

# **A Citizen Response to Draft of CNSC REGDOC 2.11.1-vol3-ver2 on Waste Management: Safety Case for Long-Term Radioactive Waste Management**

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## **PREAMBLE**

The draft of REGDOC-2.11.1-vol3-ver2 is very concerning for a list of reasons that will be discussed throughout this citizen response. Among the themes of concern include: the reliance upon computer modelling; the pattern of contradiction about expected robustness of safety versus the continuing uncertainties and; last but not least - after looking up a few bibliographic references upon which CNSC arguments are based - no progress within the body of CNSC regulations in moving beyond a “site-specific” focus to an “ecosystem approach,” the latter which has been advocated by various international organizations engaged with the nuclear industry through some years.

I would be happy if anything that I argue can be proven to be inaccurate. Frankly, I am beginning to wonder whether the independent voices of concern are heeded at all or, alternatively, the CNSC is hell-bent on a trajectory to licence the proposed deep geological repositories (DGRs) - the latter as my longstanding foremost concern - despite the lack of scientific evidence about authentic safety, now or ever.

But then, in this draft document, the CNSC does declare, repeatedly, that there are uncertainties, and risks, which apparently we - the collective “we” as per the larger public - now and forever, must accept. Fundamentally, that assumption is what I challenge and, further, raise the question why other possible resolutions about what to do with nuclear waste for the long-term

consistently are ignored, while CNSC continue to beat the drum in supporting DGRs (and other related facilities) similarly experimental and yet unproven to be viable, the latter beyond the scope of my critique on this specific draft document.

## **COMPUTER MODELLING LIMITATIONS**

After reading through most of the draft document, and witnessing a pattern of contradiction about what computer models are and are not able to tell us, the final pages appear to reveal the fundamental flaw in the reliance upon technological tools for safety analysis - indeed, the impossibility for the capacity of predictions - whether within the lifespan of the most immediate upcoming generations of people or through the time frame of thousands of years into the future.

First of all, I will cite excerpts from the final pages and then move backward into the previous sections of content. Under section **7.1.5 Developing and using safety analysis models**, read (and reread) these sentences:

*“The conceptual models of the site and the waste management system that have been developed often **need to be simplified to correspond to the limitations of mathematical equations** [my bold] and the capabilities of computer models to solve them. A mathematical model is a representation of the features and processes included in the conceptual model in the form of mathematical equations.*

*“Computer models are used to solve the mathematical equations that represent the understanding of the inter-relationships among the major features, processes, and characteristics of the waste management system in its particular environment.”... [print page 23]*

The fundamental flaw, therefore, that becomes evident in the above information (and as elaborated in the document) appears to be that the actual complex biological environment in our visible (and invisible to the

naked eye) physical world must be reduced to fit human-constructed technology, instead of the other way around.

Again, I was gobsmacked by the above emphasis that the world of Nature, ultimately, somehow must accommodate our reductionist thinking. Have we become so disconnected from the actual biological planet, and our arrogance become so egregious, that we think we have the intelligence to program technological tools that can fix the human destruction perpetrated by human beings on the planetary life support system?

What also is disturbing, not only in the draft document's sections on safety analysis, yet as well throughout the document, are contradictions, such as illustrated here by a few text examples. Under section **7.1.5.1 Confidence in computer tools:**

*"... Validation is meant to ensure that the mathematical equations in the computer model **simulate, with reasonable accuracy**, [my bold] the processes and conditions they are supposed to represent."...[print page 24]*

Next, under section **7.1.5.2 Confidence in safety analysis models**, see the contradiction below in relation to the above-cited passage on the previous page of the draft document:

*"... Although models of individual processes or phenomena can sometimes be validated by experiments and blind predictions, **the long-term predictions made by safety analysis models cannot be confirmed** [my bold]."...*

In fact, throughout Section 7, the CNSC provides further insight about the inevitable uncertainties that cannot be either identified nor resolved by computer models. The CNSC indicates international awareness therein:

*“In addition, experience in international computer model testing projects has shown that due to the complexity and spatial variability of the natural environment, an unambiguous description or model of a system **cannot** [my bold] generally be attained.”... [print page 24]*

