

# Confronting Uncertainty under NEPA

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*“[A]s we know, there are known knowns; there are things we know we know. We also know there are known unknowns; that is to say we know there are some things we do not know. But there are also unknown unknowns -- the ones we don't know we don't know. And if one looks throughout the history of our country and other free countries, it is the latter category that tend to be the difficult ones.”* – Donald Rumsfeld<sup>2</sup>

*“I beseech you, in the bowels of Christ, think it possible you may be mistaken.”*—Oliver Cromwell.

Often, it is difficult to quantify risks with confidence. For the past thirty years, agencies and courts have struggled with the treatment of uncertainty in environmental impact statements.<sup>3</sup> As we will see, the results have been an unsatisfactory muddle. We should be able to do better.

This problem is all the more important today. Climate change will require innovative solutions – new energy technologies, new adaptation strategies. These innovations will inevitably pose risks, often in the form of possible harm to human welfare or the environment. Climate change itself involves uncertainties. Evaluating these risks and informing decision makers and members of the public will be challenging.

Part I of this article will provide background on the National Environmental Policy Act (NEPA) for the uninitiated and use the example of dam failure to illuminate the problem of risk assessment in impact statements. Part II uses nuclear power as the basis for a detailed case study. In Part III, the focus turns to the effort of the Council on Environmental Quality to guide agency consideration of uncertainty. Finally, Part IV provides some suggestions for improvement, and Part V offers a brief conclusion.

## I. An Overview of NEPA

Environmental assessments of all kinds – federal, state, and even international – have their origin in a 1970 federal statute. Section 101 of the National Environmental Policy Act (NEPA)<sup>4</sup>

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<sup>2</sup> DoD News Briefing - Secretary Rumsfeld and Gen. Myers, Feb. 12, 2002, available at <http://www.defenselink.mil/transcripts/transcript.aspx?transcriptid=2636>.

<sup>3</sup> A particularly useful discussion of these methods, focusing on the Environmental Protection Agency (EPA), can be found in National Research Council, *Science and Decisions: Advancing Risk Assessment* (2009).

proclaims the policy of the federal government to administer federal programs in an environmentally sound fashion. In practice, the most significant provision of NEPA is undoubtedly section 102(2)(C). This section is designed to force agencies to take environmental factors into consideration when making significant decisions. The crucial language of this subsection reads as follows:

The Congress authorizes and directs that, to the fullest extent possible: . . . (2) all agencies of the federal government shall

. . .

(C) include in every recommendation or report on proposals for legislation and other major Federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official on

(i) the environmental impact of the proposed action,

(ii) any adverse environmental effects which cannot be avoided should the proposal be implemented,

(iii) alternatives to the proposed action . . . <sup>5</sup>

Section 102(2)(C) goes on to require the federal agency to consult other agencies with jurisdiction over or special expertise concerning the environmental problem involved. Copies of the environmental impact statement (EIS) are to be circulated among relevant government agencies and to the public (though in practice access by the general public may be more of an aspiration than a reality).<sup>6</sup> Under section 102, the EIS is also supposed to “accompany the proposal through the existing agency review processes.” Other provisions of NEPA establish the White House Council on Environmental Quality (CEQ), which has been designated as the lead agency in implementing the EIS requirement.<sup>7</sup>

In essence, the statute requires a federal agency to prepare a detailed explanation of the environmental consequences of its actions, and to make that report available to higher-level agency officials, other agencies, and the public.

Three requirements must be met before an EIS is necessary. The proposed action must (1) be federal, (2) qualify as “major,” and (3) have a significant environmental impact. Only the issue of significant impact has turned out to be difficult to resolve. To determine whether the impact of a project will be “significant,” the CEQ regulations instruct agencies to consider factors such as impact on public health, unique features of the geographic area, the precedential

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<sup>4</sup> 42 U.S.C. § 4331.

<sup>5</sup> 42 U.S.C. § 4332(2)(c).

<sup>6</sup> Internet access to EISes is still quite spotty, and EAs are often difficult to track and rarely archived. See Daniel A. Farber, *Bringing Environmental Assessment into the Digital Age* (2006), available at [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=877625](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=877625).

<sup>7</sup> NEPA §§ 202-209, 42 U.S.C. §§ 4342-4347.

effect of the action, and whether the action is highly controversial.<sup>8</sup> Even after considering these factors, a determination must be made about their magnitude. Note that there is a certain circularity here: In order to determine whether it is necessary to study and report on the environmental impacts of a project, the agency must first determine the possible scope of those impacts. Thus, there is a certain amount of overlap between the initial decision making process about whether to prepare an EIS and the actual preparation of the EIS.

The language of NEPA suggests that a detailed assessment is required in the presence of “significant” impacts, but no assessment at all is needed otherwise. There is no mention of the need for any formal assessment except when significant impacts are predicted; thus, there seems to be a binary choice between a “detailed statement” and no statement at all. The system has evolved differently. In practice, the question is usually not whether to perform an environmental assessment, but how detailed the assessment needs to be. Essentially, if significant impacts exist and cannot be mitigated successfully, the project receives a full-scale assessment. A less intense assessment is used if the agency believes that the impacts are not significant or can be eliminated through mitigation.

If the agency does decide to prepare an EIS, the first step in the EIS process is called “scoping.” Scoping is intended to obtain early participation by other agencies and the public in planning the EIS, to determine the scope of the EIS, and to determine the significant issues to be discussed in the EIS. The actual preparation of the EIS itself involves a draft EIS, a comment period, and a final EIS. Agencies with jurisdiction or special expertise relating to the project are required to comment. Major inter-agency disagreements are to be referred to CEQ for its recommendation. When an agency reaches a final decision on the project, it must prepare a “record of decision” summarizing its actions, explaining the grounds for eschewing any environmentally preferable alternatives, and discussing mitigation measures.<sup>9</sup> If significant new information emerges subsequently, the agency may be required to prepare a Supplemental EIS (SEIS).

#### A. When Is a Risk “Significant”? The Case of Dam Collapse

If it occurs, an event may be extremely harmful, yet the probability may be so low that it is not worth discussing. For instance, the chances of a meteor strike at a specific location

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<sup>8</sup> 40 C.F.R. § 1508.27.

<sup>9</sup>The CEQ has attempted to clarify both the timing and scope issues. The current regulation, 40 C.F.R. § 1508.23, defines the term “proposal” as follows:

“Proposal” exists at that stage in the development of an action when an agency subject to the Act has a goal and is actively preparing to make a decision on one or more alternative means of accomplishing that goal and the effects can be meaningfully evaluated.

Other CEQ regulations make it clear that the EIS should be “prepared early enough so that it can serve practically as an important contribution to the decisionmaking process,” not simply “to rationalize or justify decisions already made.” 40 C.F.R. § 1502.5. The CEQ regulations also require the EIS to consider “(a) connected actions which are closely related, (b) actions which may have a cumulative effect with the proposed action under consideration, and (c) similar actions that should be considered together in view of other Areasonably foreseeable or proposed agency action.” 40 C.F.R. § 1508.25.

presumably do not need to be discussed. But whether a risk is significant enough for discussion is often hotly disputed.

Plaintiffs challenging dam construction projects often argue that the projects' EISes inadequately discuss the possibility of catastrophic dam failure, and thereby violate the National Environmental Policy Act (NEPA). Courts generally find this argument unconvincing, applying the rule that "[a]n EIS need not discuss remote and highly speculative consequences" and that the "adequacy of the content of the EIS should be determined through use of a rule of reason."<sup>10</sup> In *Trout Unlimited*, the Ninth Circuit considered the erection of the Teton Dam to form a reservoir in a canyon of the Teton River.<sup>11</sup> Plaintiff environmental organizations claimed the project's EIS was defective because it failed to discuss the environmental consequences of the project in sufficient detail.<sup>12</sup> The court did not specify whether plaintiffs argued that the EIS was deficient in its treatment of the risk of catastrophic dam collapse in particular, but held that the consequences the EIS failed to address "while possible," were also "improbable," and that the EIS included a "reasonably thorough discussion of the significant aspects of the probable environmental consequences," which "is all that is required by an EIS."<sup>13</sup> Construction of the project went forward, and the Teton Dam collapsed two years later, on its first filling, causing eleven deaths.<sup>14</sup>

In the *Warm Springs Dam Task Force v. Gribble* litigation, the Northern District of California and the Ninth Circuit considered whether the possibility of an earthquake caused by one of the three faults running near the Warm Springs Dam in Sonoma County, California was sufficiently dealt with in the project's EIS.<sup>15</sup> Plaintiffs initially sought a preliminary injunction to stop construction of the dam until deficiencies in the EIS could be remedied, including its failure to discuss the "ecological impact that would result should the contemplated dam fail."<sup>16</sup> In support of this claim, plaintiffs offered experts that questioned the EIS's underlying seismic studies and its subsequent conclusions, arguing that the Corps lacked a basis for concluding that the dam could withstand the greatest possible seismic event.<sup>17</sup> The district court rejected this argument, finding that the EIS included an "extensive and detailed discussion" of the seismic features of the dam site, and that the disagreement of plaintiffs' experts with the Corps was

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<sup>10</sup> *Trout Unlimited v. Morton*, 509 F.2d 1276 (9<sup>th</sup> Cir. 1974) (citations omitted).

<sup>11</sup> *Id.* at 1279.

<sup>12</sup> *See id.* at 1283.

<sup>13</sup> *Id.*

<sup>14</sup> United States Bureau of Reclamation, the Failure of the Teton Dam, <http://www.usbr.gov/pn/about/Teton.html> (last visited Mar. 1, 2009).

<sup>15</sup> 378 F. Supp. 240 (N.D. Cal. 1974); 431 F. Supp. 320 (N.D. Cal. 1977), *aff'd* 621 F.2d 1017 (9<sup>th</sup> Cir. 1980).

<sup>16</sup> 378 F. Supp. 240, 242-43.

<sup>17</sup> *Id.* at 244.

