Planning for the Day when nuclear is suddenly unsafe: *. . . are we paying enough attention?*

a report
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on behalf of the
Canadian Coalition for Nuclear Responsibility

for use during the
Canadian Nuclear Safety Commission
public hearings May 11-12, 2022

on the re-licensing of the
Point Lepreau Nuclear Generating Station
owned by the New Brunswick Power Corporation

March 28, 2022

To: Canadian Nuclear Safety Commission
From: Canadian Coalition for Nuclear Responsibility
Date: March 28 2022
Re: PLNGS Licence

The Canadian Coalition for Nuclear Responsibility (CCNR) is a federally incorporated not-for-profit corporation. It was founded in 1974 and incorporated in 1978. It is dedicated to education and research on all issues related to nuclear energy, whether civilian or military – including non-nuclear alternatives – with a special emphasis on those aspects of nuclear energy pertaining to Canada and its provinces and territories.

CCNR is opposed to granting a Power Reactor Operating Licence (PROL) that would allow NB Power to operate the Point Lepreau Nuclear Generating Station (PLNGS) for two decades or more. In effect, granting such a licence would mean that members of Indigenous communities and the public will be silenced, for the next 20 years or more, with no opportunity to intervene before the Commission to provide perspective, raise awareness and give advice on matters related to the plant that will affect them and their children and their children's children for generations to come.

CNSC is mandated to protect the health and safety of Canadians and the environment. In our opinion it is vitally important that the Commissioners remain in touch with the people whose interests they are legally obligated to serve.

Emergency Measures

CCNR is concerned that much remains to be done with regard to emergency planning at Point Lepreau. There seems to be some misinterpretation of IAEA recommendations on this score.

From the licensee's presentation during Part 1 of these hearings, we read: (https://www.nuclearsafety.gc.ca/eng/the-commission/hearings/cmd/pdf/CMD22/CMD22-H2-1A.pdf)

"Emergency Management and Fire Protection

"• NB Power is committed to ensuring the ability to respond to radiological and conventional emergencies in a timely, effective, and coordinated manner. This is carried out by means of a comprehensive all-hazards approach to emergency management. This is demonstrated through:

- updated technical planning basis for Radiological Emergencies (2021)

- strong local and regional partnerships with Musquash Fire Department, Saint John Fire Department, NB EMO and other response agencies

- annual fire mutual aid drills

- completion of the Synergy Challenge 2021 emergency exercise

- enhanced emergency facilities and infrastructure located on site

- dedicated emergency facility in St. George

- continuing training, drills and exercises with all emergency response organization members"

However, despite the close collaboration between LPNGS staff and first responders suggested in the passage above, there are some troubling features in the Point Lepreau Off-Site Emergency Plan (New Brunswick Department of Justice and Public Safety and New Brunswick Emergency Measures Organization, 30 June 2021). This document is linked as Annex A. On page 17 we encounter a table showing a 50 km EPD zone (Extended Planning Distance zone) based on a misreading of IAEA recommendations (IAEA is explicitly cited in the table).

Off-site Emergency Planning Zones: **IAEA Planning Zones**	**NBEMO Warden Zones**	**Health Canada / CSA Planning Zones**
4 km Precautionary Action Zone (PAZ)	Warden Zones 1, 2 and at sea 1	4 km Automatic Action Zone (AAZ)
20 km Urgent Protective Action Zone (UPZ)	Warden Zones 3, 4, 5, 6, 7a,7b, 7c, 8, 9, 10, 11, 12, 13 and at sea 1 and 2	20 km Detailed Planning Zone (DPZ)
50 km Extended Planning Distance (EPD)	Warden Zones 14 and 15	50 km Contingency Planning Zone (CPZ)
Ingestion and Commodities Planning Distance (ICPD)	57 km Ingestion Planning Zone	57 km Ingestion Planning Zone (IPZ)
IAEA **General Safety Requirements** **GSR Part 7** **Section 5.38**	**New Brunswick Warden Service Procedure Manual**	**CSA N1600-16** **General Requirements for Nuclear Emergency Management Programs** **Section 7.6.1**

The latest IAEA draft report on this matter shows the 50 km radius is only appropriate for nuclear reactors with a thermal power of less than 1000 megawatts, whereas Point Lepreau has a thermal power of 2050 megawatts. For such reactors the EPD zone is 100 km, not 50 km.

