



**Supplementary Information  
Oral Presentation**

**Renseignements supplémentaires  
Exposé oral**

**Written submission from  
Philip Kienholz**

**Mémoire de  
Philip Kienholz**

In the Matter of the

À l'égard de

**BWXT Nuclear Energy Canada Inc.,  
Toronto and Peterborough Facilities**

**BWXT Nuclear Energy Canada Inc.,  
installations de Toronto et Peterborough**

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Application for the renewal of the licence for  
Toronto and Peterborough facilities

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Demande de renouvellement du permis pour les  
installations de Toronto et Peterborough

**Commission Public Hearing**

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**Supplementary Presentation**  
**to**  
**Canadian Nuclear Safety Commission**  
**Hearing Ref. 2020 -H- 01**  
**BWXT Nuclear Energy Canada Licence Renewal**  
**Peterborough, Ontario**

**Precautionary Principle and the CNSC, 2020**

by

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Peterborough, Ontario  
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**Introduction**

Arising from their interactions for a period of over a year, BWXT Nuclear Energy Canada Inc. (BWXT) and the Canadian Nuclear Safety Commission (CNSC) have jointly put forward an application for a ten-year license extension and a major extension of operations for the BWXT nuclear fuel bundle facility in Peterborough, Ontario, and, virtually simultaneously, a recommended approval of that application.<sup>1</sup> The thirteen month period of preparing the licence application and its approval document contrasts sharply with the two month period allotted for preparation of the public's response.

The public is now faced, with no prior knowledge of the two primary licencing documents, nor access at any time to underlying information and processes which have led to the two documents, with providing proof to the regulator to support objections they may have about the licence that is proposed by both the applicant and the regulator to be granted.

I do not think this is fair. I present supporting arguments below that the burden of proof ought to lie with the applicant and regulator, and the benefit of the doubt

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<sup>1</sup> Initial BWXT NEC letter advising intention to apply dated 9 November 2018, licence application dated 19 December 2019; CNSC Staff report on licence application dated 20 December 2019. See Tadros, and Snopek. Final date for submittal of public interventions: 18 February 2020.

extended to interveners who argue within an alternative status quo that has arisen among health and other professionals who work primarily outside of State purview.

Further I explore the highly interconnected topics of the precautionary principle, its democratic promise, the indeterminacy of scientific knowledge, and implications for the organization the CNSC.

### **Burden of Proof**

The legal term “standard of truth” can be defined as “The degree of certainty required to substantiate a claim, as established by scientific evidentiary norms and practices,”<sup>2</sup> “...that the party bearing the burden of proof would have to meet.”<sup>3</sup>

In considering burdens of proof within the court system, there are typically three alternative justifications used to allocate a proof burden:

*"1. Those who want a change from the status quo should bear the burden of proof. ....*

*"2. Those with the best access to relevant information or knowledge should bear the burden of proof. ....*

*"3. Equity considerations, such as resources and power, should determine which party bears the burden of proof."<sup>4</sup>*

In the second and third justifications for allocating a burden of proof, clearly the CNSC/BWXT team -- so termed based on their coordinated submittals -- have had both better access to relevant information and knowledge, and have far greater resources and power than any member of the general public.

Under these two justifications then, the applicant and regulator would bear the burden of proof and members of the public would be accorded the benefit of the doubt which is the opposite side of the same coin.<sup>5</sup> It would not be to the interveners to prove their contentions but to the applicant and the regulator to prove theirs, and to convincingly counter the public's contentions if the public's contentions oppose those expressed in the two licensing documents.

The discussion would then appear to turn to whether the applicant and the regulator have met their burdens of proof to support their opinions that the licence extension be granted, and further, whether their answers to arguments raised by public interveners against approval of the licence extension are sufficient to meet the burden of proof.

***The situation is confounded by the fact that the adjudicator of a satisfactory burden of proof, the CNSC Commission Hearing Panel, is a part of the organization***

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<sup>2</sup> Cranor, 79, *Asymmetric Information*

<sup>3</sup> Scott, 57 *Shifting the Burden*

<sup>4</sup> Scott 54f *Shifting the Burden*

<sup>5</sup> Scott 53 *Shifting the Burden*

*whose judgement, expressed in the CNSC Staff report,<sup>6</sup> would be challenged by an objecting intervenor.*

This internal contradiction within the CNSC itself, patently unfair to the point of Kafkaian or Orwellian absurdity, has, in my opinion from having watched video portions of several licence application hearings, led to frustration, anger, and derision expressed by interveners toward the CNSC and toward Panel members. The Panel is then sometimes liable to reflect negativity back toward the interveners and defend approval of applicants' licencing statements in knee-jerk response. I do not think this is a good and democratic method of governance, hurtful as it is to the interests of both the public and Panel members.