“neither fatal nor surprising.”<sup>18</sup> The court also found that the debate about earthquakes in the EIS’s comments section suggested the issue had been properly raised and considered.<sup>19</sup>

The Ninth Circuit subsequently denied plaintiffs’ motion for injunction pending appeal in the case, but later granted their application for a stay stopping construction on the project, and the case was eventually remanded to the district court for consideration of plaintiffs’ motion for a permanent injunction.<sup>20</sup> In the intervening period the Corps had supplemented the project’s EIS, including, among other items, an additional discussion of the faults surrounding the dam site.<sup>21</sup> After completion of that supplemental EIS, however, the United States Geological Survey (U.S.G.S.) published a study indicating that the Maacama fault, one of the three faults near to the dam site, might extend farther than previously believed.<sup>22</sup> This new information suggested that the worst potential earthquake in the area could be significantly larger than the Corps had accounted for in their supplemental EIS.<sup>23</sup> The plaintiffs argued that the new study rendered the supplement inadequate.<sup>24</sup> The district court rejected this argument, finding that the U.S.G.S. study did not demonstrate a substantial risk of an earthquake that the proposed dam could not withstand.<sup>25</sup> It further reasoned that were the courts to find EISes deficient on the basis of subsequently discovered information it would “enable industrious and imaginative opponents of any given project to forever postpone its construction.”<sup>26</sup> The district court therefore denied the permanent injunction, finding the “objectives of NEPA have been fully met.”<sup>27</sup>

Although the Ninth Circuit affirmed the district court, the appeals court did not agree that the Corps’ supplemental EIS satisfactorily addressed the concerns raised by the U.S.G.S. study.<sup>28</sup> The court held that although an agency does not need to formally supplement an EIS whenever new information about a project comes to light, it must be reasonable in addressing new information, and consider its environmental significance and likely accuracy.<sup>29</sup> The court

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<sup>18</sup> *Id.*

<sup>19</sup> *Id.* Finally, the court reasoned that “it is doubted that NEPA requires a report of the calamity which would flow from the unlikely event of a Project failure,” because the Corps did not intend to build an unsafe dam and clearly believed the dam would not fail. *Id.* NEPA could not require discussion of a project’s failure, because a successful challenge to an EIS on these grounds “would allow plaintiffs to maintain an otherwise dubious direct attack on the merits of the Project itself under the flimsy guise of environmental impact.”<sup>19</sup>

<sup>20</sup> 431 F. Supp. 320, 321-22 (N.D. Cal. 1977) (summarizing the case’s procedural history).

<sup>21</sup> *Id.* at 322.

<sup>22</sup> *Id.* at 323.

<sup>23</sup> *Id.*

<sup>24</sup> *Id.*

<sup>25</sup> *Id.*

<sup>26</sup> *Id.*

<sup>27</sup> *Id.*

<sup>28</sup> 621 F.2d 1017, 1025 (9<sup>th</sup> Cir. 1980).

<sup>29</sup> *Id.* at 1024.

explained that the new data “raised sufficient environmental concerns to require the Corps to take another hard look at the issues,” because despite being speculative, the study undermined a key assumption about the safety of the project.<sup>30</sup> The Corps had prepared the supplement under the belief that the San Andreas fault posed the greatest threat to the dam, not the Maacama, and had designed the project accordingly.<sup>31</sup> The study now suggested that the Maacama could be the controlling fault for design purposes, and the court reasoned this suggestion significant enough to require the agency’s consideration.<sup>32</sup> Given that the supplemental EIS did not address the data at all, the court held that its failure to do so was unreasonable.<sup>33</sup>

Nonetheless, the court held that the Corps remedied this deficiency by undertaking a ten-month study of the Maacama fault, which they began one month after the start of trial.<sup>34</sup> This “extensive” study considered the U.S.G.S. data, among others, and concluded that the Maacama fault did indeed pose a lesser threat to the dam than the San Andreas, affirming the assumptions and conclusions of the supplemental EIS.<sup>35</sup> In light of this study, the court found the Corps’ decision not to supplement the EIS a second time reasonable.<sup>36</sup> Finally, the court held that the EIS did not need to lay out the consequences of total dam collapse in the wake of a seismic event because the possibility of such an event was “remote and highly speculative.”<sup>37</sup> The court explained that were there a substantial risk of collapse, the agency’s undertaking the project would be an abuse of discretion, and stated that: “Everyone recognizes the catastrophic results of the failure of a dam; to detail these results would serve no useful purpose.”<sup>38</sup>

Similarly, in *Save the Niobrara River Ass’n, Inc. v. Andrus*, the district court held that the EIS for the Norden Dam was inadequate in part because the project’s EIS failed to discuss any risk of geological instability at the dam site.<sup>39</sup> The court explained that an agency need not eliminate all uncertainty and resolve differing views on a risk before undertaking a project, but that “the nature and basis,” of the uncertainty “and what is needed to remove it must be expressed in the [EIS] so that a decision maker may weigh it on the scales.”<sup>40</sup> Here, the Bureau of Reclamation completed an EIS for the proposed dam and reservoir without including any details about the stability of the dam’s geologic foundation, beyond concluding that “no known

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<sup>30</sup> *Id.* at 1024-25.

<sup>31</sup> *Id.*

<sup>32</sup> *Id.*

<sup>33</sup> *Id.*

<sup>34</sup> *Id.* at 1025.

<sup>35</sup> *Id.*

<sup>36</sup> *Id.*

<sup>37</sup> *Id.* at 1026.

<sup>38</sup> *Id.* at 1025-27.

<sup>39</sup> 483 F. Supp. 844, 851, 865 (D. Neb. 1979).

<sup>40</sup> *Id.* at 851.

faults exist in this area,” and therefore “[s]eismic activity is almost unknown.”<sup>41</sup> Nonetheless, plaintiffs presented contrary evidence at trial, indicating that the Bureau was aware of geologic instability in the area because it had rejected two other sites nearby to avoid this precise problem, and itself acknowledged that further testing was required to eliminate uncertainty about the strength of the dam’s foundations.<sup>42</sup> Plaintiffs further demonstrated that the geologic structures under the site could be “a poor foundation for the dam.”<sup>43</sup> The court held that the EIS did not identify the risk attendant to the underlying geology of the damsite, or describe how that risk could be designed around.<sup>44</sup> The court therefore granted an injunction halting the construction of the project until the EIS was adequately supplemented.<sup>45</sup>

In contrast, as in the case of the Teton dam discussed earlier, some other courts have rejected claims that the EISes for dams did not discuss the possibility of dam collapse sufficiently. In *EDF v. Stamm*, the court rejected plaintiffs’ argument that an EIS was “deficient in dealing with seismic and safety problems” related to the project.<sup>46</sup> The court found instead that the EIS was sufficiently thorough and detailed, and evidenced “appropriate concern for the negative effects as well as risks of the project.”<sup>47</sup> Similarly, in *Stow v. United States*,<sup>48</sup> the court held that the Soil Conservation Service’s dam EIS was sufficient in its treatment of dam safety despite including only a brief statement on the issue, and plaintiffs’ presentation of experts suggesting potential site instability. The court held that these experts’ “ cursory reviews based on incomplete data” did not indicate the agency’s decision to go forward with the project was arbitrary and capricious.<sup>49</sup> Other courts have found EISes to satisfy the requirements of NEPA despite their omission of any discussion of earthquake safety whatsoever.<sup>50</sup>

Clearly, a good deal depends on the attitude of the reviewing court. There seems to be no clear guidance about when a potential risk becomes so significant that it must be acknowledged in the impact statement.

## II. Nuclear Power as a Case Study

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<sup>41</sup> *Id.*

<sup>42</sup> *Id.*

<sup>43</sup> *Id.* at 865.

<sup>44</sup> *Id.*

<sup>45</sup> *Id.* at 863.

<sup>46</sup> 430 F. Supp. 664, 667 (N.D. Cal 1977).

<sup>47</sup> *Id.*

<sup>48</sup> 696 F. Supp. 857, 865-66 (W.D.N.Y. 1988).

<sup>49</sup> *Id.*

<sup>50</sup> See, e.g., *Story v. Marsh*, 732 F.2d 1375 (8<sup>th</sup> Cir. 1984) (overturning district court’s grant of injunction based on EIS’s failure to discuss potential earthquake damage and holding that defendant’s witness testimony concluding that such damage would not occur was sufficient).

Nuclear power has been a particularly fertile source of disputes over risk assessment. The regulatory agency (initially the Atomic Energy Commission and then the Nuclear Regulatory Commission) has repeatedly addressed these issues.

Some background may be helpful. Nuclear power utilizes utility-scale reactors to heat water to produce steam, which is then converted into mechanical work for the purpose of generating electricity. Nuclear provides a baseline constant power source in an electricity profile (as opposed to a varying level as is the case for wind farms). Capital costs of building nuclear plants are very high, but once built operation and maintenance are relatively low, therefore the price is largely dependent upon the cost of inputs. Other problems are yet to be completely (or satisfactorily) resolved, including nuclear waste disposal, safety of nuclear power reactors and other nuclear facilities and the threat of nuclear proliferation.

In June 2008, the International Atomic Energy Agency announced that global nuclear electricity generation had decreased in 2007, and there were only thirteen more reactors in the world than in 1989 – less than one addition worldwide per year.<sup>51</sup> In the U.S., the industry has been effectively stymied. No new reactor was ordered for over twenty years, from 1973 to 2005.<sup>52</sup> Despite periodic presidential announcements since 1981 promising a revival of nuclear power, there will be at most one new reactor in operation by 2014.<sup>53</sup>

Nuclear power is, however, far from dead. It supplies seventeen percent of the world's electricity.<sup>54</sup> Domestically, the Energy Policy Act provides tax incentives and loan guarantees for energy production of various types, including advanced nuclear reactor designs. This was a major incentive for new near-term commercial reactor construction and as of June 2006, 42 U.S. plants had received 20-year license renewals, 8 reactors were under review, and 23 were planned for submission by 2010.<sup>55</sup> Although “public opinion has grown steadily more receptive to nuclear power,” the nuclear industry “faces formidable long-term obstacles including a very skeptical financial community, yet-unresolved long-term waste disposal issues, uncertain decommissioning costs, and a very vocal opposition who will be readily mobilized to protest any new power plant construction.”<sup>56</sup>

#### A. Reactor Radiation Leaks

There are two overriding safety requirements in nuclear reactors. The first is to ensure that the nuclear chain reaction can be stopped dependably and rapidly under all possible operative conditions. The second requirement is to ensure the removal of the fission product decay heat,

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<sup>51</sup> Lutz Mez, Mycle Schneider, and Steve Thomas (eds), *International Perspectives of Energy Policy and the Role of Nuclear Power* (forthcoming 2009) (page references in later footnotes are to the book manuscript).

<sup>52</sup> John L. Jurewitz, *The Current Outlook for the Nuclear Power Industry in the United States*, in Mez, Schneider and Thomas, *supra* note , at 224.

<sup>53</sup> *Id.* at 3.

<sup>54</sup> Deutch Lester. *Making Technology Work* 108 (2004).

<sup>55</sup> Per F. Peterson, Department of Nuclear Engineering, University of California, Berkeley. Lecture given 28 Oct 2008, ER100 Energy and Society.

<sup>56</sup> *Id.*

which continues to be generated in large amounts even after the chain reaction has been stopped.<sup>57</sup> The coolant system is crucial to preventing the heat from resulting in a breach of containment.