The reasons have been known for more than a couple of decades, as indicated in physicist/author Fritjof Capra’s book **THE WEB OF LIFE, A New Scientific Understanding of Living Systems**. Below I will cite a passage where he cites an important revelation by computer scientists:

*“A computer processes information, which means that it manipulates symbols based on certain rules. The symbols are distinct elements fed into the computer from the outside, and during the information processing there is no change in the structure of the machine. The physical structure of the computer is fixed, determined by its design and construction.*

*“The nervous system of a living organism works very differently... [as Capra explains at length earlier in his book], [I]t interacts with its environment by continually modulating its structure, so that at any moment its physical structure changes. The nervous system does not process information from the outside world but, on the contrary, brings forth a world in the process of cognition. ...*

*“Human decisions are never completely rational but are always colored by emotions, and human thought is always embedded in the bodily sensations and processes that contribute to the full spectrum of cognition.*

*“As computer scientists Terry Winograd and Fernando Flores point out in their book **Understanding Computers and Cognition**, rational thought filters out most of that cognitive spectrum and, in so doing, creates a “blindness of abstraction.” In a computer program, Winograd and Flores explain, various goals and tasks are formulated in terms of a limited collection of objects, properties and operations, a collection that embodies the blindness that comes with the abstractions involved in creating the program” [Capra, 1996, p. 274-5].*

What is imperative to acknowledge here before continuing and, moreover, why the repetition (by me in various submissions) of Capra's wisdom significantly bears repeating, is the fact that ecological scientists and computer scientists increasingly are sitting together in the spirit of pursuing interdisciplinary methods to address the sorry plight of our global environment.

Please know I am open-minded sufficiently to recognize that science continues to evolve, and the most intelligent scientists, such as Capra, always remind us about the limitations of science. Consequently, the imperfections of science today must continuously be challenged and improved yet, always, with the awareness and humility in regard to the inevitable limitations of the human mind.

Therefore, I cannot lay blame solely on the nuclear industry for pursuing what I believe is misguided as per so much reliance upon computer modelling to identify the many uncertainties about pathways, for example, when and how radionuclides could be released, as well as the hugely unknown multiple levels of how radionuclides will contaminate numerous life forms, ranging from various organs within organisms to interactions between organisms as well as interactions with environmental media, in order to be named and mitigated effectively - through time and space, with other unknowns such as extreme weather events, etc.

Next, I will select passages that illustrate further problematic assumptions by the CNSC, followed by citations from other scientists, internationally, who point out the limitations of computer models.

### **PROBLEMATIC ASSUMPTIONS IN SAFETY STRATEGY**

Under section **6.2 Safety strategy**, subsection 'Containment and isolation' states: "The degradation of these safety functions **under**

**gradual natural processes** [my bold], or after the occurrence of **design-basis events** [my bold], shall be taken into account.”

What I observed in the above excerpt and throughout the draft document was a consistent omission of extreme weather events, as well as absolutely no reference to and acknowledgement about ‘cumulative effects.’

Instead, in section **6.2**, subsection ‘Robustness’ must be demonstrated by the licensee or applicant “showing evidence that the barrier will fulfil its safety functions under the effects of **the expected** [my bold] natural or anthropogenic disturbances during all phases of the facility.”

Again, the aforementioned is another (among several more) reference to what is assumed to be anticipated, and measured - ultimately, with major reliance upon computer modelling, based on the rationale of measuring a very long timeframe and, consequently, the limits of shorter term analogues. But, once more, I seriously question the gross assumption that computers, now or in the future, legitimately can provide data anywhere close to the potential risks and dangers endlessly lurking.

In a 2015-2016 CNSC research project document, here are a few short excerpts which refer to ‘Natural and anthropogenic analogues’:

*“Most studies define natural analogues as either naturally occurring or anthropogenic (i.e. man-made) systems. This project looked more closely at the differences between these two types of natural analogues and how they can contribute to the safety case of deep geological repository projects.”*

What I find incredible, and troubling, first of all, is the assumption that such analogues can extrapolate from data that is supposed to cover

hundreds to thousands of years. Secondly, for even a longer time span, these analogues are suggested, and rationalized, to be useful as follows:

*“As the safety case for deep geological repositories requires scientific information for long-term safety assessment - a million years or longer - naturally occurring analogues can provide information and data over geological time and spatial scales that cannot be extrapolated from laboratory experiments.”*

