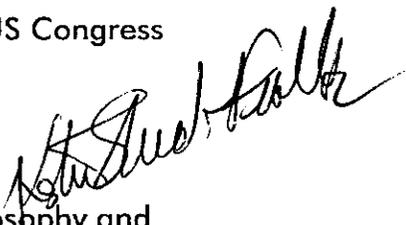


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To: President Clinton
Senators and Representatives, US Congress
W. R. Dixon, US DOE ✓



From: Kristin Shrader-Frechette, Ph.D.
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Enclosed is my analysis of the US Department of Energy Draft Environmental Impact Statement (DEIS) of the proposed Yucca Mountain Nuclear Waste facility. As a scientist whose specialization is radiological and biological effects of nuclear waste disposal, I find this document to be nothing more than a scientific sham. Under no circumstances should the Yucca Mountain facility be built, if the basis is a DEIS as scientifically and ethically flawed as this one.

1 continued
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There are strong scientific, logical, and ethical grounds for disagreeing with the conclusion of the US Department of Energy (DOE), which supports building the proposed Yucca Mountain nuclear repository. The Draft Environmental Impact Statement (DEIS) used to argue for proceeding with the facility is little more than window dressing designed to make incomplete and invalid science, logical fallacies, and questionable ethics appear as if they were valid, reasonable, and ethical.

Can I count on your support to stop this dangerous, scientifically problematic facility from being built? I hope so. Best wishes.

Methodological Problems with the Yucca Mountain Environmental Impact Statement:

Comments on the
Draft Environmental Impact Statement for a Geological Repository for the Disposal of
Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain,
Nye County, Nevada

by

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There are strong scientific, logical, and ethical grounds for disagreeing with the conclusion of the US Department of Energy (DOE), which supports building the proposed Yucca Mountain nuclear repository. The Draft Environmental Impact Statement (DEIS) used to argue for proceeding with the facility is little more than window dressing designed to make incomplete and invalid science, logical fallacies, and questionable ethics appear as if they were valid, reasonable, and ethical. The DOE asserts:

DOE's preferred alternative is to proceed with the Proposed Action to construct, operate and monitor, and eventually close a geological repository for the disposal of spent nuclear fuel and high-level radioactive waste at Yucca Mountain. The analyses in this EIS did not identify any potential environmental impacts that would be a basis for not proceeding with the Proposed Action (DEIS, 1999, 2-87).

DOE's conclusion, above, is scientifically, logically, and ethically questionable for at least 9 main reasons:

- (1) DOE's Logically Fallacious Claim of Small Environmental Impacts over the Long Term
- (2) DOE's Ignoring Scientific Data on Problematic Groundwater Migration
- (3) DOE's Begging the Question of Site Suitability
- (4) DOE's Committing the Fallacy of Bifurcation regarding Alternatives
- (5) DOE's Practicing Theological Geology
- (6) DOE's Assuming That What You Ignore Can't Hurt You
- (7) DOE's Ignoring Environmental Justice and Committing the Fallacy of Composition
- (8) DOE's Jeopardizing Future Generations
- (9) DOE's Flawed Past Record

This analysis considers these 9 problems in order.

- (1) DOE's Logically Fallacious Claim of Small Environmental Impacts over the Long Term

2 continued
on page 4

The DEIS is scientifically and empirically questionable because it repeatedly alleges that "in general the EIS analyses showed that the environmental impacts associated with the Proposed Action would be small" (DEIS, 1999, 2-74). This claim is questionable, in part, because it relies on a logical fallacy of composition. This fallacy consists of assuming that because something is true of the whole therefore it is true of the part, or assuming that a necessary condition for something to be true of a part is that it be true of the whole. Committing this fallacy, the DOE asserts that "no substantial impacts were identified; therefore, cumulative impacts...would not cause...concerns" (DEIS, 1999, 8-59). However, there could be no large impacts from radiological exposures over a given year, but the cumulative impact of these exposures could be great. For example, an annual chest x-ray might not be an important source of exposure, but having one every year for 30 years might have a substantial cumulative impact.

