack "signed up", soon qualified as a pilot and flew Spitfires during the Battle of Britain. He was shot down by ground fire on D-Day plus 1 and invalided home. Jack graduated from Queens with a B.Sc. (electrical) in 1949 and was awarded the University's middleweight boxing title. I met Jack at NPD in February 1962 and he quickly became one of my many mentors. Jack enjoyed a very successful career at Ontario Hydro, went on to become the General Manager of Engineering and then President of the 5,400 MWe Churchill Falls Project in Newfoundland and Labrador, a senior adviser to the Government of Canada on First Nations issues and, after a brief retirement, AECL Vice -President (Korea).
2. Bertrand Goldschmidt, a 21-year old chemist, was engaged as a personal assistant to Marie Curie in 1933. Madam Curie inspired Goldschmidt to pursue his academic studies after working under her supervision for one year {"Vous serez mon esclave pendant un an. Ensuite, vous commencerez une thèse sous ma direction."}. Unfortunately, Madam Curie died in 1934. However, Goldschmidt persevered and was granted a Ph. D. In 1940, he escaped from Vichy France to the United States. In 1941, he was invited by Drs. Enrico Fermi and Leo Szilard to join them at Columbia University where he undertook to solve the problems of producing very pure uranium. I met Dr. Goldschmidt in 1966 at a meeting of the Board of Governors of the IAEA. Although he was very much my senior we became friends and I quickly learned about his involvement at the Montreal Laboratory, Chalk River and about his Canadian-born wife. Persons who are interested in the nuclear subset of geopolitics would enjoy reading Bertrand's 1980 "Le Complexe Atomique" (ISBN 2-213-00773-X) / "The Atomic Complex" (ISBN 0-89448-550-4). By 1968 - 69, when I served as a member of the IAEA's Safeguards Consultants Group, Bertrand had become a friend and another of my many mentors.

As indicated earlier, there are innumerable persons who have made countless contributions to Canada's nuclear-electric power program and equally, innumerable others who have enabled Canadians to benefit personally and who have helped hundreds of thousands of citizens of other countries to enjoy the benefits of the myriad collateral applications of nuclear science and engineering particularly nuclear medicine diagnostic and therapeutic procedures.

Privilege

There are many definitions of the word privilege. I prefer to use the word in the sense that in the Canadian context:

"privilege" refers to the rights enjoyed by the citizens of Canada because we are constitutionally governed... we enjoy the privileges of a free people.

During my 25 years with the Atomic Energy Control Board, I always felt that it was my privilege to serve my fellow Canadians and I sincerely believe that with very few exceptions my associates held the same belief.

Today, I am confident that the staff members of the CNSC are equally motivated to serve Canada in the best interest of all Canadians.

Over the years, the annual reports of the Auditor General have provided clear evidence that the vast majority of Canada's Public Servants are well motivated, industrious, understand the meaning of due diligence and that they display the many other personal characteristics expected of them by the Canadian public.

Certainly, there have been exceptions. An example of such exceptions is recorded in the Auditor General's Report for 2003 which led to the establishment of the Inquiry chaired by Mr. Justice John Howard Gomery. However, the number of these exceptions in a workforce that numbers more than 450,000 (Federal departments, agencies, parliamentary officers and administrators, the Canadian Forces, the RCMP and federal business enterprises) is relatively insignificant albeit of sufficient importance to necessitate corrective action.

Happily, the CNSC and therefore its staff members, continue to receive "good press". Congratulations and well done.... indeed, very well done.

Change - 1867 to 2012

A very meaningful and forever applicable truism was stated by Prime Minister Benjamin Disraeli in 1867:

"Change is inevitable. Change is constant."

1867 marked a very important change in the lives of Canadians resulting from the Royal proclamation of the British North America Act (the BNA Act).

Quite probably, only those primary and secondary school teachers, their university colleagues and their respective students, a number of "history buffs", many older Canadians reflecting upon their citizenship and those Canadians professionally or politically involved in constitutional law matters are aware that the Royal Proclamation of 1763, the Québec Act of 1774, the Constitutional Act of 1791 and the Act of Union of 1840 which preceded the BNA Act are all constitutional Acts of Canada.

How many Canadians realize that the Magna Carta of 1215 was the precursor of all of the former?

In 1931, the Statute of Westminister recognized the Independence of Canada. The Canada Act of 1982 and the Constitution Act of 1992 brought about the patriation of Canada's Constitution and gave Canadians a Charter of Rights and Freedoms.