Importantly, what follows on the same page of the 2015-2016 research report is one of various clues behind what CNSC communicates as possible in the draft document REGDOC-2.11.1-vol3-ver2:

*“A key recommendation from this [2015-2016 research] project is that a concerted effort should be made to ensure there is a transfer of data **from the complex natural analogue field studies to the simplistic models that, by necessity, are used in performance assessment** [my bold]. Field studies should be planned to align with laboratory experiments and, ultimately, field experiments when the final repository site is selected. This will provide a more quantitative use of natural analogue data in support of a deep geological repository concept.” [print page 18, 2015-2016]*

The above research project reveals a previous CNSC source where “simplistic models” are recommended explicitly to reduce the complexity of field studies.

Meanwhile, the act of gathering baseline information in itself, albeit essential (and not pursued thoroughly enough), already is fraught with challenges, outlined in one of my previous CNSC submissions, “Critique re CNSC Guidance on Deep Geological Repository Site Characterization,” the draft document for CNSC REGDOC-1.2.1.

As for the 2015-2016 CNSC research report, it elaborates on computer models as justifiable, based upon a single comparison of a safety assessment code, and outlines the purpose of codes as follows:

*“Part of the safety assessment for deep geological repositories includes the use of computer modelling - meaning the verification and validation of computer codes are an essential part of a safety assessment evaluation.”*

[print page 19, 2015-2016]

Without the time to dissect previous document sources, the fundamental concern remains: reducing the complexity - and continual flux - in the actual physical biological world into humanly constructed equations, in order to argue for what I would characterize as merely a rationalization upon which to try and argue a safety case, but which still does not convince me as credible.

Another problematic issue is CNSC’s lenient language (which I have criticized in previous submissions), such as in this passage of section **6.3**

**Waste management system description:**

*“The safety case **should** [my bold] be updated by taking into account the improved knowledge on the behaviour of the waste management system. ... “The container **may** [my bold] be designed so that the seal can be monitored and required or replaced during the operational period. Other safety functions for the container **may** [my bold] include: shielding, heat removal, and corrosion resistance.”*

The CNSC choice of terms truly befuddles me, in accordance with the definitions of terms on the opening page of each of its regulations:

*“The words “shall” and “must” are used to express requirements to be satisfied by the licensee or licence applicant. “Should” is used to express*

*guidance or that which is advised. “May” is used to express an option or that which is advised or permissible within the limits of this regulatory document. “Can” is used to express possibility or capability.”*

My question to CNSC is why it does not use “must” instead of “may” and “should,” in reference to what so obviously are essential safety functions that, logically, to have any credibility at all, *must* be monitored and repaired through time because of seals, shields and containers inevitably deteriorate.

Regarding the draft document’s section **6.4.2 Site and engineering aspects**, I continue to question (as I did in previous submissions) the “site characterization” limits, as per the CNSC guidance:

*“The resulting information should be sufficient to develop a site-specific safety analysis.”*

My critique on the above limit will be described in a later section of my submission, where I give examples of recognition of an ecosystem approach that apparently is rejected by the CNSC.

Next, under section **6.5 Management of uncertainties**, is one of several passages within the draft document where the CNSC, first of all, concedes implicitly, or explicitly as here: “uncertainties can never be fully eliminated,” which is truthful. But, this factual honesty then is undercut by what CNSC next communicates, in this instance immediately:

*“Therefore, the licensee or applicant should identify the remaining uncertainties within the safety case and how, despite these uncertainties, the safety case is still supported.”*

Under section **6.6 Iteration and design optimization**, as well as in several other draft document sections, the CNSC reveals a pattern of, on the

one hand, identifying what cannot be known, followed by, on the other hand, presenting an ethical dilemma for the prospective licence applicant, as per what the CNSC's expectations to ensure support for a safety case:

*“As the project proceeds and additional information is gained, initial results should be refined and should replace the generic or default data, reducing the reliance on assumptions.”*

What I find fascinating as I studied this draft document is the pattern of contradictions in a back and forth communication that starts with truth telling - i.e. immediately above, the quote in reference to licence applicants' "reliance on assumptions," and then shifts to a storyline that whatever is unknown eventually will be good enough, through the continuing efforts of the CNSC and the respective licensees doing their due diligence to play catch up with never-ending efforts to improve, for example, mitigation strategies (not yet existing and/or proven to be effective) and monitoring, the latter which tragically could be minimized to how much it costs.