Twenty years ago, a combination of equipment failures and human error led to the destruction of the core at Three Mile Island Unit 2, with financial losses running into the billions of dollars. Luckily, there were no injuries, and radiation doses to the external population rose only slightly above natural background levels. Safety measures seem to have improved substantially since Three Mile Island.<sup>58</sup>

The basic strategy of regulatory agencies has been to downplay any possible risks from reactors. In *Carolina Environmental Study Group v. United States*,<sup>59</sup> the petitioners sought review of the issuance of a construction license to build two reactors about 17 miles from Charlotte, North Carolina. The issue was whether the EIS should have discussed the risk of a major nuclear accident. As the Court explained, the Atomic Energy Commission (AEC) had classified hypothetical reactor accidents from Class 1 (trivial incidents with high occurrence probability) to Class 9 (ultimate severity with occurrence highly unlikely). The Class 9 accident, known as a breach-of-reactor containment accident, involves concurrent rupture of the three-foot thick concrete containment vessel and the several inches of steel surrounding the reactor core, resulting in the exposure of the radioactive core to the atmosphere.

The AEC's Final Environmental Statement for the proposed reactors included this comment:

The postulated occurrences in Class 9 involve sequences of successive failures more severe than those required to be considered in the design bases of protective systems and engineered safety features. The consequences could be severe. However, the probability of their occurrence is so small that their environmental risk is extremely low. \* \* \*

What the A.E.C. means by the small probability of such accidents is seen in its report: some experts held that numerical estimates of a quantity [of major accidents] so vague and uncertain that the likelihood of occurrence of major reactor accidents have no meaning. They declined to express their feeling about this probability in numbers. Others, though admitting similar uncertainty, nevertheless ventured to express their opinions in numerical terms. Estimations so expressed of the probability of reactor accidents having major effects on the public ranged from a chance of one in 100,000 to one in a billion per year for each large reactor. However, whether numerically expressed or not, there was no disagreement with the opinion that the probability of major reactor accidents is very low.<sup>60</sup>

The court upheld the AEC's refusal to discuss the risks of a Class 9 accident in the impact statement:

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<sup>57</sup> Lester, *supra* note 54, at 109.

<sup>58</sup> Jurewitz, *supra* note 52, at 232.

<sup>59</sup> 510 F.2d 796 (D. C. Cir. 1975).

<sup>60</sup>The court observed that "A.E.C. report WASH—740, pg. viii, estimated that a Class 9 accident in a reactor approximately one-seventh the size of one of Duke's reactors would result in up to 3,400 deaths, 43,000 injuries, and \$7 billion property damage."

The A.E.C. is required by NEPA to set forth the factors involved, to the end that the ultimate decision on a proposed course of action shall be enlightened by prior recognition of its impact on the quality of human environment. Viewing the record as a whole, we cannot say that the A.E.C.'s general consideration of the probabilities and severity of a Class 9 accident amounts to a failure to provide the required detailed statement of its environmental impact. That the probability of a Class 9 accident is remote and that its consequences would be catastrophic are undisputed. Neither the A.E.C.'s finding of low probability, nor its methodology or basis for that finding, are challenged here by appellant.

Because each statement on the environmental impact of a proposed action involves educated predictions rather than certainties, it is entirely proper, and necessary, to consider the probabilities as well as the consequences of certain occurrences in ascertaining their environmental impact. There is a point at which the probability of an occurrence may be so low as to render it almost totally unworthy of consideration.<sup>61</sup>

There is a certain irony to the preceding decision, in light of the later Three Mile Island episode (which was classified as a class 9 accident). Despite the TMI incident, one court held that the NRC *still* did not have to consider the possibility of class 9 accidents:

As we have discussed above, the Commission did not conclude in its Statement of Interim Policy that its original assumption regarding Class Nine accidents was scientifically incorrect. Rather, it recognized the need for renewed study of the issue. The clear import of the Commission's Statement is that, until such time as its research yields a contrary result, the Commission continues to regard Class Nine accidents as highly improbable events.

We do not consider that conclusion unreasonable. Neither the 1978 study by the Risk Assessment Review Group nor the accident at Three Mile Island established that the probability of a Class Nine accident with significant environmental consequences is anything but very small \* \* \* Because the environmental consequences of Three Mile Island were scientifically and legally inconsequential, the fact that the accident occurred does not establish that accidents with significant environmental impacts will have significant probabilities of occurrence.<sup>62</sup>

The Third Circuit differed in its treatment of the TMI accident in *Limerick Ecology Action Inc., v. U.S. Nuclear Regulatory Com'n* when it was persuaded by plaintiff's argument that "after

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<sup>61</sup> Id. at 799.

<sup>62</sup> *San Luis Obispo Mothers for Peace v. NRC*, 751 F.2d 1287, 1301 (D.C.Cir.1984), vacated in part 760 F.2d 1320 (D.C.Cir.1985) (en banc). Thus, the Court concluded:

NEPA, therefore, does not require the consideration of Class Nine accidents in future EISs, nor does it require that final EISs be supplemented to take account of the Class Nine risk. The approach adopted in the Statement of Interim Policy—to include discussion of such accidents in future EISs—was a discretionary policy choice of the Commission. Because it need not have imposed upon itself the burden it did, the Commission was perfectly free to deny its new policy retroactive effect. We conclude that the Commission did not violate its obligations under NEPA by declining to supplement the Diablo Canyon EIS with a discussion of the environmental impacts of a Class Nine accident.

*Id.*

Three Mile Island, it would be irrational for the NRC to maintain that severe accident risks are too remote to require consideration.”<sup>63</sup> It therefore refused to extend *San Luis Obispo*’s rule to an impact statement released after the NRC issued its Interim Policy.<sup>64</sup> Beyond finding that the Statement of Interim Policy applied to the statement in question because of its timing, the Third Circuit also interpreted the Interim Policy itself far more strongly than the *San Luis Obispo* court, reasoning that the Policy was not a discretionary burden allowing the NRC to consider such risks whenever it felt like it, but evidence that the Commission itself did not understand the risk of severe accidents to be remote and speculative.<sup>65</sup> The court found the fact that the NRC was performing research on the likelihood of such risks indicated “that [the Commission] no longer considers such risks as remote and speculative,” and a “discussion of severe accident potential” was therefore required under NEPA.<sup>66</sup>

In addition to courts’ disagreement about whether the risk of an *accidental* release is too low to be worth considering, in the post-9/11 world, they also disagree about whether the risk of terrorism requires consideration. DOE now requires reactor operators to prepare for attack by a “suicidal, well-trained paramilitary force, armed with automatic weapons and explosives,” and the industry says it has spent over \$1 billion in security-related capital improvements.<sup>67</sup> In a recent decision, the Ninth Circuit rejected the Nuclear Regulatory Commission’s view that the risk of terrorist attacks on reactors was too speculative to require discussion in an impact statement. The court said:

If the risk of a terrorist attack is not insignificant, then NEPA obligates the NRC to take a “hard look” at the environmental consequences of that risk. The NRC's actions in other contexts reveal that the agency does not view the risk of terrorist attacks to be insignificant. Precise quantification is therefore beside the point.<sup>68</sup>

The court was also skeptical of the agency’s claim that quantitative analysis was impossible:

Even if we accept the agency's argument, the agency fails to adequately show that the risk of a terrorist act is unquantifiable. The agency merely offers the following analysis as to the quantifiability of a potential terrorist attack:

The horrors of September 11 notwithstanding, it remains true that the likelihood of a terrorist attack being directed at a particular nuclear facility is not quantifiable. Any attempt at quantification or even qualitative assessment would be highly speculative. In fact, the likelihood of attack cannot be ascertained with confidence by any state-of-the-art

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<sup>63</sup> 869 F.2d 719, 740-41 (3d Cir. 1989).

<sup>64</sup> *Id.*

<sup>65</sup> *See id.*

<sup>66</sup> *Id.* at 740, 741.

<sup>67</sup> John L. Jurewitz, *The Current Outlook for the Nuclear Power Industry in the United States*, in *International Perspectives of Energy Policy and the Role of Nuclear Power* (Lutz Mez, et al. eds.) (forthcoming 2009) (manuscript at 230, on file with author).

<sup>68</sup> *San Luis Obispo Mothers for Peace v. Nuclear Regulatory Comm’n*, 449 F.3d 1016, 1032 (9<sup>th</sup> Cir. 2006).

methodology. That being the case, we have no means to assess, usefully, the risks of terrorism at the [fuel storage] facility.

The agency nonetheless has simultaneously shown the ability to conduct a “top to bottom” terrorism review. This leaves the Commission in the tenuous position of insisting on the impossibility of a meaningful, i.e. quantifiable, assessment of terrorist attacks, while claiming to have undertaken precisely such an assessment in other contexts. Further, as we have noted, the NRC has required site-specific analysis of such threats, involving numerous recognized scenarios.

Thus, we conclude that precise quantification of a risk is not necessary to trigger NEPA's requirements, and even if it were, the NRC has not established that the risk of a terrorist attack is unquantifiable.<sup>69</sup>

In a footnote, the court also remarked that the “NRC's assertion that a risk of terrorism cannot be quantified is also belied by the very existence of the Department of Homeland Security Advisory System, which provides a general assessment of the risk of terrorist attacks. *See, e.g.*, World Market Research Centre, Global Terrorism Index 2003/4 (offering a probabilistic risk assessment of terrorist activities over a 12-month period).”<sup>70</sup>

The Ninth Circuit seems clearly correct that the inability to quantify a risk does not justify failure to discuss it if there are other grounds for considering it significant. Nothing in NEPA requires quantification, and many aspects of environmental impacts are difficult to quantify. The court's insistence that the agency actually could quantify the risk seems more debatable. Given the small degree of experience with major terrorist attacks, quantification would have to be based on the subjective judgments of experts in large part. This may be useful for some purposes, but is not necessarily more useful as a method of disclosing risks to the public than a more qualitative discussion.

Notwithstanding, the force of the Ninth Circuit's reasoning, the NRC has adamantly refused to change its policy.<sup>71</sup> The Third Circuit recently reached the opposite result when it held that an impact statement for a nuclear site re-licensing did not need to discuss the possibility of terrorist attack.<sup>72</sup> In so holding, the court did not focus on the difficulty of quantifying the risk, but on the causation issue.<sup>73</sup> It reasoned that both the criminal act of a third-party and “the failure of all government agencies specifically charged with preventing terrorist attacks” would have to occur to cause an actual terrorist attack.<sup>74</sup> Applying the proximate cause analogy from *Metropolitan*

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<sup>69</sup> *Id.*

<sup>70</sup> *Id.* at 1032 n.9.

<sup>71</sup> *In the Matter of Amergen Energy Company*, 2007 WL 595084 (50-0219-LR). Early, the agency had said that addressing terrorism was inappropriate because an EIS should only address environmental impacts that will result “with a fair degree of likelihood.” *In the Matter of Private Fuel Storage, L.L.C.*, 56 N.R.C. 350 (72-22-ISFSI 2002).

<sup>72</sup> *N.J. Dep't of Env'tl. Prot. v. U.S. Nuclear Regulatory Comm'n*, 2009 U.S. App. LEXIS 6978 (3d Cir. 2009).