These were very significant events and they prompted very significant changes in the lives of Canadians.

Flash forward from 1867 to 1946.

President Harry Truman signed into law the United States Atomic Energy Act on August 1, 1946. Thirty days later, the Atomic Energy Control Act of Canada was promulgated. Clearly, the United States and Canada were working together very closely.

Further evidence of this close cooperation is the fact that the NRX research reactor achieved initial criticality on July 22, 1947 only three years after the tripartite decision to build it. Except for those directly involved, little was known at the time and perhaps even today about the role that Pile-3 (CP-3) at the Argonne National Laboratory served as a forerunner to NRX. CP-3 was the first natural uranium fuelled, heavy water moderated reactor. It operated at power levels of up to 300 kilowatts from 1944 to 1954.

On September 26, 1946 General-Dr. Andrew George Latta McNaughton was appointed as the first president of the Atomic Energy Control Board. Nine Canadians succeeded him as president of the AECB / CNSC. I have known all nine, albeit to varying extents. From 1962 to 1978, I reported, in turn, to Drs Laurence, Hurst and Prince. They were instrumental in preparing me for my 1978 to 1987 tenure as president.

During my 8 years and 4 months as president of the AECB, I reported to:

- The Honourable Alistair William Gillespie
- The Right Honourable Ramon John Hnatyshyn
- The Honourable Marc Lalonde
- The Right Honourable Jean Chrétien
- The Honourable Gerald Regan
- The Honourable Patricia Carney
- The Honourable Marcel Masse

In my first year as president, Mr. Gillespie helped me to understand the "machinery of government". He was particularly supportive. His 2009 book "Made in Canada - A Businessman's Adventures in Politics" is very illuminating and perceptive.

Failures at Research and Power Reactors

In the Preamble to this presentation I entered four words:

knowledge >> rationality >> understanding >> wisdom.

My intent was to provide an entry for expressing a few thoughts about what are widely referred to as "reactor accidents". For my part NRX (1952), EBR - 1 (1955), Windscale 1 (1957), SL- 1 (1961), TMI - 2 (1979) and Chernobyl - 4 (1986) were not accidents. They occurred because of human error, in other words human failures.

In certain respects the term accident is a euphemism for failure and my preference is to use the latter term.

However, the term accident is used in many contexts and it has been used almost exclusively in the nuclear field whether to describe "criticality accidents", "design basis accidents", "reactor accidents" or other unfortunate actual or postulated events.

The Wikipedia definition of accident or mishap appears to be appropriate:

"An unforeseen and unplanned event or circumstance, often with lack of intention or necessity. It usually implies a generally negative outcome which may have been avoided or prevented had circumstances leading up to the accident been recognized and acted upon, prior to its occurrence."

To discuss the quite challenging subject of failures at research and power reactors, actual or postulated, without providing some background information on developments in the United States during the 1940s and 1950s seems to me to be unwise. The U.S. Atomic Energy Act of 1946 established the Congressional Joint Committee on Atomic Energy comprised of members of the Senate and the House of Representatives (nine from each). It was tasked with exclusive jurisdiction over "all bills, resolutions and other matters" related to civilian and military aspects of nuclear power. It was abolished in 1977.

During its 31 year reign, the "Joint Committee", as it came to be known, was often described as one of the most powerful congressional committees in U.S. history. Indeed it was, perhaps because it was the only permanent joint committee of Congress to exercise legislative authority acting as a co-decision maker with the Executive Branch of the Government.

In 1947, President Truman decided that advisory committees should be established to provide his Administration with much needed scientific and broad technical advice on the governance of its nuclear science and engineering programs. Thus, the Reactor Safeguards Committee and the Industrial Committee on Reactor Location were created.

Six years later, in a July 23, 1953 letter to Congressman Sterling Cole, Dr. Edward Teller (known colloquially as "the father of the hydrogen bomb") recommended that:

" ... a advisory committee should be set up to review planned reactors and supervise functioning reactors under the control of private enterprise. Instead of setting up a new committee, the present Advisory Committee on Reactor Safeguards of the Atomic Energy Commission might serve this purpose."

Congressman Sterling Cole, a lawyer, served as Vice-Chairman of the Joint Committee during its 1947-48 term, as a Member from 1949 to 1953 and as Chairman during 1953-54. He was elected as the first Director General of the IAEA in 1957 and served until 1961 when Dr. Sigvaard Eklund began his 20-year tenure.

Meanwhile, in Canada, in response to an application by McMaster University to install a 5 MWt, pool-type, research and teaching reactor at its property in the City of Hamilton, the Reactor Safety Advisory Committee of the AECB was established by President C. J. Mackenzie in 1956.