What also becomes so painfully clear in this draft document is the possibility that various still experimental types of nuclear facilities are likely to be given licences despite the horrible fact that so much important and imperative scientific evidence to verify safety does not need to exist prior to licence applicants being given a licence. For example, under section **6.8**

**Complementary safety arguments:**

*“Complementary indicators as identified from the safety analysis can also be used to derive the monitoring program, which would be a requirement of the licence. In many instances, however, **those indicators cannot be directly or practically monitored, but must be inferred by a set of sub-indicators which are easily measured or quantified** [my bold]. For example, container corrosion rates might not be measured during the licensing time frame. ... In such cases, trigger criteria should be*

*determined for the parameters, and courses of action and decision should be developed in case of deviations from the criteria.”*

Am I correct in interpreting the example above, in reference to “container corrosion rates,” that computer models will be used to determine them, instead of physical tests of containers (such as copper canisters) in underground research laboratories? I would like more clarity in the final document from CNSC, to explain whether physical types of research that *could* be undertaken are being replaced by computer modelling.

Also worrisome is CNSC, again in a contradictory fashion - first stating the problem but then providing a less than satisfactory or credible so-called safety feature - is the rationale given by CNSC, under section **6.10 Safety features during the period of institutional control** (pointing out it previously laid out this guidance in REGDOC-2.11.1-vol1 :

*“... As a result of the uncertainties associated with future human activities and the evolution and stability of societies, licensees or applicants should limit the reliance on institutional controls as a safety feature to a few hundred years.”*

As an opponent to the proposed DGRs, to whom DGR supporters always reply that we cannot pass on the problem of nuclear waste to future generations, I consider the previous passage in the CNSC draft document to be hypocritical in focusing on its continual production of a series of documents to justify the push to licence what are nothing more than experimental solutions - and then, having the nerve to propose that licensees are allowed to divest their “institutional” responsibilities (together with government regulators, it appears), and thereby leave everything still unresolved in the hands of future generations, yet by then without even institutional oversight after an oversight period gets curtailed in 300 years.

In the section **6.11 Integration of safety arguments**, the CNSC lists eight responsibilities of the licensee or applicant to carry out, preceded by this directive:

*“The licensee or applicant should acknowledge their limitations on the understanding of the waste management system, its evolution, and its potential impact on people and the environment. The licensee or applicant should justify, despite these limitations, the rationale for the continuation of the project.”*

The above directive by the CNSC is not simply unacceptable but, moreover, outrageous. Given the extraordinary limitations of understanding that currently exist, I advocate that CNSC as the regulator will be violating its moral responsibility if it chooses to give out licences for newer, still experimental, types of nuclear facilities - which ought not to be given licences in the first place. How can potential upcoming licences be endowed with any integrity, and the wider public have any trust in either the CNSC as regulator or the nuclear industry, if and when licences will be distributed to upcoming facilities when so much remains unknown as per ensuring more rather than less authentic safety?

### **PROVOCATIVE INSIGHTS IN INTERNATIONAL RESEARCH**

My critical perspective continues to be influenced by the diversity of science articles and news items, often published outside of North America yet occasionally on this continent too, which pursue investigations that expose the flaws, and inherent bias, within the nuclear industry. As well, I read research by organizations who work with the nuclear industry, often European, who appear to be much more transparent about the limitations of science than what I have been able to find within Canada.

Scepticism about the accuracy of climate models, for example, has been expressed by various scientists in other countries, who sometimes work

collaboratively. One major problem, apparently, is that the outcomes from different computer programs working on the same investigation contradict each other. (I am unable to name the sources investigating that problem, which I outlined in a few previous submissions currently inaccessible, on my desktop computer in storage during this period between two homes. For this submission, I am working on a new laptop.)