<sup>73</sup> *Id.* at \*23.

<sup>74</sup> *Id.* at \*22.

*Edison* and directly rejecting the Ninth Circuit's reasoning in declining to apply this test, the court held that "this casual chain is too attenuated to require NEPA review."<sup>75</sup> The court characterized this result as good policy because it prevents the agency from wasting its resources "assessing security risks over which it has little control which would not likely aid its other assigned functions to assure the safety and security of nuclear facilities."<sup>76</sup> The later argument seems inapplicable to licensing of new plants, because the risk of a terrorist attack would increase the desirability of placing the facility in an isolated area away from any population concentration.

The NRC's position on this issue seems all too typical of its regulatory approach. It is possible that it will prevail in the other circuits or even in the Supreme Court. But a legal victory will not assuage the fears of residents about the risk of terrorism at nuclear plants, and the NRC's stubborn refusal to address the issue on the merits will only serve to undermine its credibility as a guardian of public safety. As with the issue of nuclear waste disposal discussed below, the NRC may win many of the legal battles but lose the war for public support. And indeed, the agency does give every appearance of caring more about promoting the industry it regulates than on addressing legitimate public concerns.

## B. Disposal of Nuclear Waste

The current open nuclear fuel cycle that is commonly used in the U.S. uses freshly mined uranium, burns it a single time in a reactor and then discharges it as waste. This approach results in only about 1% of the energy content of the uranium being converted to electricity.<sup>77</sup> It also produces large volumes of spent nuclear fuel that must be disposed of in a safe fashion. Both drawbacks can be avoided by recycling the spent fuel and recovering the useful materials from it. Other countries including France, Japan and the U.K. employ what is called a closed nuclear fuel cycle to do so. In these countries, used fuel is recycled to recover uranium and plutonium (produced during irradiation in reactors) and reprocess it. This option poses the risk that the reprocessed plutonium could be extracted and manufactured into nuclear weapons or dirty bombs.

The safe storage and disposal of nuclear waste is a significant challenge and a yet unresolved problem. The most important waste stream from nuclear power plants is spent fuel. A large nuclear reactor produces 25–30 tonnes of spent fuel each year.<sup>78</sup> It is primarily composed of unconverted uranium as well as significant quantities of transuranic actinides.<sup>79</sup> Safe disposal of this waste is critical. As we will see, the NRC has insisted that permanent safe storage is possible with the support of the Supreme Court, but has faced an increasingly frustrated record of

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<sup>75</sup> *Id.* at \*23.

<sup>76</sup> *Id.* at \*27.

<sup>77</sup> James A. Lake et al., *Next Generation Nuclear Power*, *Sci. Am.*, Jan. 2002, at 77, 77.

<sup>78</sup> C. W. Forsberg, *Dep't of Energy, Assessment of Nuclear-Hydrogen Synergies with Renewable Energy Systems and Coal Liquefaction Processes* (2006).

<sup>79</sup> Per F. Peterson, Department of Nuclear Engineering, University of California, Berkeley. Lecture given 28 Oct 2008. ER100 Energy and Society

achieving this goal. In the end, it is hard, even for those who do not share his enthusiasm for nuclear power, to disagree with Richard Stewart's verdict that the "current U.S. system of nuclear waste law and policy is bankrupt"<sup>80</sup> – or rather, to the extent disagreement is possible, it is only over the appropriateness of even applying the word "system" in this context.

### 1. The Zero Release Assumption

In November 1972, the government began a rulemaking proceeding about the environmental costs associated with the uranium fuel cycle, including waste disposal.<sup>81</sup> The agency considered two alternatives: "The first would have required no quantitative evaluation of the environmental hazards of fuel reprocessing or disposal because the Environmental Survey had found them to be slight. The second would have specified numerical values for the environmental impact of this part of the fuel cycle, which values would then be incorporated into a table, along with the other relevant factors, to determine the overall cost-benefit balance for each operating license."<sup>82</sup> As the D.C. Circuit explained, "While expressed as numerical values in Table S-3, a fair summary of the conclusions incorporated into the rule is that the environmental effects of the fuel cycle are 'insignificant.'"<sup>83</sup> The agency's decision was based largely on an optimistic assurance from staff in a twenty-page document that any remaining problems with long-term storage could be solved. By the time of the D.C. Circuit hearing, however, the staff had become more pessimistic:

The unanimous task force concluded, *inter alia*, "there are still many technical problems and uncertainties in the overall area of processing of spent fuel and properly managing its radioactive waste; "(t)he costs of storage and ultimate disposal . . . are very much higher than had previously been assumed . . ."; "(the public) fear(s) that the radioactive waste generated . . . will either be neglected, and thus place an unacceptable hazard potential on mankind, or be managed in a way that will place an unacceptable burden on future generations to assure continued public safety. (T)hese . . . fears . . . are supported by a fair segment of the scientific community many of whom otherwise support the use of nuclear reactors for generation of electric power."<sup>84</sup>

The court of appeals reversed the agency decision in a confusing decision that seemed to be partly based on concerns about the inadequacy of the factual evidence cited by the agency and partly on the agency's refusal to allow cross-examination of staff at public hearings. The Supreme Court, reading the decision to be based on procedural grounds,<sup>85</sup> rebuked the court of

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<sup>80</sup> Richard B. Stewart, *U.S. Nuclear Waste Law and Policy: Fixing a Bankrupt System*, 17 NYU Env. L.J. 783 (2008). Another blistering critique of the program from a decade earlier can be found in James Flynn, Roger E Kasperson, Howard Kunreuther, and Paul Slovic, *Redirecting the U.S. High-Level Nuclear Waste Program*, 39 Env. 6 (April 1997).

<sup>81</sup> *Vermont Yankee Nuclear Power Corp. v. NRDC*, 435 U.S. 519, 528 (1978).

<sup>82</sup> *Id.*

<sup>83</sup> 547 F.2d at 642.

<sup>84</sup> *Id.* at 650 n. 51.

<sup>85</sup> 435 U.S. at 541.

appeals for overstepping its bounds in supervising agency procedures.<sup>86</sup> The Court instructed the D.C. Circuit to make a finding regarding the sufficiency of the administrative record on remand.<sup>87</sup>

The original rule before the D.C. Circuit implicitly relied on a “zero-discharge assumption” that releases of wastes into the environment would be effectively prevented, so that waste disposal would have no significant environmental impact.<sup>88</sup> After some further proceedings, the agency promulgated a new rule that “now explicitly stated that solidified high-level and transuranic wastes would remain buried in a federal repository and therefore would have no effect on the environment.”<sup>89</sup> After further modifications, the agency ended up with the following position:

[T]he final rule expressly stated that Table S-3 should be supplemented in individual proceedings by evidence about the health, socioeconomic, and cumulative aspects of fuel cycle activities. The Commission also continued to adhere to the zero-release assumption that the solidified waste would not escape and harm the environment once the repository was sealed. It acknowledged that this assumption was uncertain because of the remote possibility that water might enter the repository, dissolve the radioactive materials, and transport them to the biosphere. Nevertheless, the Commission predicted that a bedded-salt repository would maintain its integrity, and found the evidence “tentative but favorable” that an appropriate site would be found.<sup>90</sup>

In addition, the agency “rejected the option of expressing the uncertainties in Table S-3 or permitting licensing boards, in performing the NEPA analysis for individual nuclear plants, to consider those uncertainties. It saw no advantage in reassessing the significance of the uncertainties in individual licensing proceeding.”<sup>91</sup>

In short, despite lacking a solid evidentiary basis for this conclusion, the agency simply posited that any problems relating to permanent waste disposal would be solved. It is hard to see how a “zero” value for the risk could be warranted since the agency also seemed to admit that there was some uncertainty, so the risk might be higher than zero. Thus, at root, the agency’s position was that it was permissible to misrepresent a nonzero risk as zero without any explicit notation of the uncertainty relating to this estimate.

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<sup>86</sup> *Id.* at 543.

<sup>87</sup> *Id.* at 549.

<sup>88</sup> *Baltimore Gas & Electric v. NRDC*, 462 U.S. 87, 92 (1983).

<sup>89</sup> *Id.*

<sup>90</sup> *Id.* at 94. “The Commission ultimately determined that any undue optimism in the assumption of appropriate selection and perfect performance of the repository is offset by the cautious assumption, reflected in other parts of the Table, that all radioactive gases in the spent fuel would escape during the initial 6 to 20 year period that the repository remained open, and thus did not significantly reduce the overall conservatism of the S-3 Table.” *Id.*

<sup>91</sup> *Id.* at 94.

Remarkably, the Supreme Court upheld the agency's action in an opinion by Justice O'Connor. The Court emphasized three factors. First, the zero assumption was made only for the limited purpose of ruling that waste disposal concerns would never be enough to tip the balance against licensing a particular plant.<sup>92</sup> Second, the Court said, the overall table was intended to be conservative, with the unduly low zero-risk assumption balanced by other figures in the table.<sup>93</sup> Third, "a reviewing court must remember that the Commission is making predictions, within its area of special expertise, at the frontiers of science. When examining this kind of scientific determination, as opposed to simple findings of fact, a reviewing court must generally be at its most deferential."<sup>94</sup>

Perhaps not surprisingly, there is very little case law citing *Baltimore Gas*. Several cases dealing with nuclear waste cite *Baltimore Gas* for the principle that courts should give agency determinations a certain level of deference.<sup>95</sup> Research did not reveal any cases reading *Baltimore Gas* as generally allowing agencies to view uncertain risks as equaling zero, or allowing agencies just to assume that some solution will be found to future problems.<sup>96</sup> As a matter of policy, the NRC may have been within its rights to decide that, for purposes of issuing individual licenses, it would simply ignore the possibility that a new reactor would add to the amount of waste requiring long-term disposal. It is hard to see, however, a justification for allowing the agency to mask this important policy decision in a seemingly factual table without providing any indication of the associated uncertainty. In effect, doing so misled the public into thinking that what was actually a policy decision to disregard a risk was instead a scientific judgment that the risk was zero. The agency gave the unfortunate impression of being more anxious to serve as a public relations advocate for the industry than to provide objective information. To this day, so far as research has revealed, the agency has not modified this figure.

## 2. The Yucca Mountain Fiasco

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<sup>92</sup> *Id.* at 102.

<sup>93</sup> *Id.* at 102-103.

<sup>94</sup> *Id.* at 103-104.

<sup>95</sup> See, e.g., *Citizens for Alternatives v. United States DOE*, 485 F.3d 1091 (10<sup>th</sup> Cir. N.M. 2007); *Ohio v. Nuclear Regulatory Com.*, 814 F.2d 258 (6<sup>th</sup> Cir. 1987); *Deukmejian v. Nuclear Regulatory Com.*, 243 U.S. App. D.C. 68 (D.C. Cir. 1984); *New York v. United States Dep't of Transp.*, 715 F.2d 732, 753 (2d Cir. N.Y. 1983); *Lower Alloways Creek v. Public Service Electric & Gas Co.*, 687 F.2d 732 (3d Cir. 1982).