In considering in turn the first justification for allocating a burden of proof, that of wanting a change from the *status quo*, I can see three alternative definitions of the *status quo*. Indeed, "Obviously, what constitutes the *status quo* is a matter of perspective."<sup>7</sup>

The first definition of *status quo* would have the licence approved, period, full stop, based on the opinion of the staff of the State's regulator, and in light of the historical approval of the vast majority, if not all, of the licence applications that have come before the CNSC. This is both the historical *status quo* of the CNSC and the *status quo* of this particular licence application as it now stands before the CNSC. This definition of *status quo* is, in my opinion, deficient in that it ignores the relevance of reasoning presented below in considering the third definition. As well, numerous presenters to the 2017 Expert Review Panel on environmental assessment processes expressed the opinion that the CNSC promoted projects they were regulating and were co-opted by the industry they were regulating.<sup>8</sup> The legitimacy of the results of using this *status quo* definition would be entirely questionable

The second definition of *status quo* that I can see derives from the historical record of regulation of nuclear enterprise world wide. It has been proposed, by ecopsychologist and lawyer Zhiwa Woodbury, along with others: Albert Einstein, James Agee, J. Robert Oppenheimer, and Isidor Issac Rabi, that the initial instances of nuclear explosions, first tested in the Nevada desert and then deployed as weapons within the Japanese cities of Hiroshima and Nagasaki in 1945, and the extensive period of nuclear test explosions that continued into the 1970s, in sum constitute a psychological disruption within the collective consciousness that has led to generalized traumatizing of humanity, from which we still suffer.<sup>9</sup>

The inception and continuation of the international Cold War while the nuclear traumatizing was having its negative effects brought a perceived fearful need for the acquisition of weapons to offset dangers from other nation states. The physical health

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<sup>6</sup> Tadros *CNSC Staff Report*.

<sup>7</sup> Scott 67 *Shifting the Burden*

<sup>8</sup> Gelinias 50 *Building Common Ground*.

<sup>9</sup> Woodbury 3f, 20, 24-26, 87f, 93, 96 *Climate Sense*.

problems associated with ionizing radiation exposure, the problem of traumatized mass psychology, the abhorrence of the effects of atomic explosions by the general public, combined with the perceived need for nuclear weapons led to attempts to find peaceful uses of atomic energy, and eventually to the compromise of regulated exposure limits and the As Low As Reasonably Achievable (ALARA) principle within nuclear enterprise, both civilian and military. These conditions have continued into the present as the *status quo* of international nuclear regulation.

The reasoning of this second definition uses thinking that, though relevant to Canadian nuclear regulation, is outside the demonstrated expertise of the State-assigned regulator as it is now constituted, to consider, critique, and correct. This second definition of a *status quo* is nevertheless the underlayment of Canadian state-sponsored nuclear regulation

The third definition of *status quo* that I can see is a consideration of the alternative view of radioactive risk expressed by health and other professionals who work outside of State purview, and who are not bound by a weapons-based rationalized underpinning of the second definition of *status quo* above.

The linear-no-threshold model of low-dose risk that followed from the BEIR studies<sup>10</sup> confirmed that any ionizing radiation dose carries a health risk. As well, philosophical analysis<sup>11</sup> of the problems associated with the utilitarian philosophy of the second *status quo* definition, in relation to the development and adaptation of human rights philosophy<sup>12</sup> cast severe doubt on the ethicality of the basis of international nuclear regulation. Further, regulatory reliance on limits to external body dose has been shown by additional science studies and the experiential health effects of depleted uranium weapons used in Afghanistan, Iraq and the Balkans to be deficient in lack of general credence given to internal dosages from alpha-emitting particles of uranium and other radioactive materials,<sup>13</sup> eg. the uranium dioxide powder used to form compressed and sintered pellets for CANDU nuclear power plant fuel rod bundles, the process proposed to be started at the Peterborough BWXT facility.

Summing up the arguments to justify the allocation of burden of proof:

*"1. Those who want a change from the status quo should bear the burden of proof. ...."*

Of the three proposed definitions of the *status quo*, in my opinion only the third definition has validity -- that of alternative science outside of State political influence.

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<sup>10</sup> National Research Council "BEIR VII."

<sup>11</sup> Busby and Valentin. *Public Debate*: video 1(2) 49:58-52:20, and video 2(2) 0:00-01:10; Busby et al 2010, 22-25 *Health Effects of Exposure*

<sup>12</sup> United Nations *Universal Declaration of Human Rights*.

<sup>13</sup> Busby 2010 10-21 *Uranium and Health*; Busby et al 2010 *Health Effects*; Al-Ani and Baker *Uranium in Iraq*.

The first definition of *status quo* is discredited by the history and mandate of the CNSC. The second definition of *status quo* has been superseded by adoption of human rights principles, the linear-no-threshold low dose model, and experimental and experiential evidence of internal alpha-emitters.

"2. Those with the best access to relevant information or knowledge should bear the burden of proof. .... This would point to the applicants and to the regulator, not to interveners, as responsible for bearing the burden of proof.

"3. Equity considerations, such as resources and power, should determine which party bears the burden of proof." This would also point to the applicants and to the regulators and not to interveners, as responsible for bearing the burden of proof.

On these bases the rather surprising result is that the burden of proof should logically lie with the regulator and the applicant, and the benefit of the doubt should be given to the presentations of interveners who argue from within the third definition of the *status quo*, that of the alternative view of radiation risk developed by scientists primarily outside the purview of State-supported reasoning.

But this is not how the CNSC operates. In real terms, all adjudication of the allocation of burden of proof is retained within the CNSC. This is in keeping with the observation that "rules relating to the burdens of proof are largely governed by the substantive law."<sup>14</sup>

Yet how absurd that the CNSC exists within a democratic government, yet operates under a mandated State policy<sup>15</sup> that nuclear industry must go forward. There does not appear to be room for discussion on this key point, at least not within the CNSC.<sup>16</sup>

The repeated questioning and rejection of the CNSC's legitimacy by interveners, and by the presenters at the 2017 Expert Review Panel on federal environmental assessment processes are underlain by the foundational unfairness of the CNSC.