TABLE VI.2. SUGGESTED SIZES FOR THE OFF-SITE EMERGENCY PLANNING ZONES AND EMERGENCY PLANNING DISTANCES[h]

Facilities	**Precautionary action zone (PAZ) radius**[a,c,d]	**Urgent protective action planning zone (UPZ) radius**[b,c,d]	**Extended planning distance (EPD)**[e]	**Ingestion and commodities planning distance (ICPD)**
		Emergency preparedness category I facilities		
Reactors ≥ 1000 MW(th) $\left[\frac{A}{D}\right]_2$ from **Appendix II** is $\geq 10^5$[f]	3–5 km	15–30 km	100 km	300 km
Reactor 100–1000 MW(th) $\left[\frac{A}{D}\right]_2$ from **Appendix II** is $\geq 10^4$–10^5[f]	3–5 km	15–30 km	50 km	100 km

The recommended radius takes in parts of the province of Nova Scotia and state of Maine. In other words, emergency measures officials and first responders in those jurisdictions should also be involved. Here is the relevant table from the draft IAEA report (www.ccnr.org/draft_ds504.pdf p.143):

The IAEA draft document from which this graph is taken is entitled **Arrangements for Preparedness and Response for a Nuclear or Radiological Emergency** Version 8.2 Dated: 2021-07-16.

This 2021 document includes the statement made two years earlier by then Director General of the IAEA, Yukiya Amano: .

"Governments, regulatory bodies and operators everywhere must ensure that nuclear material and radiation sources are used beneficially, safely and ethically. The IAEA safety standards are designed to facilitate this, and I encourage all Member States to make use of them." [Yukiya Amano, IAEA Director General (died in July 2019)]

CCNR feels it is important that emergency planning be thorough and realistic, and that CNSC follow the dictates of the Nuclear Safety and Control Act, section 9, part (a)(iii), indicating that one of the "objects of the Commission" is to "achieve conformity with measures of control and international obligations to which Canada has agreed."

As the IAEA draft report points out, "Emergency planning zones and distances should not stop at national boundaries." It is therefore necessary for Point Lepreau staff to contact the appropriate authorities within a 100 km radius of Point Lepreau, whatever jurisdiction they may be in, to pursue the same kind of collaboration and training they are already practicing with New Brunswick authorities.

First Responders

According to the Point Lepreau Off-Site Emergency Plan (Annex A):

> "The Radiation Protection Regulations . . . prescribe dose limits for the emergency response phase. They indicate an effective dose not exceeding 500 mSv and an equivalent dose to the skin not exceeding 5,000 mSv during the control of the emergency. These dose limits could apply to workers onsite at the accident or to members of the public involved in the offsite response, such as first responders."

These are extraordinarily large radiation doses. They are ten times greater than the maximum doses allowed for an atomic worker in one calendar year, and from 33 to 100 times greater than the maximum doses normally permitted for any other person.

On consulting the CNSC document from which these numbers are taken (https://laws-lois.justice.gc.ca/eng/regulations/sor-2000-203/page-2.html#h-656878) we find that such doses are only to be permitted in extreme circumstances calling for heroic behaviour, such as "actions to prevent health effects of radiation that are fatal or life-threatening, or that result in permanent injury".

The Point Lepreau Off-Site Emergency Plan goes on to say that

> "Emergency workers not designated as such in advance shall not be the first emergency workers chosen for taking actions that could result in their doses exceeding the guidance values of dose for lifesaving actions, as given in Appendix I. Helpers in an emergency shall not be allowed to take actions that could result in their receiving doses more than an effective dose of 50 mSv."

> "The operating organization (PLNGS) and response organizations (NB Provincial Departments and Agencies) shall ensure that emergency workers who undertake emergency response actions in which doses received might exceed an effective dose of 50 mSv do so voluntarily; that they have been clearly and comprehensively informed in advance of associated health risks as well as of available protective measures; and that they are, to the extent possible, trained in the actions that they might be required to take."