<sup>96</sup> Only one opinion went beyond merely citing *Baltimore Gas* for the proposition discussed in depth the zero-release assumption in *Baltimore Gas*. That decision gave the agency considerably less leeway than *Baltimore Gas*. In *Limerick Ecology Action, Inc. v. United States Nuclear Regulatory Com.*, 869 F.2d 719 (3d Cir. 1989), a citizens' group challenged the NRC's issuance of a full power operating license to the Limerick Nuclear Power Generating Station. The group alleged that the EIS failed adequately to consider the threat of reactor sabotage. The Commission did not account for sabotage risk, because an analysis of sabotage risk was "considered to be beyond the state of the art of probabilistic risk assessment." *Id.* at 741-742.

As it turned out, the agency's optimism about permanent disposal has yet to be vindicated. Presently, waste is stored at over a hundred facilities across the country, within seventy-five miles of the homes of 161 million people.<sup>97</sup>

Congress has designated Yucca Mountain as the only potential site for permanent disposal.<sup>98</sup> The effort to establish a permanent site in Yucca Mountain has run into a wall of litigation<sup>99</sup> and political resistance. The Department of Energy (DOE) has spent over \$8 billion in studying the site.<sup>100</sup> By 2036, the total amount of waste from existing plants will exceed the storage capacity at Yucca Mountain in any event.<sup>101</sup> In March of 2009, the project suffered a potentially fatal blow at the hands of the Obama administration, whose proposed budget fulfilled a campaign promise by cutting off nearly all the project's funding.<sup>102</sup> Despite this setback, as of early April 2009, the DOE was still moving forward with the facility's licensing proceedings.<sup>103</sup> But even Republican Senator John McCain, a long-time proponent of the project, acknowledged that it may be politically doomed, and urged Congress to "be honest with the American taxpayers and move forward on Yucca Mountain as we need to ... or if not, close it and refund the money."<sup>104</sup> By 2036, the total amount of waste from existing plants will exceed the storage capacity at Yucca Mountain in any event.<sup>105</sup>

Yucca Mountain is located in the desert about a hundred miles from Las Vegas, adjacent to the Nevada Test Site where nuclear bombs were tested.<sup>106</sup> The plan is to place the waste in containers consisting of a four-inch outer layer of carbon steel and a one-inch corrosion proof inner layer.<sup>107</sup> The waste will be conveyed by unmanned vehicles to a series of tunnels hundreds of feet below the surface and also hundreds of feet above the water table.<sup>108</sup> The rock at the site

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<sup>97</sup> Reko Reblitz-Richardson, *In Brief -- D.C. Circuit Rejects EPA's Proposed Standards and Extends Timeline for Yucca Mountain Nuclear Waste Repository*, 32 Ecology L.Q. 743 (2005)(student comment).

<sup>98</sup> See 42 U.S.C. § 10133(a), 10172(1-2).

<sup>99</sup> Some of the major cases include *Nevada v. Herrington*, 777 F.2d 529 (9<sup>th</sup> Cir. 1985); *Nevada v. Burford*, 708 F. Supp. 289 (D. Nev. 1989); *Nevada v. Watkins*, 914 F.2d 1545 (9<sup>th</sup> Cir. 1990); *County of Esmeralda v. U.S. DOE*, 925 F.2d 1216 (9<sup>th</sup> Cir. 1991); *Nevada v. United States*, 133 F.3d 1201 (9<sup>th</sup> Cir. 1997); *Nevada v. United States DOE*, 133 F.3d 1210 (9<sup>th</sup> Cir. 1998).

<sup>100</sup> Jurewitz, *supra* note 67, at 227.

<sup>101</sup> *Id.* at 227.

<sup>102</sup> Matthew L. Wald, *Future Dim for Nuclear Waste Repository*, N.Y. Times, March 5 2009, at A15.

<sup>103</sup> Alexandra Berzon, *Yucca Mountain; Energy Department presses for licenses as if nothing's changed*, LAS VEGAS SUN, April 4, 2009, at News 1.

<sup>104</sup> Steve Tretuealt & Keith Roger, *McCain: Time for Yucca Plan B*, Las Vegas Rev.-J., April 1 2009, at 1B.

<sup>105</sup> Jurewitz, *supra* note 67 (manuscript at 227).

<sup>106</sup> David P. Ross, *Yucca Mountain and Reversing the Irreversible: The Need for Monitored Retrievable Storage in a Permanent Repository*, 25 Vermont L. Rev. 815 (2001)(student comment).

<sup>107</sup> *Id.* at 821.

<sup>108</sup> *Id.* at 821.

was originally thought to be impermeable, but it turns out that fractures allow water percolation and that plutonium is surprisingly capable of traveling in water.<sup>109</sup>

The major problem is the longevity of the waste – plutonium will be dangerous for 250,000 years.<sup>110</sup> Although it is now considered feasible to model the geologic and physical processes at the site over such time periods, no one seems to have a clue about how to model possible changes in human behavior and society.<sup>111</sup> As one commentator remarked, “[i]t is hard to comprehend the complexities that thinking along a 10,000-year timeline entails – nuclear waste did not exist 50 years ago, America did not exist 500 years ago, and recorded history did not exist 5000 years ago – but it certainly is not difficult to comprehend the uncertainty that extends such an extended timeline.”<sup>112</sup> In any event, EPA excludes from consideration events that have less than a one in ten thousand chance,<sup>113</sup> which simplifies the task but at the possible cost of overlooking potential risks.<sup>114</sup> In essence, this amounted to eliminating any risk that would not be likely to materialize in the next ten thousand years. The fact that no single risks is likely to materialize in the next ten thousand years does not necessarily mean that the cumulative probability of at least one of the risks materializing is equally low.

As it turns out, ensuring safety for the next ten thousand years is not legally sufficient. In *Nuclear Energy Inst., Inc. v. EPA*,<sup>115</sup> the Court held that the government had failed to justify departing from the recommendations of the National Academy of Science, which were entitled to deference under the statutory scheme.<sup>116</sup> As the court explained:

With respect to the length of the compliance period, NAS found “no scientific basis for limiting the time period of the individual-risk standard to 10,000 years or any other value.” According to the Academy, “compliance assessment is feasible for most physical and geologic aspects of repository performance on the time scale of the long-term stability of the fundamental geologic regime – a time scale that is on the order of  $10^6$  [one million] years at Yucca Mountain.” NAS also explained that humans may not face peak radiation risks until tens to hundreds of thousands of years after disposal, or even further into the future.”<sup>117</sup>

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<sup>109</sup> *Id.* at 834.

<sup>110</sup> *Id.* at 826.

<sup>111</sup> *Id.* at 829.

<sup>112</sup> *Id.* at 838.

<sup>113</sup> *Id.* at 838.

<sup>114</sup> It seems initially plausible to exclude such remote risks, but there are two important caveats. First, some of the unlikely events could have such significant consequences that they are worth considering. Second, there may be a number of such risks that cumulatively could add to the overall level of risk – if there are ten 1/10,000 risks of containment failure, this adds up to almost 1/1000. (“Almost” because of the possibility that more than one risk might eventuate in any given scenario.)

<sup>115</sup> *Nuclear Energy Inst., Inc. v. EPA*, 373 F.2d 1251 (D.C. Cir. 2004).

<sup>116</sup> *Id.* at 1273.

<sup>117</sup> *Id.* at 1267.

The court also described as “odd” the government’s decision that, “since it was ‘impossible to predict either human activities or economic imperatives,’ it would assume ‘current conditions’ would persist indefinitely.”<sup>118</sup> What this means is that the calculation of the physical likelihood of leakage should hopefully be reasonably accurate, the assumptions about human presence and activities in the area (and therefore about exposure) are speculative, and the possibility of human interference with the integrity of the site is completely unknown. Also it would appear that low probability (under 1/10,000) events are being disregarded. This may be the best that can be done in terms of approving a particular site for permanent disposal. It’s not terribly helpful in terms of deciding whether permanent geological disposal is the best solution or whether the waste problem is intractable enough to justify keeping the brakes on industry expansion.<sup>119</sup>

Rebecca M. Bratspies describes Yucca Mountain as a paradigm example of the breakdown in the public’s trust of regulatory agencies and their ability to make decisions in the face of uncertainty.<sup>120</sup> Citing a survey demonstrating that less than a third of the public trusted the federal government to be honest about its research in assessing the project’s risks, Bratspies concludes the data “reveal a lack of trust in the objectivity and intellectual honesty of the decisionmakers, and suggest a clear perception that the research process was an attempt to drum up public support for an already crafted agenda, rather than a genuine attempt at dialogue and shared agenda building.”<sup>121</sup>

Amanda Leiter has recently summarized what she calls the “pathetic” history<sup>122</sup> of Yucca Mountain, observing that “the federal government has had its eyes on Yucca Mountain for more than a quarter century, yet it does not plan to break ground until 2011, waste disposal will not begin until 2017 at the earliest, and even that delayed timeline remains open to debate and modification. . . . As of 2017, the Yucca Project will have been in the works for forty years.”<sup>123</sup>

### III. The Rise and Fall of the Worst Case Scenario

An environmental impact statement does not dictate the substance of regulatory decisions but is at least supposed to force the agency to take a “hard look” at the relevant factors.<sup>124</sup> As we have seen, the problem of how to handle potentially catastrophic risks has vexed the courts. The problem is even more difficult when the risk is not understood well enough to be quantified. At

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<sup>118</sup> *Id.* at 1275.

<sup>119</sup> The problem of nuclear waste disposal has proved intractable even in France, despite that country’s general enthusiasm for nuclear power. See <http://www.pbs.org/wgbh/pages/frontline/shows/reaction/readings/french.html>

<sup>120</sup> Rebecca M. Bratspies, *Regulatory Trust* 59-61 (Working Paper March 18, 2009), available at [http://papers.ssrn.com/sol3/papers.cfm?abstract\\_id=1364314](http://papers.ssrn.com/sol3/papers.cfm?abstract_id=1364314).

<sup>121</sup> *Id.* at 60.

<sup>122</sup> Amanda Leiter, *The Perils of a Half-Built Bridge: Risk Perception, Shifting Majorities, and the Nuclear Power Debate*, 35 *Ecology L.Q.* 31, 61 (2008).

<sup>123</sup> *Id.* at 63. Notably, even in France, where the public widely supports nuclear power: “When it came time to develop a waste facility, however, people balked. There were widespread demonstrations and even riots. And the problem has yet to be solved.” *Id.* at 67.

<sup>124</sup> See *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332 (1989).

one time, White House guidance directed agencies to deal with such uncertainty by discussing the “worst case” scenario. The history and implementation of this regulation is instructive.