## **Precautionary Principle**

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<sup>14</sup> Sopinka *et al.* 53 *Law of Evidence*.

<sup>15</sup> Canadian Nuclear Safety Commission, 2018 1 *Regulatory Fundamentals*. "The Government of Canada has determined that the use of nuclear substances and nuclear energy offers benefits, and that the associated risks must not be at an unreasonable level." Government of Canada, 1997, 2017, Preamble, *Nuclear Safety Act*, "Whereas it is essential in the national and international interests to regulate the development, production and use of nuclear energy and the production, possession and use of nuclear substances, prescribed equipment and prescribed information...."

<sup>16</sup> Scott 55 *Shifting the Burden*, Sopinka *et al.* 53 *Law of Evidence*.

In plain language then, in both the current example of the BWXT licence renewal application and in general, implementing the precautionary principle would seek to shift the burden of proof to “those who create the hazard, benefit from the hazard, or advocate for the hazard.”<sup>17</sup> It is a moral injunction<sup>18</sup> that calls for action in the face of “scientific uncertainty to prevent potential harm to human health or the environment.”<sup>19</sup> It deals with suspected risks, not just proven risks, and stimulates change by placing the onus on those who create the hazard, and by emphasizing alternatives and democracy.<sup>20</sup> Ethical and moral reasoning would rather prevent “harms to the environment and public health at the cost of banning or slowing the development of harmless chemicals.”<sup>21</sup>

Only recently have polluting activities been called into question.<sup>22</sup> “if we are ignorant, why should it always count against our health?”<sup>23</sup> A societal model often used is the 1992 *Rio Declaration on Environment and Development* “...[w]here there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.”<sup>24</sup>

Opponents to the precautionary principle, labeling it “anti-scientific, irrational and unworkable,”<sup>25</sup> argue that the “...principle is dangerous because it could be applied to force regulatory action on perceived risks where there is no sound scientific basis for action, unnecessarily stifling innovation.”<sup>26</sup>

A primary criticism is that “‘safety’ or harmlessness can never be proved.”<sup>27</sup> But the precautionary principle does not need absolute proof of safety. “[The *absence of evidence of harm* is not the same as *evidence of the absence of harm*.”<sup>28</sup> The precautionary principle calls for “scientific evidence of the absence of harm.”<sup>29</sup> The Royal Society of Canada states that

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<sup>17</sup> Scott 66 *Shifting the Burden*

<sup>18</sup> Dovers and Handmer 178 *Analytical Framework*

<sup>19</sup> Scott 50 *Shifting the Burden*

<sup>20</sup> Scott 50 *Shifting the Burden*, Kriebel et al, 872 *Precautionary Principle in Environmental Science*

<sup>21</sup> Shrader-Frechette 111 *Ethics of Scientific Research*, Page 207 *Generic View*, Cross *Paradoxical Perils*

<sup>22</sup> Scott 50 *Shifting the Burden*, Ogilvie *Expert Consultation*, Freestone 36 *Precautionary Principle*, Freestone and Hey 268 *Implementing Precautionary Principle*, Cameron 46 *Precautionary Principle Core Meaning*, Nollkaemper 85 *What You Risk*, Olson 894 *Shifting the Burden of Truth*

<sup>23</sup> Scott 53 *Shifting the Burden*

<sup>24</sup> *Rio Declaration*

<sup>25</sup> Cross 852 *Paradoxical Perils*, Gray 174 *Statistics*

<sup>26</sup> Conko *Throwing Precaution*

<sup>27</sup> Leiss and Hruday 11 *Proof and Probability*

<sup>28</sup> Kriebel et al. 871 *Precautionary Principle in Environmental Science*

<sup>29</sup> Scott 56 *Shifting the Burden*

“evidence of the absence of harm’ would imply that ‘rigorous and intensive scientific investigation’ has failed to show any evidence for harm.”<sup>30</sup>

Burden of proof is central to discussions of precautionary principle. A “framework of an ethically defensible and socially acceptable distribution of burdens of proof” is needed for environmental and health regulation to be effective.<sup>31</sup> Discussions of burdens of proof highlight the pervasiveness of trade-offs. For example: benefit of the doubt/burden of proof; risk of convicting the innocent/risk of freeing the guilty; Type I error: false alarm/Type II error: devastating tragedy<sup>32</sup>. The discussions touch on the nature of certainty, the difference between risk assessment and risk management, and error burdens in statistics and law.<sup>33</sup>

Cranor makes the point that the “epistemology implicit in scientific standards and burdens of proof”<sup>34</sup> need not “pre-empt our achievement of social goals in line with the values embodied by the precautionary principle.”<sup>35</sup>

Nor will bringing precaution into the core of scientific “truth seeking” cause “giving up on the truth” Just the opposite. Burdens of proof are biased, deliberately. Shifting burdens of proof means being explicit about what values are favoured and why. Without this clarity of understanding any truth arrived at by science encompasses “a hidden judgement -- a measure of justice not disclosed.”<sup>36</sup>

The presumptions of conservatism are not ethically neutral doctrine.<sup>37</sup> [T]he values are not explicit, “which makes it too closed and inflexible to respond to the complexities of implementing the precautionary principle.”<sup>38</sup> A respectful approach would recognize the value of an unpolluted or less-polluted environment and apply the burden of proof to those who would maintain a polluted state or increase the pollution. Doing otherwise “institutionalizes the polluting activity [either current or in the past] as the status quo.”<sup>39</sup>