More importantly, however, is a very recent piece of research published in the journal ***Geophysical Research Letters***, cited by Yale University at <https://e360.yale.edu/digest/europe-is-warming-faster-than-even-climate-models-projected>. The article also quotes Geert Jan van Oldenborgh, a climate analyst whose independent findings agree with the aforementioned research, who says:

*“In the Netherlands, Belgium, France, the model trends are about two times lower than the observed trends.”*

The above not so surprising discoveries illustrate the problem in reliance by CNSC and the nuclear industry upon computer modelling, given current, increasingly disruptive, as well as yet unknown future planetary changes, that appear to be accelerating beyond what our technological tools can predict.

As for studies more specific to ionising radiation, a position paper prepared for the 4th IUR Workshop in June 2018, by the International Union of Radioecology addresses the inadequacy of “treating radiation as a single or unique stressor” and called for “the development of a multidisciplinary approach...to address key concerns about multiple stressors in the ecosphere.” The position paper is titled: “The tubercular badger and the uncertain curve:- The need for a multiple stressor approach in environmental radiation protection.”

## **WHY DOES CNSC STILL IGNORE `ECOSYSTEM APPROACH`?**

I became aware of the `ecosystem approach` while preparing my oral interventions and written submissions for the two public hearings (in 2013 and 2014) on the deep geological repository for low-and-intermediate level radioactive waste proposed by Ontario Power Generation.

The primary source that I cited as an intervenor was a document produced by the International Commission for Radiological Protection (ICRP), in which CNSC is a longstanding member. Why, therefore, do you not develop research methodologies based on an `ecosystem approach,' which are being pursued by various international researchers and organizations? A few examples follow.

The International Union of Radioecology (IUR) produced a `statement of work' titled "**Ecological risk assessment of radiation - putting the ecosystem approach into practice**" some years ago in collaboration with the Centre for Environmental Radioactivity (CERAD), outlined on [www.iur-uir.org/en/task-groups/id-2d-joint-iur-cerad-ecosystem-approach-task-group](http://www.iur-uir.org/en/task-groups/id-2d-joint-iur-cerad-ecosystem-approach-task-group).

The latest research done by CERAD, which is located at the Norwegian University of Life Sciences, continues to evolve thanks to funding by the Research Council of Norway, identified on a web page for the university at <https://www.nmbu-no/en/services/centers/cerad>, in the right sidebar:

*"CERAD CoE will develop an ecosystem based scientific approach to help protect people and the environment from ionizing radiation, with a programme of targeted focused long term research."*

The ***Journal of Environmental Radioactivity*** provides scientific investigations that cover a range of topics and perspectives. I will cite two articles that mention why an `ecosystem approach' is more accurate to

determine the extent of contamination. Here is an excerpt from the Abstract for “Challenges associated with the behaviour of radioactive particles in the environment,” Volume 186, June 2018, Pages 101-115:

*“... When radioactive particles are deposited in the environment, weathering processes occur and associated radionuclides are subsequently mobilized, ... Thus, particles retained in soils or sediments are unevenly distributed, and dissolution of radionuclides from particles may be partial. For areas affected by particle contamination, the inventories can therefore be underestimated, and impact and risk assessments may suffer from unacceptable large uncertainties if radioactive particles are ignored. To integrate radioactive particles into environmental impact assessments, key challenges include the linking of particle characteristics to specific sources, to ecosystem transfer, and to uptake and retention in biological systems. ...”*

Another article in the same journal is titled “A modelling approach to assess the environmental/radiological impact of C-14 release from radioactive waste repositories,” Volumes 205-206, September 2019, Pages 61-71, in which the Abstract identifies uncertainties discovered through disparities among different models. Its closing sentence sums up an imperative:

*“This modelling work illustrates also the importance of far field parameters, such as the rock permeability and the release area of gas pathway, to the assessment of effective dose.”*

More international examples that advocate for an ‘ecosystem approach’ could be named. But my purpose in showing a few examples is to show that the **CNSC REGDOC-2.9.1, Environmental Principles, Assessments and Protection Measures** (April 2017) is not following international practice as per the recognition of an ‘ecosystem approach.’ REGDOC-2.9.1

is one among several bibliographic references for draft document REGDOC-2.11.1-vol3-ver2 that seem to me to be dated.

But my critique here raises the serious question why CNSC has created a regulatory document in 2017 - to which it continues to refer as guidance - which is frozen in time as far back as 2013, if not earlier?