The McMaster Nuclear Reactor (MNR) was designed and manufactured by a long established company (1900) in the United States, American Machine and Foundry.

Dozens of these reactors were installed at universities throughout the United States and several world-wide including Iran and Pakistan. Their highly enriched uranium fuel elements provided sufficient positive reactivity to permit the installation of several in-core (negative reactivity) irradiation facilities.

Dr. Mackenzie wisely decided that his part-time colleagues who comprised the majority (4 : 1) membership of the Board, would benefit by receiving the advice of an independent, multi-disciplinary advisory committee. He asked his longtime friend Dr. George Craig Laurence to serve as Chairman of the Committee.

As Chairman of the RSAC, Dr. Laurence drafted a number of "papers" that he presented at international conferences organized after the 1955 Geneva Conference on "The Peaceful Uses of Atomic Energy" following President Eisenhower's declaration of the U.S. "Atoms for Peace Program". Dr. Laurence's papers drew upon the advice of many of his associates but principally Dr. Wilfrid Bennett Lewis, Dr Donald Hurst and Dr. Ernest Siddall.

In 2012, Dr. Laurence's papers would be termed "Draft Regulations" and published for public comment.

Perhaps three of the most important principles outlined in Dr. Laurence's papers were:

1. ensuring that the design and operation of nuclear facilities, whether in the field of nuclear medicine or electricity generation, address the reality of "cross-linked faults";
2. the ultimate responsibility for the overall occupational and public safety aspects arising from the operation of nuclear facilities rests with the operator; and

3. redundancy, as exemplified by the triplication of "control" channels in the process and special safety systems of CANDU nuclear-electric power stations, is the sine qua non of availability, reliability and testability.

These three principles and the many others that were documented by the AECB, Ontario Hydro, Hydro Québec, NB Power, the CNA and the CSA as Canada's nuclear-electric power program evolved remain valid today.

The massive earthquake that occurred under the Pacific Ocean off the North-East coast of Japan on March 11, 2011 and the resulting tsunami continue to be the subject of world-wide consternation and debate. The CNSC's prompt response, its Fukushima Task Force Report, its immediate regulatory actions and its Fukushima Omnibus Amendment Project are indicative of the comprehensive efforts made by the Commission to examine the information provided by Japanese authorities and also that reported by the IAEA and national nuclear regulatory agencies and to pursue the incorporation of its findings into its ongoing regulatory programs.

In another context, that of informing the general public, once again much of the international media's reportage was unhelpful and alarmist. Quite clearly much of the reportage had not been edited by technically competent persons. One example was that of the mistaken report of a "tidal wave of more than 14.2 metres in height".

It was not a single wave.

The tsunami caused a rapid rise in sea level in proximity to the ten units at Fukushima-Daichi. The rise was estimated to have reached a peak of more than 14.2 metres.

The March 11, 2011 tragedy reinforced the reality of the importance of what Dr. Laurence termed "cross-linked faults". In the U.S. they were initially termed "common cause failures", and elsewhere, "common mode failures". Unless carefully analyzed and both design and operating defences incorporated to protect against them, these potential faults / failures constitute a generic weak link in the chain of nuclear safety systems and operating procedures.

The Fukushima-Daiichi disaster is illustrative. All thermal-electric generating stations have switchyards with the main and station service transformers and standby power units located closely adjacent. Some standby power units are located in carefully designed, protective buildings. In the case of hydro-electric stations, the design requirements for standby power systems are less demanding and therefore simpler, occupational safety being the primary concern.

The Fukushima-Daiichi standby power systems were the weak link.

The Fallacy of the Linear No Threshold Hypothesis

In 1989, the IAEA published an updated version of a pamphlet entitled "Facts About Low-Level Radiation" that very comprehensively summarized information then available about the origins of radiation protection. It traced the 1928 formation of the International X-ray and Radium Protection Committee (the forerunner of the International Commission on Radiological Protection), the findings of the Atomic Bomb Casualty Commission, 1946-75, (later the Radiation Effects Research Foundation of Japan), the 1955 decision by the UN General Assembly to establish the UN Scientific Committee on the Effects of Atomic Radiation and the reports of several national advisory organizations particularly those in the United Kingdom and the United States.

The pamphlet dwelt at length on such subjects as uncertainty about the effects of exposure to radiation at low dose and dose rate and what it termed "the low-level radiation controversy. It states, "...(this uncertainty) is because effects, if they exist at all, are masked by the ‘normal occurrence' of disorders which may or may not be due to radiation exposure".