Considerations of the theory of distribution of argumentative burdens: “the codification of probative responsibilities in law is a procedural expression of underlying principles of fairness”<sup>40</sup> will indicate that in each situation whether there is justification for a shifted burden:

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<sup>30</sup> Royal Society of Canada, *Elements of Precaution*

<sup>31</sup> van den Belt and Gremmen 105 *Distributing Burdens*

<sup>32</sup> Scott 70 71 *Shifting the Burden*

<sup>33</sup> Scott 59, *Shifting the Burden*

<sup>34</sup> Cranor 79 *Asymmetric Information*

<sup>35</sup> Scott 65 *Shifting the Burden*

<sup>36</sup> Scott 66 *Shifting the Burden*

<sup>37</sup> Raikka 467 *Burden of Proof Rules*

<sup>38</sup> Scott 67 *Shifting the Burden*

<sup>39</sup> Olson 894 898 *Shifting the Burden of Proof*

<sup>40</sup> Kaufield, 246 *Presumptions and Distribution*

By harkening back to the traditional purpose of burden of proof, maintaining the status quo ante, courts could effectively use the legal process and existing, well-developed and widely accepted doctrine to protect the environment from polluting activities. Shifting the burden of proof in the context of toxic or hazardous chemicals is a truer expression of the purpose underlying that burden than allowing such pollution to continue in the guise of protecting the status quo. Shifting the burden of proof does nothing more than internalize the costs, risks and uncertainty of hazardous products or by-products to those who have the information, expertise, and control in the first instance.<sup>41</sup>

“The onus to demonstrate safety placed on [the agents...whose actions contribute to or pose the threats]” would provide benefits to society for “their greater need to minimize damage than would be in place if they did not bear the burden of proof.”<sup>42</sup>

In the field of statistics that comes into play in considering the precautionary principle, we have to indulge in esoteric terminology, terms that are abstract, complex to grasp and easy to confuse. These terms are used to discuss the science that evaluates the probability of being true that proposed hypotheses have.

Type I error: “false alarm,” rejecting a true hypothesis, creates a false positive.

Type II error: “devastating tragedy,” accepting a false hypothesis, creates a false negative.

Typical burdens of proof in science, which are designed to prevent false positives, “tend to protect potential toxic substances (and those with an interest in these substances)”<sup>43</sup>

“Statistical power analysis focuses on the risk of committing a Type II error. .... The process of scientific peer review enforces this convention by demanding statistical significance at the 95 percent confidence level before research findings are considered robust enough for publication. This means that ‘early warnings’ are essentially precluded -- a truly precautionary science would not wait to report until the risk of committing a Type I error was below the 5 percent convention.”<sup>44</sup>

“The choice of a threshold of statistical significance is ‘an issue of pure policy’ .... ...to ‘take precaution by avoiding Type II errors rather than Type I errors is...no threat to the objectivity of science’.”<sup>45</sup> A precautionary science might use “statistical power

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<sup>41</sup> Olson 915 *Shifting the Burden of Proof*

<sup>42</sup> Scott 68 *Shifting the Burden*, Canor 86 *Asymmetric Information*

<sup>43</sup> Cranor 79 *Asymmetric Information*, Barrett and Raffensperger 112 *Precautionary Science*

<sup>44</sup> Olson 63 *Shifting the Burden*, Sanderson and Peterson 221 *Power Analysis*, Fairbrother and Bennett 943 *Ecological Risk Assessment*

<sup>45</sup> Scott 64 *Shifting the Burden*, Schrecker 42 *Using Science*, Buhl-Mortensen 531 *Type II Statistical Errors*

analysis to arrive at reasoned levels for acceptable risks for both positive and false negatives.”<sup>46</sup> Fairbrother and Bennett have urged, “a critical review of the default assumptions used in risk assessment’ and advocat[ed] for increased attention to ‘reducing the Type II error of risk assessment studies’”<sup>47</sup>

Also calling for radical review of a scientific bias against false positives are Barrett and Raffensperger: “following false positives may generate more research questions and ultimately yield more correct information than following false negatives.”<sup>48</sup>

Precautionary science explicitly confronts “...inherent uncertainties in complex systems. Acknowledging that these uncertainties are profoundly uncontrollable and largely irreducible need not be paralyzing, but it will have profound repercussions for the methods and roles of science.<sup>49</sup> We should strive at all times to make the boundaries of our knowledge very explicit.”<sup>50</sup>

In implementing the precautionary principle there have been many different methods used, and that itself is the primary characteristic of implementation, that each particular case must determine, through the interaction of the “underlying principles of fairness” how the principle is implemented, if it is.<sup>51</sup> Each situation will raise unique moral choices and consequences, so that a standard practice would not likely be fair. The lesson that can be drawn from law, regarding allocation of the burden of proof is that the allocation must, at least in part, be based on policy and fairness.<sup>52</sup> Burdens of proof would be better conceived as provisional and variable, fluid and shifty.<sup>53</sup>

Many imaginative variations of standards of proof and burdens of proof have arisen, for example, in two extremes within international agreements:

a) “...action to avoid potentially damaging impacts of substances that are persistent, toxic, and liable to bioaccumulate even when there is *no specific evidence* to prove a causal link between emissions and effects.”<sup>54</sup>

“b) “...‘completely certain scientific evidence of harmfulness’ is not required in order to justify regulatory action,’<sup>55</sup> where “the party coming forward with the ‘evidence’ is still the party alleging harm.”