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Another reason that the DOE errs in claiming that there will be no substantial impacts of the Yucca Mountain repository, over its life, is that the DOE's own peer reviewers unanimously concluded that it was impossible to show, scientifically and statistically, that the impacts would be small, because they could not be calculated; as the DOE peer reviewers noted, in a unanimous "Consensus Statement:

Many aspects of site suitability...predictions involving future geologic activity, future value of mineral deposits and mineral occurrence models...rates of tectonic activity and volcanism, as well as mineral resource occurrence and value, will be fraught with substantial uncertainties that cannot be quantified using standard statistical methods (Yunker, Albrecht, et al., 1992, B-2).

Moreover, the National Academy of Sciences committee on Yucca Mountain admitted that it was impossible to calculate the effects of repository intrusion, something that must be known in order to conclude that the environmental impacts will be small (NRC 1995). The same Academy Committee also noted that it was impossible to predict human/social factors, such as institutional control of radioactive waste, beyond one hundred years (NRC 1995). If the National Academy believes that one cannot predict human intrusion and meaningful human behavior after 100 years, then the DOE DEIS (1999, see 7-6) needs to explain how it can claim to predict what will happen 10,000 years into the future, and especially, that there will be no adverse environmental impacts as a result of the proposed Yucca Mountain facility. That is, it is scientifically impossible to conclude that the impacts of a repository, for thousands of years into the future, will be small, because it is impossible to know the future to the degree of precision necessary to draw this conclusion. There is no prior experience with permanent radioactive waste disposal on which to draw, and no nation has yet successfully employed permanent disposal.]

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Another reason that it is problematic for the DOE to assert that the environmental impacts of a permanent, high-level nuclear waste repository will be small is that the DOE admits that repository flooding would be catastrophic, and yet that Yucca Mountain experienced a wetter and cooler period 10,000 to 50,000 years ago (DEIS, 1999, 3-49); if the repository area was flooded 10,000 years ago, then it is reasonable to believe it could be flooded again, in the future, especially because the climate changes appear to be cyclic. Even the DOE admits that climate change at Yucca Mountain is uncertain, and that "the record shows continual variation, often with very rapid jumps, between cold glacial...and warm interglacial climates" (DEIS, 1999, 5-17).

DOE's alleging that the impacts of Yucca Mountain will be small also is inconsistent with its own statements when it reported the findings of Dublyansky (1998) that warm upwelling water has infiltrated the Yucca repository site (DEIS, 1999, 3-49). In response to these findings, the DOE notes that "both parties [the DOE, which supports the repository, and the state of Nevada, which opposes it] have agreed that additional

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research is needed to resolve the issues [surrounding this upwelling finding](DEIS, 1999, 3-50). If the DOE thus admits that the upwelling data need to be resolved, and if such repository flooding would be catastrophic, then the DOE cannot consistently claim that effects of Yucca Mountain will be minor. In addition, the DOE admits that the data on Yucca Mountain are sparse and contradictory; for example, the DOE says that "there are a number of published estimates of perennial yield for many of the hydrographic areas in Nevada, and they often differ from one another by large amounts" (DEIS, 1999, 3-127). Given such discrepancies, it is inconsistent, controversial, and therefore premature to say that building a repository in such an area will cause few environmental impacts.

On the issue of repository flooding, it is interesting to note that the DOE itself claims that "The potential for flooding at the repository site is extremely small" (DEIS, 1999, 4-19), even though its own claims in the preceding paragraph cast doubt on this issue. In particular, if the claims are correct, then it is impossible to know whether the potential for flooding is small or great until the upwelling data are resolved.

(2) DOE's Ignoring Scientific Data on Problematic Groundwater Migration

4 continued
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The DEIS likewise is scientifically questionable because it substitutes scientific judgment or opinion in areas, like groundwater migration, in which there already is confirmed scientific evidence to the contrary. In the case of groundwater migration, the primary means whereby radionuclides would migrate offsite, the DEIS alleges that, given the groundwater at Yucca Mountain, there would be "minimal potential to involve substantial contaminant releases" (DEIS, 1999, 8-33). This opinion, however, is doubtful because even the DEIS (1999, 3-42) admits that the perched groundwater at Yucca Mountain is very young (and therefore that rapid groundwater migration has occurred): "The apparent age of the perched water based on carbon-14 dating indicates this recharge occurred during the past 6,000 years." If the Yucca Mountain groundwater was recharged during the last 6,000 years, and if the waste is above the groundwater, then it is reasonable to assert that groundwater, migrating through the waste, may recharge the groundwater in the next several thousand years, just as it did in the past. On a related point, the DEIS also admits that

Chlorine-36 analyses at Yucca Mountain have identified locations where water has moved fairly rapidly (in several decades) from the surface to the depth of the proposed repository....About 13 percent of the samples (31 samples) had high enough chlorine-31-to-total-chlorine ratios to indicate the water originated from precipitation occurring in the past 50 years (that is, nuclear age precipitation) (DEIS, 1999, 3-47 and 3-48).