In 1978, the Council on Environmental Quality, the executive agency supervising implementation of the EIS requirement, provided direction to agencies on how to deal with scientific uncertainty.<sup>125</sup> The regulation applied when there were “gaps in relevant information or scientific uncertainty” about a project’s environmental impacts.<sup>126</sup> When such information was obtainable at reasonable cost, the agency was instructed to obtain it but otherwise the agency was told to pursue the following course:

If (1) the information relevant to adverse impacts is essential to a reasoned choice among alternatives and is not known and the overall costs of obtaining it are exorbitant or (2) the information relevant to adverse impacts is important to the decision and the means to obtain it are not known (e.g. the means for obtaining it are beyond the state of the art) the agency shall weigh the need for the action against the risk and severity of possible adverse impacts were the agency to proceed in the face of uncertainty. If the agency proceeds, it shall include a worst case analysis and an indication of the probability or improbability of its occurrence.<sup>127</sup>

In a 1981 guidance document, CEQ explained this rule as mandating “reasonable projections of the worst possible consequences of a proposed action.”<sup>128</sup> As an illustration, CEQ said that where a proposed water quality facility would have an unknown impact on juvenile fish, the EIS must include “the possibility of the loss of the commercial or sport fishery.”<sup>129</sup> Note that agencies were not directed to avoid taking action in the face of uncertainty but rather to engage in a balancing test weighing the need for the action against the risk. Worst case analysis was a disclosure requirement, not a decision technique.

*Sierra Club v. Sigler*<sup>130</sup> was the leading case to apply the worst case requirement. The case involved a controversial proposal to allow oil tankers to operate in an estuary near the Port of Galveston.<sup>131</sup> The EIS concluded that the project would not significantly increase the probability or likely harm of an oil spill.<sup>132</sup> The relevance of oil spills to the decision was unquestioned and the parties agreed that “an analysis of a supertanker oil spill involving a total cargo loss beyond 24 hours after it occurs is beyond the state of the art.”<sup>133</sup> The agency had thought this possibility was too remote to warrant discussion. Relying on CEQ’s 1981 guidance document, however, the

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<sup>125</sup> See Edward A. Fitzgerald, *The Rise and Fall of Worst Case Analysis*, 18 U. Dayton L. Rev. 1 (1992).

<sup>126</sup> 40 C.F.R. § 1502.22 (1991).

<sup>127</sup> *Id.* § 1502.22(b) (1991).

<sup>128</sup> Vicki O. Masterman, *Worst Case Analysis: The Final Chapter?*, 19 Env’tl. L. Rep. 10026, at 10027 n.14 (1989).

<sup>129</sup> *Id.*

<sup>130</sup> *Sierra Club v. Sigler*, 695 F.2d 957 (5th Cir. 1983).

<sup>131</sup> *Id.* at 962.

<sup>132</sup> *Id.* at 968.

<sup>133</sup> *Id.* at 973.

Fifth Circuit held that the EIS was invalid because it “failed to discuss the ‘catastrophic impact’ of a total cargo loss by a supertanker in the Bay” and the court faulted the agency for failing to consider “that impact and the probability of its occurrence” in deciding to proceed.<sup>134</sup>

The worst case requirement was criticized as being excessively pessimistic and too intrusive on agency discretion.<sup>135</sup> In its 1981 guidance document, CEQ explained the rule as mandating “reasonable projections of the worst possible consequences of a proposed action.”<sup>136</sup> In 1983, CEQ proposed (but later withdrew) a guidance document that would have required a worst-case analysis only when a risk crossed an “initial threshold of probability” and was reasonably foreseeable but its consequences were uncertain.<sup>137</sup> In the Fifth Circuit’s view, the fact that a risk was extremely remote was relevant in assessing its ultimate import for the final decision but not relevant in deciding whether to include a discussion of it as the worst-case scenario.<sup>138</sup> The court hastened to add, however, that “while remoteness of a possible occurrence does not permit disregarding it in such circumstances as these, where a real possibility of the occurrence has been proved and a database for evaluating its consequences established, the Corps need not concern itself with phantasmagoria hypothesized without a firm basis in evidence and the actual circumstances of the contemplated project, or with disasters the likelihood of which is not shown to be significantly increased by the carrying out of the project.”<sup>139</sup>

After withdrawing the 1983 proposal, CEQ called for public comment on possible methods of dealing with uncertainty. It received a laundry list of complaints about the worst case requirement such as “the limitless nature of the task of conjuring the worst possible case,” “the lack of expert support for worst-case analysis in the growing field of risk analysis,” and the “minimal value of fanciful worst-case analyses to federal decision-makers who must balance a full range of proven competing interests.”<sup>140</sup> CEQ then issued a new regulation dealing with uncertainty, replacing the worst-case scenario requirement. The new regulation, which is still in effect, tells agencies that when important information is not available at a reasonable cost, they must include in the EIS:

- (1) A statement that such information is incomplete or unavailable;
- (2) a statement of the relevance of the incomplete or unavailable information to evaluating reasonably foreseeable significant adverse impacts on the human environment;
- (3) a summary of existing credible scientific evidence which is relevant to evaluating the reasonably foreseeable significant adverse impacts on the human environment;
- and (4) the agency’s

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<sup>134</sup> *Id.*

<sup>135</sup> See Note, *Federal Agency Treatment of Uncertainty in Environmental Impact Statements Under the EPA's Amended NEAP Regulation § 1502.22: Worst Case Analysis or Risk Threshold?*, 86 Mich. L. Rev. 777, 807-09 (1988).

<sup>136</sup> Masterman, *supra* note 128, at 10027 n.14.

<sup>137</sup> *Id.*

<sup>138</sup> *Sigler*, 695 F.2d at 974.

<sup>139</sup> *Id.* at 975 n.14.

<sup>140</sup> Masterman, *supra* note 128.

evaluation of such impacts based upon theoretical approaches or research methods generally accepted in the scientific community.<sup>141</sup>

The regulations define “reasonably foreseeable” to include impacts “which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.”<sup>142</sup>

It should be noted that, although the new regulation avoids the term “worst case” and calls for a broader discussion of potential risks, it does still call for discussion of low-probability catastrophes. In effect, it defines “worst case” in terms of the rule of reason rather than completely eliminating the worst case requirement.

The Supreme Court upheld this regulation in *Robertson v. Methow Valley Citizens Council* and held that NEPA does not require a worst case analysis.<sup>143</sup> In response to a Forest Service decision to allow construction of a private ski resort, the state game department had “voiced a special concern about potential losses to the State’s large migratory deer herd, which uses the Methow Valley as a critical winter range and as its migration route.”<sup>144</sup> The state agency projected a possible 50% reduction in the herd.<sup>145</sup> The Forest Service was more optimistic but admitted that off-site development caused by the project might “noticeably reduce” the herd.<sup>146</sup> Although the court of appeals held that the EIS was invalid because it failed to put forward an explicit worst-case scenario, the Supreme Court held that the CEQ’s current regulation was a reasonable interpretation of the statute.<sup>147</sup> Hence, agencies were no longer required to conduct an explicit worst-case analysis after the new regulation went into effect.

CEQ’s new regulation applies when an agency completing an EIS has “incomplete information” that is relevant to “reasonably foreseeable significant adverse impacts,” including “impacts which have catastrophic consequences, even if their probability of occurrence is low, provided that the analysis of the impacts is supported by credible scientific evidence, is not based on pure conjecture, and is within the rule of reason.”<sup>148</sup> If this information is “essential to a reasoned choice among alternatives,” and the cost of obtaining it is not “exorbitant,” the information must be included.<sup>149</sup> If the information is relevant but cannot be obtained because the cost is too high or the “means to obtain it are not known,” the EIS must include four items: a statement of the information’s unavailability; a statement of its relevance to reasonably

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<sup>141</sup> 40 C.F.R. § 1502.22(b).

<sup>142</sup> *Id.*

<sup>143</sup> *Robertson v. Methow Valley Citizens Council*, 490 U.S. 332 (1989).

<sup>144</sup> *Id.* at 342.

<sup>145</sup> *Id.*

<sup>146</sup> *Id.* at 343.

<sup>147</sup> *Id.* at 354-55.

<sup>148</sup> 40 C.F.R. § 1502.22 (1986).

<sup>149</sup> 40 C.F.R. § 1502.22(a).

foreseeable impacts; a summary of the existing scientific evidence relevant to assessing the impacts; and the agency's evaluation of these impacts based on generally accepted scientific methods.<sup>150</sup>

Courts have provided little guidance to agencies seeking to comply with the new rule.<sup>151</sup> Courts have, however, given some indication of the limited scope of the regulation's application. First, an agency need only follow section 1502.22 if it is relying on deficient or incomplete information.<sup>152</sup> Second, the missing information must be relevant to a reasonably foreseeable and significant adverse impact, not a speculative or minimal one.<sup>153</sup> For instance, in *Lee v. United States Air Force*,<sup>154</sup> the court held that section 1502.22 did not apply to the Air Force's assessment of a project's impact on property values because the Air Force concluded the impact would be minimal, despite the fact that its EIS admitted the effect was "impossible to quantify." However, the court's analysis in *Sierra Club v. Marita* indicates confusion as to whether section 1502.22 must be followed when there is missing information about whether a certain scientific methodology is applicable to the assessment of a potential impact's likelihood.<sup>155</sup> There, the court declined to say whether NEPA required the Forest Service to discuss conservation biology in its EIS, given the Service's doubts about the applicability of the theory to the forests in question.<sup>156</sup> The court held instead that "[t]o the extent 1502.22 did mandate a discussion of conservation biology," the Service's discussion in its Record of Decision was adequate to satisfy its burden, without providing any analysis of how this discussion met the requirements of 1502.22.<sup>157</sup>

Where courts have applied section 1502.22, they have often read the regulation to place few formal requirements on an EIS. In *Holy Cross Wilderness Fund v. Madigan*, the court held that the Army Corps of Engineers' EIS did not need to include a discussion of incomplete information regarding the likelihood that its grant of a permit would cause wetland losses because the permit specifically mandated that such losses not occur.<sup>158</sup> The court essentially held that an agency does not need to make particular statements about unavailable information as required by section 1502.22(a) and (b) so long as it otherwise ensures that the adverse impact will be avoided.

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<sup>150</sup> 40 C.F.R. § 1502.22(b)(1)-(4).

<sup>151</sup> See Carla Mattix & Kalthleen Becker, *Scientific Uncertainty and the National Environmental Policy Act*, 54 Admin L. Rev. 1125, 1142-56 (2002).

<sup>152</sup> See, e.g., *Ground Zero Ctr. for Non-Violent Action v. United States Dep't of Navy*, 383 F.3d 1082, 1090-91 (9<sup>th</sup> Cir. 2004) (holding that § 1502.22 did not apply because the Navy made a "detailed study of the risk of an accidental [missile] explosion," and its information was complete).

<sup>153</sup> See 40 C.F.R. § 1502.22.