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<sup>46</sup> Scott 66 *Shifting the Burden*, Royal Society of Canada 199 *Elements of Precaution*

<sup>47</sup> Scott, note 126 *Shifting the Burden*

<sup>48</sup> Barrett and Raffensperger, 117 *Precautionary Science*

<sup>49</sup> Barrett and Raffensperger, 119 *Precautionary Science*

<sup>50</sup> Barrett and Raffensperger, 120 *Precautionary Science*

<sup>51</sup> Kauffield 246 *Presumptions and the Distribution*

<sup>52</sup> Scott 55, 62 *Shifting the Burden*

<sup>53</sup> Nollkaemper 85 *What Your Risk*

<sup>54</sup> *Final Ministerial Declaration* 658

<sup>55</sup> Scott 58 *Shifting the Burden*, Cameron 46 *Precautionary Principle, Core Meaning*

Three examples of “international agreements...already operating under a regime employing a shifted burden for many years.”<sup>56</sup>

- a) Oslo 1972 Commission: dumping wastes at sea.<sup>57</sup>
- b) 1979 moratorium on commercial whaling.<sup>58</sup>
- c) 1989 international law of the sea: driftnet fishing.<sup>59</sup>

A recent example is an intermediate position taken by the European Commission: action is justified when “reasonable suspicion” of an unacceptable environmental risk exists but the causal relationship is unclear.<sup>60</sup>

Another type calls for “a standard analogous to the civil law standard of proof -- a ‘balance of probabilities.’” This, “in conjunction with a burden of proof to the promoter of a technology, would mean that the promoter would have the burden of establishing that at least the weight of evidence does not support a *prima facie* case of serious risk.”<sup>61</sup> But the scheme may “allow the proponent to come forward with evidence that rebuts the alleged harm in order to avoid the regulatory action,” as is the case with the *Convention on Biological Diversity*<sup>62</sup>

Yet another example is the widespread practice of “reverse listing,” which “requires proponents of potentially harmful substances or activities to apply for permits to operate or enter a market.” A proponent must demonstrate “safety” according to some pre-determined threshold in order to proceed. Although reverse listing and other similar regulatory solutions “work well for substances and products deliberately introduced onto the market, they are not effective at addressing risks from toxic pollution or the unanticipated by-products of industrial processes.”<sup>63</sup> However, “with respect to toxic chemicals in Canada there is nothing ‘precautionary’ about the regulatory regime.<sup>64</sup> ‘although the [*Canadian Environmental Protection Act, 1999*] endorses the precautionary principle in theory, in practice toxic chemicals are allowed to be used in Canada until there is conclusive scientific evidence of their health or environmental impacts’.”<sup>65</sup>

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<sup>56</sup> Scott 56 *Shifting the Burden*

<sup>57</sup> *Convention for the Prevention of Marine Pollution*

<sup>58</sup> Nollkaemper, note 64, *Amendments to the Schedule of International Convention for the Regulation of Whaling*, adopted by the 31st annual meeting of the International Whaling Commission, 13 July 1979

<sup>59</sup> *Resolution 44/255 on Large-Scale Pelagic Driftnet Fishing and Its Impact on the Living Marine Resources of the World’s Oceans and Seas*, 22 December 1989, reprinted in (1990) 29 I. L. M. 241

<sup>60</sup> European Commission 19 *Communication on Precautionary Principle*

<sup>61</sup> Royal Society of Canada 57 *Elements of Precaution*

<sup>62</sup> Farrier 108 *Factoring Biodiversity*

<sup>63</sup> Cranor 94 *Asymmetric Information*

<sup>64</sup> Scott note 68 *Shifting the Burden*

<sup>65</sup> Boyd 40 *Unnatural Law*

Burdens of proof also “can aim to protect against mistakenly overturning the hard-earned epistemic *status quo* and mistakenly adding to the stock of scientific knowledge.”<sup>66</sup> Burdens of proof can be shared by the parties.<sup>67</sup>

A major on-going discussion regards whether precaution is better implemented at the risk assessment state or the risk management stage of analysis. The European Commission assigns the precautionary principle to be implemented by policy makers - not scientists.<sup>68</sup>

Two distinct approaches to an appropriate role for science under a precautionary principle have emerged: a) undisturbed “sound science” identifies all the risks before precaution is applied “essentially as an exercise in risk management.”<sup>69</sup> b) precaution is forced into the core of science, “to penetrate the institution of risk management and to challenge the way science is conducted.”<sup>70</sup>

Underneath discussion of the precautionary principle lies a conflict of authority: between policy decisions based on “sound science on the one side, and deference to a moral authority on the other side, to democracy, or to ethics:

The opposition between scientific and ethical authority...has fostered a contemporary drama in which scientific reason comes under periodic scrutiny from a purportedly higher normative tribunal. As part of their adversarial confrontation...both science and ethics have increasingly modelled themselves on judicial proceedings.<sup>71</sup>

The precautionary principle is aligned with a broad transition in science, moving from the “reductionist, analytical worldview that divides systems into smaller and smaller elements” to a systems view based on “unpredictability, incomplete control and a plurality of legitimate perspectives.”<sup>72</sup> The precautionary principle will assist in renegotiating the appropriate role for science in public discussion about risk.