Doing so brings into question the trustworthiness of CNSC as regulator. For example, within REGDOC-2.9.1, under section **2.1 The CNSC's guiding principles for protection of the environment**, the CNSC stipulates that a licence application shall demonstrate (various) assessments with "performance indicators and targets that are **based on sound science** [my bold]," which I challenge as simply not a fact. Instead the basis seems to be scientific experimentation that might perhaps eventually create "sound science."

Another simply incorrect point of guidance is written in REGDOC-2.9.1, under section **3. Environmental Assessments**, reads as follows:

*"... the Commission must determine whether the completion of a proposed project is likely to cause significant adverse environmental effects, in accordance with section 67 of CEAA 2012."*

But a serious truth revealed during the period of the two aforementioned public hearing for the proposed OPG DGR is that CEAA 2012 did not give a clear definition for "significant adverse environmental effects," and because the Joint Review Panel shamelessly accepted OPG's declaration that none existed (in reference to its proposed DGR), the OPG was allowed to avoid carrying out due diligence, until the Ministry of Environment and Climate Change (ECC) made further demands from OPG, based partly upon Saugeen Ojibway Nation's dissatisfaction with OPG, shared with ECC, in regard to OPG's major information gaps.

More of REGDOC-2.9.1's content could be challenged, but why bother when it undoubtedly will be rewritten in the near future to accommodate the upcoming federal Impact Assessment Act which will replace CEAA 2012, or will it do so only partially? What will need to be clarified by the CNSC at that time, in a range of documents, is whether the proposed OPG DGR, and already-existing nuclear facilities still must adhere to the regulations in CEAA 2012 or adapt to a newer set of regulations created for the Impact Assessment Act.

### **CLOSING COMMENTS**

Among various sources that I researched online, I did look up a 2008 article in the *Journal of Environmental Radioactivity* titled "Addressing uncertainties in the ERICA Integrated Approach." In the Abstract which was accessible on my personal computer (but the full article was not), I recognize that the CNSC is following a protocol that fits with one international line of thinking that is a technologically-based approach, here identified as: "the [ecological risk] assessment is dependent on models, scenarios, assumptions and extrapolations." The Abstract also states:

*"Throughout its development, ERICA has recommended that assessors deal openly with the deeper dimensions of uncertainty and acknowledge that uncertainty is intrinsic to complex systems."*

Therefore, in fairness I do give credit to the CNSC for spelling out its awareness about uncertainties so very clearly in this draft document. Nevertheless, I still challenge what I believe is sorely misguided confidence in relying so heavily on a technologically-based approach vis à vis the perilous road ahead for our planet's survival and well being.

For a concerned citizen who seeks deeper understanding on complex issues, I would like to take this opportunity that pertains to the better inclusion of

other citizens in public comment participation on government decisions. A wealth of information is available online, but significant sources are not accessible because of the huge expense to download, for example, science journal articles. To prepare this submission, car troubles and lack of money disallowed me travelling from Lake Huron to the University of Toronto, where I do have access on the university computers as a graduate. There I pay only the modest cost of printed pages, instead of prohibitive costs per article charged by academic publishers on privately owned computers.

This dilemma is undemocratic and elitist, excluding citizens from participating more actively, because of financial costs pertaining to accessibility. I mention my own situation only to illustrate what is a much larger inequity that undoubtedly limits the number of submissions to government departments and agencies in which the citizen can cite deeply informed source materials to reinforce their genuine concerns.

But, in preparing this submission, what actually made me angry was being obstructed from looking up one of this draft document's bibliographic references - namely a document produced by the CSA Group - which source works hand-in-hand with government authorities to produce standards. I refer to the document **CSA N288.6 "Environment risk assessment at Class 1 nuclear facilities and uranium mines and mills."** While searching where to simply read it, and not necessarily download it, the cost was more than \$1000. How can this price be justified, and who benefits?

Therefore, I advocate that this unacceptable cost, hence creating a lack of transparency so close to government authorities be changed, so that CSA Group documents are accessible to the wider public. The reason is, for citizens to comment intelligently on serious matters that affect their well being, they require accessibility to any and all documents that provide insights regarding how and why decisions are made that impact the lives of people and all planetary life.

