



Oral presentation

Submission from the Society of Professional Engineers and Associates

In the Matter of the

Canadian Nuclear Laboratories

Application for the renewal of the Nuclear
Research and Test Establishment Operating
Licence for the Chalk River Laboratories

Commission Public Hearing

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À l'égard des

Les Laboratoires Nucléaires Canadiens

Demande de renouvellement du permis
d'exploitation d'établissement de recherche
et d'essais nucléaires pour les Laboratoires
de Chalk River

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Comments regarding the proposed renewal of the nuclear research and test establishment operating licence for the Chalk River Laboratories, with a proposed expiry date of April 1, 2028

The Society of Professional Engineers and Associates (SPEA), established in 1974, represents Engineers, Scientists, Technologists, Technicians and Designers in the employ of Candu Energy and SNC Lavalin Nuclear Corporation working in, and on secondment from, their Mississauga, Ontario-based sites. Prior to the 2011 sale to SNC Lavalin, most of SPEA's members worked for the engineering division of Atomic Energy of Canada (AECL), known within AECL as, simply, the "Engineering Company" or "CANDU Ops." For decades many of SPEA's members worked in close cooperation with their counterparts at Chalk River Laboratories (CRL) in product development and problem solving regarding operation and design issues associated with the CANDU reactor. Indeed, it was not unusual for engineers or scientists at CRL to report to section heads and managers in Sheridan Park, Mississauga and vice versa. Hence SPEA members have a unique perspective regarding the value and importance of CRL as it pertains to CANDU technology.

CRL had its origins in the Manhattan Project during the Second World War. Cooperation between British, Canadian and American scientists was established in 1942, which led to the decision to build a heavy water moderated reactor in Chalk River for the purposes of Plutonium extraction. Thus, in 1944 the Chalk River site was born and that reactor, the Zero Energy Experimental Pile (ZEEP), went into operation in 1945. We mention this history because many of the buildings at the CRL site were built at this time; so-called "World War 2 temporary structures." Quite a number of these are still standing and the first radioactive waste disposal sites were also first established in the 1940s. In the subsequent 15 years, after ZEEP went critical, most of the legacy nuclear facilities were established and are either in current operation or in some state of decommissioning or have been "mothballed." In its early history the hazards of nuclear radiation, at least when it comes to storage and disposal, were not well appreciated. Perhaps unwittingly, Canada's nuclear pioneers built a site (CRL) that could not be walked away from if its other uses were deemed to be unnecessary in the future. On the positive side, this has ensured that the communities that have historically relied on CRL for employment should not become ghost towns, like many other places in rural Canada have become. On the negative side there is a legacy waste issue that requires significant attention and investment to contain and remediate.

Anyone familiar with the CRL site over the years is also acutely aware that it has suffered from insufficient funding to deal with its important role in maintaining CANDU expertise or its legacy

waste obligations, particularly since 1985, when the infamous¹ “Mulroney mini-budget” slashed AECL funding in half. In the subsequent two years approximately 800 of the 2300 staff at Chalk River were laid off or left voluntarily. There was a tremendous loss of intellectual capital around this time. Almost all of the scientists whose programs were cut, were quickly snapped up by universities in Canada, the USA and Britain as well as US government labs. CRL had a good reputation as, essentially, a government laboratory doing R&D in a wide range of subjects, some only loosely related to the nuclear industry. While it’s original raison d’être was CANDU reactor design and support, much of the work produced was also published in the open scientific literature.

Following the 1985 budget cuts, funding very slowly increased and the focus of the work performed at CRL became much more applied towards the CANDU product. Fortunately for Canada and the CANDU industry many outstanding technical people remained at CRL after 1985 and they were still able to recruit good people as well. More importantly, the critical technical knowledge required to support the CANDU product remained.

SPEA highlights this aspect of CRL’s role because, under the mandate through which the laboratory’s operations were privatized, the new management consortium, the Canadian National Energy Alliance (CNEA), is required to:

1. Address nuclear legacy and historic waste liabilities.
2. Provide nuclear S&T capabilities and services to federal government departments.
3. Support the nuclear industry’s needs for in-depth nuclear research and development, and for test and evaluation expertise.

While all three of these mandates are important to the Canadian people, the third one is of particular importance to SPEA members and to those operating CANDU nuclear power plants in Canada and, by extension, those that rely on electricity from these plants – almost all Ontarians for example.

Design of a nuclear reactor, and the support of safe operation, requires significant depth of knowledge in almost all scientific and engineering disciplines: Physics, chemistry, biology, environmental and computer science, civil engineering, mechanical engineering, electrical engineering and many others. Fortunately for the industry much of this knowledge has historically resided in Chalk River. The CANDU reactor design was a joint effort between Ontario Hydro (now OPG), Canadian General Electric and Atomic Energy of Canada. Over time, however, General Electric and Ontario Hydro disbanded their design divisions and most of their R&D capability, secure in the belief that this would be maintained by the Federal Government through AECL.