<sup>154</sup> 354 F. 3d 1229, 1241-42 (10<sup>th</sup> Cir. 2004).

<sup>155</sup> See 46 F.3d 606, 623-24 (7<sup>th</sup> Cir. 1995).

<sup>156</sup> *Id.*

<sup>157</sup> *Id.*

<sup>158</sup> 960 F.2d 1515, 1526 (10<sup>th</sup> Cir. 1992).

The court in *Colorado Envtl. Coalition v. Dombeck*<sup>159</sup> was also “unwilling to give a hyper-technical reading of” 1502.22(b) and require agencies to complete “a separate, formal disclosure statement in” an EIS regarding non-essential incomplete information. There the court found that the Forest Service was not obligated under 1502.22(a) to obtain missing information regarding a ski resort expansion’s impact on lynx because plaintiffs had not demonstrated that the information was “essential” to the Service’s decision. Given that 1502.22(a) did not apply, the court appeared to hold that 1502.22(b) did, but its demands were met as the “record...amply demonstrate[d]” the Service was “well aware of the relevance” and “scarcity” of the missing data, and as such “an additional formal statement...would serve no purpose.”<sup>160</sup> Similarly, in *Trout Unlimited v. United States Dep’t of Agric.*,<sup>161</sup> the court held that 1502.22 did not apply because plaintiffs did not demonstrate that data acknowledged by the Forest Service to be missing from its EIS was “essential,” but the court did not discuss whether the missing information was merely relevant, thereby triggering the requirements of 1502.22(b). Instead the court held that the EIS in question satisfied 1502.22.

A handful of recent courts have given 1502.22 more bite and found the treatment of uncertainty in EISes to be inadequate. In *Sierra Club v. Flowers*,<sup>162</sup> the district court granted summary judgment for plaintiffs on their claim that the United States Army Corps of Engineers had collected insufficient data about the risk of contamination to a wellfield providing drinking water in its EIS regarding mining permits, thereby running afoul of section 1502.22. However, the Eleventh Circuit overturned this decision on the grounds that the lower court had failed to adequately defer to the Corps as required by the Administrative Procedure Act.<sup>163</sup> On the other hand, the Eighth Circuit vacated the Surface Transportation Board’s final decision approving a project to construct railroad lines to coal mines in *Mid States Coal. for Progress v. Surface Transp. Bd.*, in part because the Board failed to discuss an adverse impact due to incomplete information.<sup>164</sup> The corporation undertaking the project argued that the impact on air quality caused by the rail lines’ supply of coal to power plants was too speculative to trigger section 1502.22, but the court clarified that “when the *nature* of the effect is reasonably foreseeable but its *extent* is not,” the agency’s EIS must follow 1502.22.<sup>165</sup> Despite these instances of courts giving teeth to the new regulation, some commentators still view section 1502.22 as less

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<sup>159</sup> 185 F.3d 1162, 1172 (10<sup>th</sup> Cir. 1999).

<sup>160</sup> *Id.* at 1173.

<sup>161</sup> 320 F. Supp. 2d 1090, 1110 (D. Colo. 2004).

<sup>162</sup> 423 F. Supp. 2d 1273, 1314-15 (S.D. Fla. 2006).

<sup>163</sup> 526 F.3d 1353, 1361 (11<sup>th</sup> Cir. 2008).

<sup>164</sup> 345 F. 3d 520, 549-50 (8<sup>th</sup> Cir. 2003).

<sup>165</sup> Likewise, in *Cabinet Res. Group v. United States Fish & Wildlife Serv.*, the court set aside the Forest Service’s final EIS because it failed to address gaps in a key study it relied on in assessing a motorized access plan’s impact on grizzly bears. 465 F. Supp. 2d 1067, 1099-1100 (D. Mont. 2006). The court found that the missing information was “essential to a reasoned choice among alternatives” based on statements from the study’s authors and other scientists in the field, and interpreted 1502.22 to require agencies to explicitly “acknowledge and discuss any flaws,” in studies relied on in an EIS. *Id.* at 1100.

demanding of agencies than the earlier rule.<sup>166</sup> In *Salmon River Concerned Citizens v. Robertson*, the court considered an EIS based on incomplete information that was drafted to comply with the former worst case analysis requirement.<sup>167</sup> The court appears to have found that the EIS's inclusion of a worst case scenario satisfied the new regulation.<sup>168</sup>

#### IV. Improving the Treatment of Risk under NEPA

Current law distinguishes between the normal situation where harmful impacts are reasonably known and the abnormal situation where a risk is poorly understood but potentially serious. The “worst case” regulation and its successor are one attempt to deal with this situation; *Baltimore Gas* illustrates another possible approach. As we have seen, the regulation seems to be too vague to provide much guidance, while the *Baltimore Gas* approach seems to countenance dishonest representations in impact statements. Trying to straighten out the situation first requires that we deconstruct the dichotomy between normal well-understood impacts and abnormal mystery-shrouded risks.

##### A. The Pervasiveness of Uncertainty

NEPA does not require agencies to perform later checks on their EIS predictions, and agencies do not generally do so.<sup>169</sup> Evidence on predictive accuracy that does exist is not reassuring. Studies find that the predictions are often too vague to be tested at all. Among those that can be verified, the results are no more reassuring, with fewer than one out of three being substantially accurate.<sup>170</sup>

This is not a peculiarly American problem – studies from the United Kingdom and Canada produce similar results.<sup>171</sup> In contrast, however, the Netherlands does require systematic monitoring of project impacts, though compliance may be spotty.<sup>172</sup> Case studies indicate that “better prediction products arise more from the feedback between predictions and experience than from the introduction of more sophisticated predictive methodologies.”<sup>173</sup>

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<sup>166</sup> See, e.g., George Cameron Coggins & Robert L. Glicksman, *Public Natural Resources Law* §10G:22, at 10G-139 (2007) (describing the new regulation as “water[ed] down”); James Jay Tutchton, *Robertson v. Methow Valley Citizens Counsel and the New “Worst Case Analysis” Regulation*, 8 UCLA J. Envtl. L. & Pol’y 287, 299 (1989) (predicting that courts could use the language of new regulation to weaken the scope of environmental protection provided by worst case analysis).

<sup>167</sup> 32 F.3d 1346 (9<sup>th</sup> Cir. 1994).

<sup>168</sup> See *id.* However, this finding is not explicit as court cited to section 1502.22, but did not specifically state that it applied the new regulation. See *id.* at 1358.

<sup>169</sup> Bradley C. Karkkainen, *Toward a Smarter NEPA: Monitoring and Managing Government’s Environmental Performance*, 102 Colum. L. Rev. 903, 927 (2002).

<sup>170</sup> *Id.* at 928.

<sup>171</sup> *Id.* at 928-929.

<sup>172</sup> *Id.* at 951.

<sup>173</sup> Daniel Sarewitz, Roger A. Pelke, Jr., and Radford Byerley, Jr., *Prediction: Science, Decision Making, and the Future of Nature* 369 (2000).

Without the check provided by such feedback, overly optimistic predictions can result from the “economic and political pressures placed on the technical consultants and the government managers, which lead them to use inadequate models and to misuse their predictive results.”<sup>174</sup> As one study puts it,

In the absence of any inducements linked to actual performance, a decisionmaker is likely to be averse to the substantial risk that an audit will prove embarrassing by documenting a project’s shortcomings. Thus, with few positive incentives to self-evaluation and substantial risks, agency managers seem to live by the maxim that ignorance is bliss.<sup>175</sup>

The same study found that only a third of predictions in EISes were “particularly accurate,” most of the remainder being “either accurate solely by virtue of the vagueness of the forecast or somewhat inaccurate in various complicated ways.”<sup>176</sup>

As a wag once said, “prediction is always difficult, especially when it’s about the future.” Environmental documents should avoid making flat predictions without any indication of uncertainty. The paradigm case is the “zero release” assertion in the NRC’s assessment of the risks of nuclear waste disposal after permanent disposal, which was clearly misleading. If nothing else, agencies should avoid flatly declarative language in predictions and use modifiers such as “probably” or phrases such as “past experience indicates” or “some experts believe.” Overdoing the use of such qualifiers leads to fuzzy academic prose, but even that is better than leading the public to believe that something is a fact when it really involves a judgment call.

When the likelihood of a hazard is unclear and it is material to the decision, the agency should provide more explicit discussion of the nature of that hazard and the uncertainties. When a quantitative model is used, the agency should always report confidence intervals and if possible conduct a sensitivity analysis, determining whether the conclusions hold up if the assumptions are tweaked.<sup>177</sup>

If the issue is an important one, the agency should explain why it has chosen the model, the assumptions underlying the model, its reasons for thinking that the model reflects reality, and whether other plausible models would lead to different conclusions. It is important for the agency to do this even if the model claims high accuracy (small confidence intervals) and the results are not very sensitive to parameter changes.

Simply reporting a point estimate of the probability of a result should not be considered acceptable practice. Consider the NRC’s estimate of the likelihood of a significant release from a permanent storage facility. Apparently, the NRC believes that this event is virtually

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<sup>174</sup> Robert E. Moran, *Is this Number to Your Liking? Water Quality Predictions in Mining Impact Studies*, in Sarewitz et al., *supra* note 173, at 187.

<sup>175</sup> Paul J. Culhane, H. Paul Friesema, and Janice A. Beecher, *Forecasts and Environmental Decisionmaking: The Content and Predictive Accuracy of Environmental Impact Statements* 146 (1987).

<sup>176</sup> *Id.* at 253.

<sup>177</sup> Daniel H. Cole, *The Stern Review and Its Critics: Implications for the Theory and Practice of Benefit-Cost Analysis*, 48 *Nat. Resources J.* 53 (2008).

impossible, thus justifying the “zero release” assertion in its environmental disclosure. Suppose that there are two models available for the storage facility. NRC is eighty percent sure that Model A is correct, but thinks there is a twenty percent chance that Model B is correct. Model A predicts a zero probability of a release. Model B predicts a ten percent probability of a release. So the NRC’s beliefs can be summarized as follows: “we think that there is an 80% chance that the way the world works is described by Model A and that there is consequently no risk of a release, but a 20% chance that the way the world works is described by Model B and that there is consequently a 10% chance of a release.”

In this hypothetical situation, the NRC could truthfully say that the best estimate of the probability of a release is zero, and that it is highly confident of that estimate. But taking both models into account, there is actually a twenty percent chance that Model B is right, and then a ten percent chance under Model B that a release would take place. Putting these together means that the probability of a release is ten percent of twenty percent ( $0.1 \times 0.2$ ) or two percent (0.02).<sup>178</sup> Two percent could be quite a significant risk if the costs associated with a release are high. No one would step on a commercial airplane with a two percent (one in fifty) chance of crashing.