The actions to be taken by these workers will require considerable training. They must become acquainted with the wide variety of radioactive materials, including alpha-emitters and beta-emitters, that can be released into the air we breathe, the food we eat, the water we drink and the ground we stand on. Radioactive contamination of soil, buildings, roadways, clothing, vegetation and skin is notoriously difficult to remove. Doctors and nurses often have no idea how to treat a radioactively contaminated patient without endangering themselves. But the Off-Site Plan assumes that these skills will be available, and that Mobile Decontamination Centres (MDCs) will be ready to go.

“Concept of Operations:

“Decontamination must be conducted as soon as possible to be effective in saving lives, limiting injuries and reducing the spread of contamination. Responders should use resources that are immediately available and start decontamination as soon as possible. Mass decontamination will be conducted in 4 stages:
Stage 1: Determine the need to deploy MDCs;
Stage 2: Set up the MDCs to include manning and full resources;
Stage 3: Conduct decontamination of evacuees, as required; and
Stage 4: Prepare for the Recovery Phase (Remediation)”

Point Lepreau Off-Site Emergency Plan, page 117.

Since the protection of the health and safety of humans and the environment is first among the three or four legal objectives of the Commission, as spelled out in article 9, part (a)(i) of the Nuclear Safety and Control Act, we respectfully request that the Commissioners assure themselves that every aspect of the training and planning be carried out in the best possible way, involving not only emergency measures folk and first responders in New Brunswick, but also in the affected portions of Nova Scotia and Maine that are within the 100 km radius proposed by IAEA.

Recommendation 1

CCNR recommends that the Commissioners not grant a PROL licence for Point Lepreau for a period of more than 3 years, during which time the Point Lepreau staff and CNSC staff can work together with emergency measures people and first responders to consolidate and improve the off-site emergency plan in accordance with best practice as recommended by the IAEA. This will necessitate close collaboration with appropriate authorities in Nova Scotia and Maine.

Severe Accident Analysis

The previous paragraphs deal with emergency preparedness to cope with the consequences of a severe nuclear accident, whereby a small but significant fraction of the radioactive inventory in the core of the reactor is released into the environment. Although such events are unlikely, previous failures (e.g. the meltdowns at Three Mile Island in Pennsylvania, at Chernobyl in Ukraine, and at three of the six reactors at Fukushima-Daiichi in Japan) have led regulators around the world to try to plan for the consequences of such a severe accident regardless of the presumed improbability of such an event.

Thousands of pipes at Lepreau were replaced for safety reasons during the four year refurbishment that took place from 2008 to 2012 at a cost of about $2.4 billion (one billion dollars over budget). Some of these old pipes were getting rather brittle under the influence of high temperatures and pressures and intense radiation. Other pipes were gradually losing wall thickness and so they were becoming thinner and more fragile.

Brand new pipes are sturdier and much less likely to break. Any sudden rupture of a pipe in the primary cooling circuit of a nuclear reactor leads to a “loss of coolant accident” or LOCA. If it’s a small leak, nothing terrible happens. But if it’s a major leak, additional coolant has to be provided quickly and continuously to prevent the fuel from overheating, melting, and releasing a sizable fraction of its radioactive inventory.

Surprisingly, severe overheating can happen even after the fission process has been completely shut down, because radioactivity cannot be shut off. The radioactivity in the core of a reactor is so intense that it continues to generate a lot of heat for a long time, at a rapidly diminishing rate. It’s more than enough heat to melt the core of the reactor. The triple. meltdown at Fukushima happened because, even though all three reactors were completely shut off, there was no way to cool the core due to a “station black out” – no electrical power to run the pumps. The backup diesel generators were flooded and therefore useless. Radioactive heat built up, the temperature soared, explosions occurred, and airborne radioactivity was scattered over a very large area as the cores of the three reactors melted down into the sub-basements and perhaps into the ground beneath the floor – no one knows for sure.

The IAEA draft document assumes that “”The source term (release) used for reactor emergencies is based on the maximum expected release characteristics (e.g. release of 10% of the volatile fission products, a ground level release, release duration of 10 hours) that could potentially lead to severe deterministic effects or to stochastic effects off the site.” Deterministic effects are health effects that are experienced shortly after exposure, ranging from reddening of the skin and hair loss to radiation sickness and possible death. Stochastic effects are subsequent radiation-induced diseases such as cancer that typically occur years or even decades after exposure.