After thus noting that much of the groundwater, below the proposed repository, was 50 years old or less, the DEIS admitted that a continuous fracture path in the rock most

likely caused this fast transit time (DEIS, 1999, 3-47). The DOE also noted that, because of the mineral concentrations in the groundwater, there was "strong evidence that flow through faults and fractures is the primary source of the perched water [at Yucca Mountain]" (DEIS, 1999, 3-48). It is interesting to note that, a decade earlier, the DOE (1986, 6-32, 257,298,299) was maintaining, contrary to other geological reports, that the transit time from the surface to repository depths would be greater than 10,000 years and that fracture flow was virtually nonexistent. If a mere ten years of research have changed the DOE position on a crucial determinant of repository safety, one can only argue that more research is needed prior to building the repository and that, for now, no action is the best alternative.

It also is interesting to note that the DEIS concludes that, because of slow groundwater migration time, the radionuclides migrating from the Nevada test site would result in an individual's receiving only a maximum annual dose of about 0.2 rem, or less than .01 of normal annual background exposure. However, after drawing such a conclusion about minimal impact, the DEIS notes that "there is a high degree of uncertainty associated with this estimate" (DEIS, 1999, 8-76). If there is so much uncertainty, then one wonders why the DEIS bothered to give a number that was virtually meaningless. In the same discussion, the DEIS admitted that "the underground tests are based on one data set from one well over a very short time (fewer than 50 years) and then extrapolated to 10,000 years" (DEIS, 1999, 8-76) One wonders why the DOE bothered to use such a misleading number, based on one sample, and then extrapolated from less than 50 years to 10,000 years. Such one-well tests and extrapolations are contrary to all good practice in the science of geology (see Shrader-Frechette 1993, 42-50).

(3) DOE's Begging the Question of Site Suitability

The DEIS allegation that environmental impacts of Yucca Mountain "in general ... would be small" (DEIS, 1999, 2-74) is not only inconsistent with existing empirical data and with the DOE's own claims about groundwater, perched water, and upwelling, but this DOE claim is also logically invalid because it begs the question. It begs the question because the DOE has not yet determined many scientific facts whose validity is essential to drawing this conclusion. For one thing, to allege that future impacts would be small, despite the million-year lifetime of the repository, seems incredible, because it is impossible to predict the specifics of what will happen over so long a time frame. Also, such DOE predictions are disguised as scientific when, in reality, they are no more than guesses.

Consider several examples of this logically-invalid, question-begging character of the DOE's analysis. When the DOE says, for instance, that "sixteen accident scenarios....bound the consequences of credible accidents at the repository" (DEIS, 1999, 4-61), this claim begs the question because it presupposes, ahead of time, what accidents are credible, and then, after this presupposition, concludes that the accidents

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will be minor. DOE begs the whole question of the accidents that Yucca Mountain would be likely to cause because it sets up the problem in a question-begging way. It prescribes what accidents are "reasonably foreseeable" (DEIS, 1999, 6-41), despite the fact that it is impossible to predict human error, especially so far into the future, as the National Academy noted (NRC, 1995). After assessing only these question-begging accidents, the DOE then concludes that the risks are small. The "reasonably foreseeable" accidents that the DOE proposes, however, are quite different from those that the State of Nevada, where most such accidents would occur, alleges. Thus there are strong grounds for believing not only that DOE has "stacked the deck" in the material it considers, but also that its resultant conclusions are little more than begging the question. |