A variant on this situation would be that the agency has confidence in Model A, and there are no really strong alternatives – rather there are ten other models, all of which are quite speculative (probability of only two percent that each model is correct), but each of which predicts a 10% probability of a release. This looks quite different because Model A does not have any serious rival; indeed, most scientists would probably view it as the consensus choice. But actually, the arithmetic in this situation works out the same as in the original version of the story – there is still a two percent probability of failure.

In actual practice, there may be no well-developed alternatives to Model A. Model A is the best that the agency can do, and it is highly confident of the outcome. But except in cases where the applications of Model A to similar situations has been widely tested and validated, it would be foolish to assume that Model A is a sure thing. Even a well-tested model may involve assumptions that fail to hold. For instance, we have enormous experience with steel I-beams in construction projects. But there could be a manufacturing defect or human error in installing the I-beam, or the building could be subjected to stresses outside of its design parameters such as an earthquake in a previously stable area. In this sense, Model B is always lurking even when we have not imagined an alternative to the well-tested Model A.

How important is “model uncertainty”? Clearly, it depends on the context – on how well we understand the dynamics and on whether failure is merely a setback or a catastrophe. We have never designed and tested a facility with a 250,000 year life, and as the NRC says, we know little or nothing about the human environment that such a facility would confront. Model uncertainty is a major worry. Models also have mixed records with more mundane tasks like predicting

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<sup>178</sup> Suppose that we had a hundred situations with different models but the same statistics – an 80% probability that a model is correct which shows zero risk, and a 20% probability that a competing model is right predicting a 10% risk of harm. (So we have one situation with Models A and B, another with Models C and D, etc., each pair of models satisfying this description.) Out of those hundred situations, we would expect that the second model in the pair would be right about twenty times, and of those twenty times, we would expect the risk to materialize in two cases.

fishery stocks. How to make decisions in the face of model uncertainty is a knotty problem,<sup>179</sup> but NEPA requires only an answer to the much simpler question of whether such uncertainty should be disclosed to the public.

Because of model uncertainty, there can be no clear dichotomy between cases of quantifiable risks and non-quantifiable uncertainty. A model or past experience may allow us to quantify the risk, but there is always the chance that the model does not apply or that the system dynamics might shift in a way that makes previous empirical regularities suspect. For instance, it must have seemed at one time that weather records over many decades were a reliable basis for predicting future climate at a location. As it turns out, that assumption is false because human emissions of greenhouse gases are shifting the global climate. The “hundred year storm” is not what it used to be, because the implicit model of an unchanging climate turned out to be false.

#### B. Improving the Post-“Worse Case” Regulation

The extent of detail that is warranted in discussing an issue depends on how central that issue might be to the agency’s decision. An outcome might be worth extensive discussion because it would be moderately important and fairly plausible, or because it would be catastrophic and cannot be completely dismissed.

Analysis of uncertainty is warranted in several situations. First, the agency may be lacking key data entirely (are there any smelt in that lake?) or its estimates may be imprecise. As the current regulation instructs, the agency should collect more information if this is feasible and the answer is important. If it is unable or unwilling to collect more data, it should not simply supply an estimate, but instead should provide confidence intervals where statistical methods are used and should conduct a sensitivity analysis to determine the boundaries of the possible outcome set.

Second, the agency may – in fact, almost certainly will – have an incomplete knowledge of system dynamics. It should explain what model (quantitative or otherwise) underlies its predictions. If there are other credible models, these should also be explained, along with the reasons for rejecting them. In any event, the assumptions of the model should be explained and information about model validity should be given. At the very least, the impact statement should disclose that there is some uncertainty about model validity.

Third, the agency should consider catastrophic outcomes whenever there is a credible argument that they are possible. Even if the agency believes that the probability of the outcome is very low, the potential for such outcomes should be noted, and the agency should consider the possibility of including higher margins of safety or other precautions. The quantifiability of the risk should not be relevant.

Finally, the agency should not take the current state of knowledge as fixed. If the potential outcome is important, the agency should put in place monitoring or experimental techniques to help fix the parameter values or the model’s structure more closely.

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<sup>179</sup> See National Research Council, *supra* note 3, at 105-106 (“One of the dimensions of uncertainty that is difficult to capture quantitatively (or even qualitatively) involves model uncertainty.”)

Agencies may be reluctant to take these steps. Openly discussing uncertainties undermines the agency's claims to omniscience and provides ammunition to project opponents. But decision-makers, legislators, and members of the public are entitled to a candid discussion of the limits of the agency's ability to predict the future. Strong guidance from CEQ would help channel agency consideration of these issues in the right direction.

Regardless of the agency's good faith, credibility is difficult to establish when a potential catastrophic risk might raise serious doubts about a major project or regulatory program to which an agency is clearly committed. It was wise of Congress to provide for an independent scientific review of the Yucca Mountain decision. In a previous era, the congressional Office of Technology Assessment was another source of independent risk assessment, but unfortunately ended in an ill-considered political gesture.<sup>180</sup> Congress should make wider use of external reviewers, and at the very least, agencies should be required to obtain peer reviews of predictions regarding potential catastrophic failures whenever a scientific dispute about the magnitude of the risk exists. Even where Congress has not mandated outside review, agencies would be well-advised to obtain such reviews. The additional expense and time, as well as the risk of an adverse conclusion, are worthwhile in the interests of objectivity and also of public credibility.

The current version of the CEQ regulations says very little to guide the agency's analysis. Section 1502.6 calls for an interdisciplinary approach. Section 1502.24 insists on the value of scientific integrity, instructs the agency to identify methodologies, and requires footnotes to the scientific research. The regulations devote more attention to describing the document's format and cover sheet (sections 1502.10 and 1502.11). This is not sufficient, to say the least.

### C. Judicial Review

*Baltimore Gas* exhibited an extremely deferential attitude toward the agency's risk assessment as well as a willingness to tolerate incomplete if not misleading treatment of risk issues. The case seems to be out of tune with the Court's more recent teachings about the judicial role in NEPA cases.

The Supreme Court clarified the scope of judicial review under NEPA in *Marsh v. Oregon Natural Resources Council*,<sup>181</sup> The plaintiffs in *Marsh* claimed that a dam required a supplemental EIS (SEIS) because of two new documents: a report from the state department of fish and wildlife suggesting that the dam would have more effect on downstream fishing than the original EIS suggested, and a federal soil survey that implied greater downstream turbidity. Although the issue was whether a supplemental EIS was needed, rather than the threshold requirements for an initial EIS, the Court stressed that the two issues are similar. If new information shows that a federal action will affect the environment "in a significant way or to a significant extent not already considered," a supplemental EIS is required.<sup>182</sup> This is obviously very similar to the threshold requirement for an EIS. In both situations, the Court said, NEPA

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<sup>180</sup> See Barbara Rosewicz, *Today's Last Rights for Small Technology Agency Mark the Start of a 'Wrenching' and Historic Shift*, Wall St. J., Sept. 1995, at A16.

<sup>181</sup> 490 U.S. 360 (1989).

<sup>182</sup> *Id.* at 303.

requires an agency to take a "hard look" at the environmental effects of its proposal.<sup>183</sup> The Court held the proper standard for review is the arbitrary and capricious test, because the agency's decision whether to issue an EIS or SEIS involves "a factual dispute the resolution of which implicates substantial agency expertise."

The "arbitrary or capricious" test is not necessarily as deferential as it sounds. Lower court judges, the Court said, "should not automatically defer to the [agency] without carefully reviewing the record and satisfying themselves that the agency has made a reasoned decision ...." On the other hand, where experts disagree, the agency may "rely on the reasonable opinions of its own qualified experts even if, as an original matter, a court might find contrary views more persuasive." In applying this test, the Court reviewed the record in great detail before upholding the agency decision, rather than simply deferring to the agency's judgment as in *Baltimore Gas*. Thus, the Court's embrace of the "arbitrary and capricious" test does not free the agency's decision from serious scrutiny on review.

Of course, judges are not scientists and should not be second-guessing the agency's judgment. What the courts should do, however, is to ensure that the impact statement reflects a careful consideration of the available science, and that areas of disagreement or uncertainty are flagged rather than being swept under the carpet. Thus, courts should resist the urgings of agencies that low-probability risks of very serious harms be dismissed from consideration or that the risk be evaluated only under the agency's favored theoretical model without taking into account the possibility that other credible models might be correct. The ultimate decision is up to the agency – what NEPA requires (and what courts should vigorously demand) is a full airing of serious uncertainties.

## V. Conclusion

When we are unable to quantify risks or the resulting harms, reaching the right decision may be a knotty task. NEPA, however, poses an easier question. NEPA does not dictate any particular decision or method of decision making.<sup>184</sup> What it does require is a "hard look" at potential environmental impacts. Unfortunately, it has been difficult to codify this directive in the context of catastrophic risks, which generally have low probabilities but extreme consequences.

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<sup>183</sup> *Id.*

<sup>184</sup> As the Supreme Court said in the *Robertson* case:

If the adverse environmental effects of the proposed action are adequately identified and evaluated, the agency is not constrained by NEPA from deciding that other values outweigh the environmental costs. In this case, for example, it would not have violated NEPA if the Forest Service, after complying with the Act's procedural prerequisites, had decided that the benefits to be derived from downhill skiing at Sandy Butte justified the issuance of a special use permit, notwithstanding the loss of 15 percent, 50 percent, or even 100 percent of the mule deer herd. Other statutes may impose substantive environmental obligations on federal agencies, but NEPA merely prohibits uninformed -- rather than unwise -- agency action.

*Robertson v. Methow Valley Citizens*, 490 U.S. 332, 350-351 (1989).

As we have seen, agencies have widely differed in terms of the seriousness and candor with which they have approached these tasks. The Council on Environmental Quality attempted to rectify the situation with a relatively clear regulation that critics believed skewed the presentation in favor of emphasizing remote risks. It then replaced the regulation with a newer, perhaps more evenhanded regulation. The amended regulation's content seems reasonably sensible but seems to give too little guidance to agencies.

This article has suggested six improvements in current practice:

- Where possible, confidence intervals should be provided for critical data.
- When the agency relies on formal modeling, validation issues should be directly addressed.
- Whether or not a formal model is used, the agency should discuss the limitations of current understanding of system dynamics and conflicting models found in the scientific literature.
- Rather than relying solely on model output as a basis for evaluating risk, the agency should give explicit attention to model uncertainty.
- The agency's reasoning should be transparent and model assumptions should be clearly stated.
- Where the agency has proposed a major project or regulatory initiative, and a possible catastrophic risk could attend that action, the agency should at least obtain a peer review of its analysis and ideally should procure a risk assessment from an independent body.
- Courts should not second-guess an agency's scientific judgments, but neither should they allow expertise to function as a smokescreen for any agency's failure to probe the relevant science in depth, explore opposing viewpoints, and candidly disclose analytic uncertainties.

All of this seems reasonably obvious. That makes it all the more important to ensure that these requirements are clearly articulated and faithfully observed.