As the burdens of proof have been tentatively moving close to the core of scientific reasoning, it becomes clear that science is not “natural” knowledge, but it “involves the possible reshaping of the ‘natural’ knowledge itself.”<sup>73</sup> The precautionary principle will not present easy choices, rather more likely will it be raised “in contexts that present difficult choice between the environment and public health...or between one health risk

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<sup>66</sup> Cranor 79 *Asymmetric Information*

<sup>67</sup> van den Belt and Gremmen 111 *Distributing Burdens*

<sup>68</sup> European Commission *Commission Adopts Communication*

<sup>69</sup> Scott 60 *Shifting the Burden*

<sup>70</sup> Myers 214 *Precautionary Principle Puts Values First*

<sup>71</sup> Gaskins xvi *Burdens of Proof*

<sup>72</sup> Functowicz and Ravetz 1881 *Uncertainty, Complexity, Capra and Luisi passim Systems View*

<sup>73</sup> Wynne 112 *Uncertainty and Environmental Learning*

and another... It is these situations that will test the value of the precautionary principle.<sup>74</sup>

Precaution will only gradually be accepted by decision-making institutions and the political consciousness of humanity, as the tenor of the times permits.<sup>75</sup>

### **Democratic Promise**

Shifting the burdens of proof to favour the precautionary principle will most likely occur gradually “as reversible, contingent, and with circuitous tendencies,” and not as a sudden, revolutionary change. When it does come about, public engagement with risk is not likely to have a sense of shared values that could “determine without controversy where burdens of proof should rest. The “ensuing dialogue and deliberation, on the basis of explicitly stated value assumptions, associated with the allocation of proof burdens, coupled with a transparent discussion of distributive impacts, will be critical to achieving democratic resolution of risk controversies.”<sup>76</sup>

“The cost of blindly pretending that the determination of risk is a ‘truth-seeking’ technocratic exercise is that the public cedes the power to seek justice in risk management.”<sup>77</sup>

“Democratic ideals require that decisions affecting people’s health be made in a manner that affords them a voice. Precaution, because it forces decision makers to regulate without recourse to the authority of formal science, sanctions the participation of a broad array of societal actors.”<sup>78</sup> ...“by explicitly noting the limits of scientific determination,” the precautionary principle legitimates the public, political determination of issues. ...[it] “allows for the democratization of international environmental regimes.”<sup>79</sup>

Restricting discussions to science, with values not allowed into discussion, “simply serves to ensure that the values currently upheld continue to reign.”<sup>80</sup> The democratic promise of burden shifting “derives from its tendency to expose the trade-offs inherent in risk analysis.”<sup>81</sup> This change, the “democratic promise of shifting truth burdens and applying them in recognition of particular circumstances is not a monumental nor [an] unnatural change.”<sup>82</sup>

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<sup>74</sup> Scott 71 *Shifting the Burden*

<sup>75</sup> O’Riordan and Cameron 26 *History and Significance*

<sup>76</sup> Scott 70 71 *Shifting the Burden*

<sup>77</sup> Scott 69 *Shifting the Burden*

<sup>78</sup> Scott 69 *Shifting the Burden*

<sup>79</sup> Cameron 43 *Precautionary Principle, Core Meaning*

<sup>80</sup> Meyers 215 *Precautionary Principle Puts Values First*

<sup>81</sup> Scott 52 *Shifting the Burden*

<sup>82</sup> Miller and Conko *Science of Biotechnology*, Wildavsky 430 *But Is It True*

## Indeterminacy of Scientific Knowledge

"You can tell a critic of the precautionary principle by his or her vehement defence of 'sound science'." This dramatic overstatement nevertheless invokes the tension between a valorized view of science and a democratic view of science. Each of the many science fields has its own methods, models and assumptions.<sup>83</sup> "Sound Science" within each field "is as much a product of culture as of principle."<sup>84</sup> The underpinning ideas of "conventional science are not explicit. Procedures promoted as objective and neutral are actually steeped in in a very specific set of values." So "the problem with seeking only truth in science...is that science does not deliver an objective truth. It delivers truth with a healthy dose of justice mixed in."<sup>85</sup> No single scientific method of generating "objective evidence" upon which to base policy exists. There are "[m]any methods, many of which aim to avoid the most obvious errors: "controlled comparisons; double-blinds; matching of populations for age, sex, income, and so on; replication and statistical analysis; mathematical models; and hypothesis testing."<sup>86</sup>

Conventional risk assessment methods "...treat all uncertainties as if they were due to the incomplete definition of an essentially determinate cause-effect system." "Scientific "uncertainty is conventionally described as a lack of data," eg. a situation unmonitored or situation too expensive to measure, which leads to viewing risk as "amenable to resolution...by 'more science' to fill the gaps."<sup>87</sup> A complaint is sometimes put forward "that risk assessors adopt 'worst-case' assumptions when data are unavailable or insufficient.<sup>88</sup> But this is countered by the argument that use of "worst-case" assumptions cannot be justified solely on scientific ground, or else the risk assessor is assuming the role of a risk manager in deciding if "a given risk is 'acceptable' to society."<sup>89</sup>

Complex systems may "operate according to processes that cannot be captured by...methods" of conventional science.<sup>90</sup> All scientific assessment has contingencies due to the "chaotic, inherent unpredictability in natural processes" and "the conditional and erratic influences of social behaviour."<sup>91</sup>