In 2009, a paper by Dr. Jerry Cuttler, Cuttler Associates, Mississauga, Ontario, and Dr. Myron Pollycove, School of Medicine, University of California, San Francisco, was published in the proceedings of the International Dose Response Society. It is entitled "Nuclear Energy and Health - And the Benefits of Low-Dose Radiation Hormesis". The following is an excerpt from the preface of the paper:

"... Studies of actual health effects, especially thyroid cancers, following exposures are assessed. Radiation hormesis is explained, pointing out that beneficial effects are expected following a low dose or dose rate because protective responses against stresses are stimulated. The notions that no amount of radiation is small enough to be harmless and that a nuclear accident could kill hundreds of thousands are challenged in light of experience: more than a century with radiation and six decades with reactors."

The LNT hypothesis was used by USSR authorities who initially predicted that there would be about 4,000 excess cancer deaths as a result of the Chernobyl accident and ordered that all persons living within a 30 km Exclusion Zone around the plant be evacuated. Later, at an IAEA meeting in Vienna on August 25, 1986, the Soviet Delegation tabled a revised estimate showing that about 200 of the 135,000 who were evacuated would die of cancer as a result of the accident or about 1% of the 17,000 people who would die of cancer from other causes. In the ongoing discussions, the Soviet representatives conceded that their modeling of the estimates of internal exposure via the food chain could be ten times too high.

What has not been documented is how many of the citizens of Belarus and Ukraine have suffered various health effects as a result of being uprooted from their homes, their farms, their places of work, their towns and villages and their churches. From June 24-28, 2012, the American Nuclear Society held its Annual Meeting in Chicago. One of the sessions, "The President's Special Session on Low Level Radiation and its Implications for Fukushima Recovery" attracted wide attendance.

One of the participants, Dr. Wade Allison, Emeritus Professor of Physics, Oxford University, presented a paper entitled "A Tragedy of Misunderstanding: There was No Major Radiation Disaster at Fukushima".

Another participant, Mr. Kazuaki Matsui, Executive Director, Institute of Applied Energy, Japan, stated that "... The earthquake and tsunami on March 11, 2011, left 25,000 dead, injured or missing. In contrast, there was 'probably minimal or no health effect' from radiation from the damaged reactors. However, the ensuing evacuation disrupted more than 150,000 lives and has led to 13 suicides, along with 50 deaths of elderly evacuees. The prevalent widespread radiophobia has led to grotesque overreactions." Dr. Jerry Cuttler also attended the ANS Annual Meeting. As recorded in the ANS Nuclear Cafe posted on July 11, 2012, he summarized the results of his analysis of a number of careful investigations as follows:

1. Organisms have powerful defenses developed to survive.
2. Low radiation doses stimulate defenses.
3. High doses inhibit defenses.
4. Fukushima's radiation levels are comparable to high natural background areas.
5. The Radiation protection standard in the 1920s was a safe tolerance dose 680 mSv / yr (68 cGy / yr).
6. Based on human data:
    1. A single whole body exposure of 12 cGy is safe.
    2. Continuous exposure (amounting to) 70 cGy is safe.
    3. Both of these exposure rates are also beneficial.
7. Radioiodine is not a significant cause of cancer.
8. Total body low dose therapy can prevent cancers and eliminate metastases.
9. Spontaneous DNA damage rate is more than 6 million times higher than 1 mSv / y DNA damage rate.

Following from his conclusions, Dr. Cuttler stated a number of recommendations including:

1. Stop calculating nuclear safety cancer risk.
2. Stop regulating harmless radiation sources.
3. Develop public communication programs and inform every (interested) person.
4. Raise the level for evacuation from 2 to 100cGy / yr.

In its June 14, 2012 Presidential Task Force Report on Response to Japan Nuclear Power Events entitled "Forging a New Nuclear Safety Construct" the ASME stated in section 1.4 - The Accident's Outcome:

"The public health outcome of the Fukushima Dai-Ichi nuclear accident, from a radiological protection perspective, resulted in no prompt fatalities and the continuing expectation of no significant delayed radiological public health effects."

Challenge for the Canadian Nuclear Safety Commission

Undertake a careful study of the extensive information available internationally on the subject of Low-Dose Radiation Hormesis and publish the findings.

In consultation with Health Canada and others, pursue discussions with the IAEA with a view to establishing an international initiative to revise existing radiation dose limits for both occupational workers and members of the public.