¹ Infamous at least in Chalk River and the surrounding area

The Canadian nuclear industry has relied heavily on AECL to solve critical destiny issues associated with the reactor design. For example, the Pickering A and Bruce A reactors were consistently among the best performing nuclear reactors in the world through the 1970s and early 1980s with capacity factors far exceeding those of other designs, due in large part to the ability to refuel on line. However, in 1983 Pickering A, Unit 2 suffered a loss of coolant accident (LOCA); known in the industry as the P2 G16 incident. While there was no loss of life, or even radiation exposure, due to the incident, it shook the CANDU industry to its core. Unlike its light water counterparts, the CANDU pressure vessel is multiplexed into hundreds of pressure tubes, all of which are monitored for leakage using an annulus gas detection system that was supposed to detect a “leak before break.” This would give ample time, during an extended outage, to replace any problem pressure tubes. But clearly, the expected leak before break did not happen for Pickering A unit 2 channel G16.

After this LOCA, AECL virtually “dropped all tools” and directed nearly the entire technical staff at CRL to solve this problem. If the root cause had not been identified and a solution found, it would likely have resulted in the closure of all CANDU plants in Canada and around the world. Without going into too much technical detail, the problem was solved and it turned out to be one with many causes and influencing factors, ranging from mechanical (garter spring movement) to chemical (hydrogen ingress) and material selection. Indeed, the latter was foreseen in a sense, when an AECL expert² at Chalk River recommended that the pressure tubes in Pickering B and Bruce A and B be made out of a different zirconium alloy than the ones at Pickering A— an alloy that survived better when subjected to hydrogen ingress. This same alloy, Zr-2.5Nb was used in all CANDU 6s and all subsequent Ontario Hydro reactors as well.

Tools to measure hydrogen ingress and a surveillance regime to support fitness for service of pressure tubes were all developed at AECL Chalk River following this incident.

However, the industry has faced other emergencies and destiny technical issues in the more recent past as well. In December of 1990 there were fuel failures in Darlington Unit 2 (channel N12). This was the first Darlington reactor to be commissioned and it had to be shut down and the commissioning of the other units put on hold. The fuel manufacturer was blamed. This was a huge issue since the Darlington reactors were new, were already well over budget, and an unknown problem delaying commissioning was not needed by Ontario Hydro. Again there was a great deal effort at Chalk River to get to the bottom of the issue and eventually the problem was solved, in good measure by Chalk River (and Whiteshell) staff demonstrating that there was nothing wrong with the fuel (it was a vibration issue having to do with a design change made to the PHT pumps by Ontario Hydro).

Again in the mid-1990s it was discovered the outlet feeders in the CANDU 6 reactor in at Pt. Lepreau, New Brunswick, were thinning much faster than expected. Subsequent measurements in other CANDU reactors, both CANDU 6s and those built by Ontario Hydro, showed that this problem was generic, though there were different rates of thinning in different reactors. Needless to say this was a big problem. Pressure tube ageing and elongation were supposed to

² Dr. Windsor Evans at AECL Chalk River

limit the lifetime of a CANDU reactor, not other factors, and some feeder pipes were going to reach end of life well before the pressure tubes. Again, there was a great deal of effort directed at this by Chalk River from many different departments, since the cause was not known. Again the effort was successful and flow accelerated corrosion (FAC) was identified as the mechanism that was causing the premature ageing. The solution was a combination of a materials changes to feeder materials (for new installations) and changes to some of the chemistry specifications for normal operating conditions, in order to slow down the rate of corrosion. Again the solution was found largely thanks to CANDU experts at CRL.

If the CANDU reactor were an automobile then the CRL site has been the “CANDU garage” that you take it to when it needs to be fixed. And as CANDU reactors go through life extension far beyond their original design life, it would be naïve to assume that all things that could go wrong have already gone wrong.

We highlight these past successes for a number of reasons:

1. When there have been emergency issues associated with CANDU reactor operation in the past, AECL made their resolution a number 1 priority. This was because the CANDU brand was the most important thing for the designer of CANDU reactors. It was also good for the Canadian public that CANDU experts were available at CRL to solve these problems. Having this dedicated expertise in place, capable of providing comprehensive solutions to complex problems also gave the regulator confidence that CANDU reactors were designed with sufficient margin and capable of operating safely.
2. Under private sector management, the primary focus of R&D will naturally be to turn the intellectual property at CRL into profits for the corporations in the ownership consortium. This is a different paradigm for CRL. To be sure, there have been successful commercial businesses developed and spun off from CRL over the years but it was never the number one priority. So it will be a challenge for the CNEA consortium to balance its legitimate business needs with a mandate that historically belonged to the government of Canada and was not a “for profit” mandate. [MD1]
3. We are gratified to see renewed investment at the CRL site, and into repair and possible replacement of critical facilities such as the hot cells, used for Post Irradiation Examination (PIE). It is stated that there will be a new Advanced Nuclear Materials Research Centre that will combine the capabilities of Universal Cells, (Building 234), Fuels and Materials Hot Cells (Building 375), Recycle Fuel Fabrication Laboratories, the metallographic laboratories (Buildings 300, 375 and 380) and the NRU reactor rod bays into a modern shielded facility and laboratory research complex. We certainly hope that this is the case.