The failure of our "environmental management regimes" -- and of our health protections against radiological hazards -- shows the "poverty of our science and the danger of lodging final authority in scientific experts."<sup>92</sup> "Dissatisfaction with risk

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<sup>83</sup> Scott 59 *Shifting the Burden*

<sup>84</sup> Scott 59 *Shifting the Burden*, Wynne and Meyer 33 *How Science Fails the Environment*

<sup>85</sup> Scott 59 69 70 *Shifting the Burden*, Sanderson and Peterson 126 *Power Analysis*

<sup>86</sup> Levins 155 *International Summit*, Shrader-Frechette 150 151 *Ethics of Scientific Research*

<sup>87</sup> Wynne 112 *Uncertainty and Environmental Learning*, Silbergeld 100 *Risk Assessment and Risk Management*, Hunt 118 *Social Construction*

<sup>88</sup> Breyer 48-49 *Breaking the Vicious Circle*, Cross, *Paradoxical Perils*

<sup>89</sup> van den Belt and Gremmen 115 *Between Precautionary Science and Sound Science*

<sup>90</sup> Wynne and Meyer 80 *How Science Fails the Environment*

<sup>91</sup> Scott 69 *Shifting the Burden*

<sup>92</sup> Scott 53 *Shifting the Burden*

assessment models... has stimulated a rejection of 'the idealistic notion that all scientific certainties can be accounted for and controlled' because the view premised on a world that is deterministic (ultimately knowable) and probabilistic (calculable) has been largely discredited."<sup>93</sup> Indeterminacy is an important impetus behind the precautionary principle;<sup>94</sup> the principle applies only in situations of scientific uncertainty.<sup>95</sup> It "implicitly recognizes and takes seriously the indeterminacy of scientific knowledge...and this opens up the normally closed-off connection between the intrinsically open question, how much harm might this discharge do? And the social question, how much do we need this process which causes this discharge?"<sup>96</sup> Indeterminacy recognizes 'the essentially open-ended and conditional nature of all knowledge and its embeddedness in social contexts.'<sup>97</sup>

Although "implementation of the precautionary principle...is a technical problem" involving only "reconsidering some assumptions and manipulating some values into a statistical formula that is rarely challenged ...the reconsideration of the structure of hypothesis testing is a decidedly political matter. The choice to move to a precautionary science is very much about values."<sup>98</sup>

"If the status of scientific knowledge shifts from being the objective, final arbiter to a more conditional and consensus-seeking form, which allows other forms of knowledge equal standing (and there is evidence that this is occurring), then its legitimate function may be affirmed through a more realistic, and less rhetorical appreciation of what science can and cannot do with respect to environmental management."<sup>99</sup> "...a science incorporating 'mutual respect among various perspectives and forms of knowing' opens up the 'possibility for the development of a genuine and effective element in the life of science'."<sup>100</sup>

### **CNSC Organization**

The references below discuss the disagreement between science as only objective and science as influenced by values.<sup>101</sup>

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<sup>93</sup> Barrett and Raffensperger 113 *Protecting Public Health*

<sup>94</sup> Gaskins 20 *Burdens of Proof*, Raikka 463 *Burden of Proof Rules*

<sup>95</sup> Scott 57 *Shifting the Burden*

<sup>96</sup> Hunt 121 *Social Construction*

<sup>97</sup> Hunt 118 *Social Construction*, Barrett and Raffensperger 119 *Precautionary Science*

<sup>98</sup> Sanderson and Peterson 126 *Power Analysis*, Scott 65 *Shifting the Burden*

<sup>99</sup> Hunt 125 *Social Construction*.

<sup>100</sup> Functowicz and Ravetz 1882 *Uncertainty, Complexity*

<sup>101</sup> Silbergeld 99 100 *Risk Assessment and Risk Management*, Wildavsky 431 *But Is It True?*, Gray 1990a 174 *Statistics and the Precautionary Principle*, Gray 1990b 599 *Rejoinder to Johnston and Simmonds*, Johnston and Simmonds 402 *Letters: Precautionary Principle*, Jasanoff 9 100 *The Fifth Branch*, Shelton 212 *Impact of Scientific Uncertainty*, Skodvin and Underdal 22 *Exploring the Dynamics*, Breyer 48-49 *Breaking the Vicious Circle*, Cross 851

What is sometimes seen as the ideal relationship between science and politics is artificial: “knowledge -- generated by competent truth-seeking scientists working in accordance with stringent professional standards -- is communicated, undistorted, to decision-makers who then utilize it as factual premises for policy decisions.”<sup>102</sup> But this “negotiated and constructed model of scientific knowledge, which closely captures the realities of regulatory science, rules out the possibility of drawing sharp boundaries between facts and values or claims and context.”<sup>103</sup> Nor can experts “be separated from their own views and perspectives...”<sup>104</sup> The “diversity of values...will lead individual scientists to different conclusions concerning phenomena that are uncertain.”<sup>105</sup>

Regarding CNSC internal practices, there is no clear answer that I could find to the question of whether to apply the precautionary principle at the risk assessment stage (licencing) or at the risk management stage (regulation). However, neither “risk assessment nor risk management are ‘neutral,’ ‘objective’ processes, so there is no reason to presume that burden shifting should occur at the latter stages only.”<sup>106</sup> And the “allegedly purely ‘scientific’ risk assessment now must consider the ‘politics’ of risk management.”<sup>107</sup>

A few final thoughts from the literature:

“...inferential caution and scepticism intended to protect ‘progress’ can have the result of protecting certain interests at the expense of others.”<sup>108</sup>

“Choosing the appropriate statistical test involves a determination of which is the more harmful mistake: interrupting business-as-usual to declare a substance harmful, when it is later shown to be safe, or to carry on business-as-usual when the substance is actually harmful” Each situation will be unique. The decision is not a technical one.<sup>109</sup>

As an eloquent implied call for the implementation of the precautionary principle please allow me one more quotation.