One of the most important of the “volatile fission products” is cesium-137, a very strong gamma-emitter that is released as a hot metallic vapour which quickly condenses to a solid and bonds to cool surfaces such as soil, roadways, roofs, clothing and skin. The Point Lepreau reactor holds more than 70 quadrillion becquerels (70,000 terabecquerels) of cesium-137, and ten percent of that would be 7 quadrillion becquerels (7,000 Terabecquerels). That’s the amount of cesium-137 that the IAEA supposes might be released in the event of a severe core melting accident.

By contrast, the CNSC staff has estimated a release of only 100 terabecquerels following a severe reactor accident, without providing any calculations or analysis to demonstrate how staff arrives at such a small release. The CNSC figure is only 0.14 percent of the inventory of cesium-137, whereas the IAEA figure is 70 times larger.

A becquerel is the international unit of radioactivity. One becquerel indicates that there is one atomic disintegration occurring every second – or 60 disintegrations per minute and 3600 disintegrations per hour. Evidently 70,000 terabecquereks is an enormous amount of radioactivity.

Recommendation 2

CCNR recommends that the Commission order an independent assessment of the CNSC source term of 100 terabecquerels of cesium-137 following a severe fuel melting accident compared with the IAEA source term of 7,000 terabecquerels of cesium-137.

Unresolved Safety Questions

Good emergency planning must be based on realistic estimates of risk. There is no advantage in underestimating the nature of a nuclear emergency ahead of time as it may lead to a woefully inadequate response if and when such an accident occurs. At the same time, every reasonable measure should be taken to prevent such an emergency from ever occurring in the first place. These two aspects of prudent planning are not contradictory but complementary.

Dr. Sunil Nijhawan, a conscientious and experienced nuclear scientist who has spent most of his professional life studying the causes and the consequences of severe nuclear accident scenarios in CANDU reactors, has posed a list of suggested engineering approaches that can be undertaken to either help prevent such an accident from happening or to mitigate the off-site consequences of such an accident if it were to happen.

Here is Dr. Nijhawan's list, taken from a presentation he put together on October 1 2018, attached as Annex B.

Possible design enhancements to be considered in CANDUs to diminish the likelihood and dampen the consequences of a severe nuclear accident

1. Passive makeup by steam driven auxiliary feedwater pumps; de-aerator location and control enhancements for automatic provision of coolant to boilers

2. HTS overpressure protection enhancements for avoidance of uncontrolled ruptures

3. High pressure makeup of HTS inventory loss by boiloff; improved reliability of loop isolation – or means for HTS

4. Calandria vessel overpressure protection enhancements for avoidance of deliberate voiding ; moderator makeup.

5. Calandria vessel structural design enhancements for retention of core debris

6. Calandria vault overpressure protection enhancements for avoidance of structural failure

7. Calandria vault heat removal capacity enhancements for retention of debris in CV

8. Containment penetration reinforcement for avoidance of overpressure failures

9. Containment pressure suppression improvements: intelligent dousing, local sprays and external support to coolers

10. Containment dousing water pool use for core debris heat sink purposes in calandria vault and reactor vault

11. Instrumentation enhancements for detection of important accident parameters

12. Filtered venting from containment for avoidance of imminent structural failures

13. Emergency hookups for water and power to safety critical systems (e.g.water makeup to the boilers, reactor cooling system, moderator system, and reactor vault)

14. Improved Class 1 batteries and better definition of anticipated loads over prolonged periods of loss of AC power

15. External water makeup to a stranded fuelling machine after a LOCA

16. External water makeup and heat removal from the spent fuel bay

17. Off-site measurements of releases and correlating them to source terms; development of dose prediction tools at unmonitored locations

Recommendation 3

CCNR recommends that the Commission not approve a PROL for Point Lepreau in excess of three years and that the Commissioners task the CNSC staff to report back to the Commission on the merits and demerits of the 17 safety enhancements suggested by Dr. Nijhawan at the next relicencing hearing for the Point Lepreau Nuclear Generating Station.

Annex A: http://www.ccnr.org/Lepreau_Emergency_Plan_2022.pdf

Annex B: http://www.ccnr.org/Nijhawan_CANSAS_2018.pdf