We do want to point out, however, that there is much more money to be made doing PIE of LWR fuel than CANDU fuel, simply because there are many more LWR reactors in the world. South of the border there are approximately 100 of them. Most facilities for doing PIE in the United States are also very old so it is quite likely that new facilities in

CRL would be welcomed by the LWR community and potentially be a major money maker for CRL. However, hot cells designed for LWR fuel are different than those designed for CANDU fuel. We note that in the description of this facility (page 7 of the Submission by CNL – 3rd bullet) it appears that hot cells to deal with LWR fuel are envisioned. We do want to make sure that CANDU reactor needs are also a high priority when it comes to hot cell replacement.

Currently the state of Bldg. 234 and 375 cells is not good (especially metallographic capability in 375, which has very low throughput because of the leaking liquid waste disposal system). In addition, reduction in the Iodine limits is crippling to response times. Storage of components is now limited to NRU bays, since the closure of NRX³. In the past the AECL management response was always that AECL could not afford to have these facilities in *tip-top* shape anymore and the industry should pay for that type of response capability if they want it. Indeed, this is the US utility model. But there is a hole in the capability of CRL in this respect, one that the federal government felt an obligation to fill in the past. We are gratified to see that the CNEA consortium appears willing to make the huge capital investment required to build new PIE capability but caution that in Canada, they must be designed to deal with CANDU fuel. Certainly not having these facilities replaced represents a licensing risk, not for the CRL site, but for operating CANDU stations.

4. Our major concern, however, is one that is likely outside the scope of this licensing process but one that SPEA feels should be identified. Many of the tools in the “CANDU garage” may be broken, facility wise, but a greater threat to the industry and the public is that without an operating nuclear research reactor you cannot have the next generation of many critical CANDU experts with the breadth and depth of experience required. Most CANDU experts cannot be hired off the street. Rather they must be grown and matured from within the CANDU community. A reactor, and neutron source, of sufficient size that CANDU type fuel and materials testing in experimentally significant numbers can be done, is the basis for exposing the next generation to the CANDU world. You can then have those experts to call on when needed. You don’t become a CANDU expert simply by reading literature. You learn by doing, by seeing and by being part of and involved in the continued R and D environment, at the centre of which is functional research reactor, similar to NRU.

To be fair, AECL and Chalk River is not the only place that one finds CANDU reactor expertise. All operating stations have operations expertise and internal safety analysis and licensing capability. There are smaller nuclear companies, for example, Kinectrics, Nuclear Safety Solutions and CANDESCO, that have very strong expertise in niche areas – better than CRLs. Candu Energy/SNC Lavalin Nuclear, the successor company to AECL’s engineering company, is a large company that has a great deal of expertise in many areas, though it has historically been involved in design and construction of new reactors and maintenance of operating reactors. So there has been some devolution of

³ This is because the NRX bays were leaking.

CANDU expertise over the years. But CRL has the greater breadth and depth of CANDU expertise in most areas.

We realize that a reactor the equivalent of NRU is a huge capital investment, and not one that the CNEA management consortium can make. But we feel that it is essential to a viable nuclear industry in Canada and is a worthy subject for investment by the Federal Government. The Harper government was not interested in renewing the commitment to the Canadian nuclear industry that was begun under a liberal government and strongly supported by all subsequent ones. Canada is soon to become unique in that after the spring of 2018 it will be the only country in the civilian reactor design and construction business without a nuclear research reactor. And that presents a future licensing risk for all CANDU reactors, not to mention a financial risk to CANDU operators, since timely answers to critical questions will not be easy to get if one has to rely on results from research reactors in other countries, whose number one priority is not CANDU.

Summary

SPEA members were part of AECL⁴ for 37 years, the same company that owned and operated CRL. We are acutely aware of the synergies between R&D, design and operation of CANDU reactors. Our members have routinely visited CRL and been seconded there for extended periods. We have seen the impact of decades of underfunding on the physical site itself and on its capabilities. In this respect we are gratified to see the renewed investment in the Chalk River site. One sees an immediate difference simply by entering the site today.

The decommissioning of old WWII temporary structures, where many radioactive facilities built in the 1950s are still located, and where many people work and have offices, is long overdue and we welcome the activity that the CNEA management consortium is doing along these lines.

The storage and remediation of nuclear effluent, both current and historic is a very necessary and important activity. Based on what we have read, and seen, this work is proceeding in a positive direction, though the amount of work left to do is immense and will take decades.

As an organization that consists of technical experts who design CANDU nuclear reactors and play a key role in their construction, maintenance and refurbishment, SPEA recognizes the key role that CRL plays in the CANDU industry. The CNEA mandate to “support the nuclear industry’s needs for in-depth nuclear research and development, and for test and evaluation expertise” is one that used to belong to AECL and, by extension, the federal government. The challenge for the regulator, as the guardian of nuclear safety for the CRL site and other nuclear installations in Canada, is to ensure

⁴ We note that AECL is still the owner of CRL, though not the operator, and those employees at the CRL site are no longer employees of AECL.

that this critical mandate is respected within the “profit motive” principle under which a private sector management will operate. If this mandate is not an utmost priority it represents a licensing risk for operating CANDU stations.