By far, the most influential obstacle to disease recognition and its consequences has been the onerous burden of proof placed on the worker coupled with an out-dated view of how disease (sic) is produced by work, one that is out of sync with advances in occupational health and cancer research .... This paradigm is imbedded in current scientific research and standard setting processes and is expressed in our obsession with protecting

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*Paradoxical Perils*, van den Belt and Gremmen 115 *Between Precautionary Principle and Sound Science*.

<sup>102</sup> Skodvin and Underdal 22 *Exploring the Dynamics*.

<sup>103</sup> Jasinoff 231 *Fifth Branch*

<sup>104</sup> Jasinoff 9 *Fifth Branch*

<sup>105</sup> Shelton 212 *Impact of Scientific Uncertainty*

<sup>106</sup> Scott 60 *Shifting the Burden*

<sup>107</sup> van den Belt and Gremmen 119 *Between Precautionary Principle and Sound Science*

<sup>108</sup> Scott 65 *Shifting the Burden*

<sup>109</sup> Scott 63 *Shifting the Burden*

against “false positives” without thinking about the consequences of “false negatives.” Unfortunately, this mindset has permeated into administrative tribunals and standard setting bodies, which has produced its own set of detrimental consequences including unjust denial of compensation for diseases caused by work and delayed regulatory action for disease prevention.<sup>110</sup>

## **Conclusion**

All the arguments and discussion about burden of proof, indeterminacy of science, and the precautionary principle are moot, so long as the adjudicator of the allocation of the burden of proof is the regulator itself, which has a legal mandate, under legislation, to advance the very processes that are the source of the pollution.

As noted above, the preamble of the *Nuclear Safety Act* states, “Whereas it is essential in the national and international interest to regulate the development, production and use of nuclear energy....” And the first statement of the CNSC *Regulatory Fundamentals* is “The Government of Canada has determined that the use of nuclear substances and nuclear energy offers benefits....” Both these documents then quickly proceed to recognize the importance of safety, but nevertheless safety remains secondary to “development, production and use.”

Now we can see why the licensing process invariably results in licence approval, why the 2017 Environmental Assessment Review Panel heard repeated complaints of the nuclear regulator promoting projects they were also regulating and that their regulatory efforts were captured by the interests of the industries they were regulating, and why CNSC hearing interveners are regularly frustrated by, and angry at the adjudicating panel, perhaps even a reason why Peterborough’s Shield Source Inc. was allowed to continue releasing amounts of tritium into the air far above what their deficient stack monitoring equipment showed, even after the public complained of elevated tritium levels in the neighbourhood near the plant.

All of that is the actual legislated role of the CNSC: To regulate in a way that does not interfere with the benefits of nuclear substances and energy in their production, development and use.

At last we get it -- we understand the rationale, and we get the human and living environmental suffering caused by the polluting results of the rationale.

So I want to end my presentation with a poem that I wrote called, “To the CNSC Hearing.”

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<sup>110</sup> DeMatteo *et al.* 2, *General Electric Retrospective Exposure Profiling*

*To the CNSC Hearing*

one atom to another  
let's blow this fascist pop stand  
another atom to the one  
relax we are already

Einstein, Bohr, Wheeler,  
Schrödinger, Pauli, Bohm,  
Feynman, Heisenberg, von Neumann, Planck,  
Oppenheimer, Gell-Mann, Lederman, Hill,  
Mindell, Preskill, Stapp,  
Rabi, Vedral  
physicists all singing in chorus  
we can observe but we cannot understand  
we can observe but we cannot understand

call us by our true names  
-- borderland ( ) firebrand --  
lighting the crossover  
dharmakaya's chance of awakening  
only two inches above the floor  
and journey of a thousand lives

oh look  
you have attracted a three dimensional triangular  
gaggle of followers  
trailing your footsteps

why squander your moxie  
carrying water for corporate bureaucrats  
transcendent beauty of the quantum  
is wasted on weapons  
on boiling water for mechanical electricity  
while geese flying low over the city  
honk their name to follow  
your lead

- CNSC stands for Canadian Nuclear Safety Commission
- Inadequacy of physicists' rational thinking to grasp quantum from Levy, *Quantum Revelation*
- True names from Thich Nhat Hanh, *Please Call Me by My True Names*
- Two inches above the floor from Puja for *Realization of Awakening: The Recollection of the Innate Identity of Everyday Mind and the Awakened Mind To Be Done Internally*, oral instruction from Joti Dhamma 1974; D. T. Suzuki in *Spanda Journal VII.1*
- Dharmakaya as possibility of awakening from Miura and Sasaki, *Zen Koan*

## Glossary

ALARA: As Low as Reasonably Achievable  
BEIR: Biological Effects of Ionizing Radiation  
BWXT: BWXT Nuclear Energy Canada Inc.  
CANDU: Canadian Deuterium and Uranium  
CNSC: Canadian Nuclear Safety Commission  
ECRR: European Committee on Radiation Risk  
GE: General Electric

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