7

Likewise, for example, when the DOE says that "sabotage...would be unlikely to contribute to impacts from the repository....sabotage events would be unlikely at the repository" (DEIS, 1999, 4-65), again it is merely begging the question. DOE concluded that sabotage events would be unlikely at the repository (DEIS, 1999, p. 4-65), even though the National Academy of Sciences (NRC 1995) committee noted that it would be impossible to predict any sabotage events. There are no data that show sabotage is unlikely, and US Office of Technology Assessment data show that human error and terrorism are well known to be responsible for 60 percent of all technology-related threats (Shrader-Frechette 1993, 69; see also 67ff.). Given the enormity of this statistic, the DOE ought not merely beg the question about the likelihood of terrorism or sabotage. Because the DOE assumes that the repository will be breached only by "inadvertent intrusion," (DEIS, 1999, 5-41) it is able, fallaciously, to dismiss sabotage and therefore conclude that the risks are smaller than might be thought. |

8

Similarly, the DOE begs the question of the safety of the waste canisters. It says that "the waste packages would be the primary engineered barrier to inhibit the release of radioactive material to the environment" (DEIS, 1999, 2-31). Yet, the DOE is still "developing specific waste package designs" and has, so far, only a "preliminary conceptual design" for the canisters (DEIS, 1999, 2-32). In the absence of specific canisters that have been tested, the DEIS speaks instead of how "the design of a specific cask would be tailored to the type of material it would contain" (DEIS, 1999, 4-88). In short, the DOE provides no empirical analysis of what would happen to specific empirical casks, and instead it says what "would" happen, given the casks that it "would" make. Such claims ought to qualify, not as environmental impact analysis but as theological impact analysis, since the DOE prefers to analyze its promises and beliefs rather than the facts. |

9 continued
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Just as DOE assumes that its canisters will be effective and safe, even though they are not yet designed, so also the DOE assumes that the transport routes, for shipping waste to Yucca Mountain, will be effective and safe, even though it has specified neither the routes to be taken, nor the mode of transport. Moreover, it is not even known "when

DOE would make any transportation-related decisions" (DEIS, 1999, 6-1). DOE goes on to say that the mode of transport used to ship waste "would depend on several factors that DOE does not control" (DEIS, 1999, 6-1). If DOE does not know the routes and the modes of transport, it is difficult to claim that it has assessed the environmental impacts from Yucca Mountain, particularly because most experts maintain that transport-related impacts will be the most serious, at least over the period when the repository is open.

10

It is even more question-begging, and even more incredible, when DOE knows neither the canister that will eventually be designed, nor the routes, nor the modes of transport, to claim that "the overall radiological accident risk...from all accident scenarios over the 24 years of transportation activities...would be about 0.07 latent cancer fatalities" at most (DEIS, 1999, 6-7). Obviously such fatalities depend strongly on the mode and routes of transport, so these figures appear to be mere guesses, and surely they are not science. Besides, as the state of Nevada pointed out, the DOE simplified cask design and accident scenarios, "created" data to fill the gaps, ignored human error in transport, and so on (DEIS, 1999, 6-29). Given all these problems with the DOE's using subjective data, there is no way that a reliable probability about cancer fatalities, induced by transport, could be given by the DOE. And if not, then the DEIS is not an example of science but an example of mere opinion, rhetoric, and begging the question.

11

DOE also begs the question when it admits that "Isolated nuclear criticality events could occur if the engineered control measures in the waste packages failed and other conditions (such as the presence of water) occurred," but then concludes, "If a nuclear criticality even occurred (highly unlikely) it would not have a significant effect on long-term impacts from the repository" (DEIS, 1999, 5-46). Given that criticality is an uncontrolled nuclear chain reaction, the bland reassurance of the DOE is, again, subjective. DOE's claim appears, at best, to be based on a theoretical model built on a number of DOE's own conclusions. Hence, DOE uses opinions to support its models, then claims that its models show that "there is no chance" of criticality accident. Such examples of begging the question arise, in part, because the DOE uses its own subjective models, in the absence of empirical data and long-term studies, to provide opinions on problems like criticality and groundwater migration. Such models, however, produce conclusions that are merely a function of the original assumptions that DOE put into the model (see Shrader-Frechette 1993. 50-53). As such they are not science but logically invalid modes of rhetoric, examples of begging the question.

(4) DOE's Committing the Fallacy of Bifurcation regarding Alternatives

12
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As should already be apparent, the DOE is guilty of numerous logical, scientific, and ethical fallacies -- such as inconsistency, begging the question, and the fallacy of composition -- in the reasoning used in the DEIS. Another flagrant logical fallacy in the DEIS is bifurcation. The fallacy of bifurcation occurs when someone argues for one of two positions in a situation in which there are only two options for choice and in which the other option (than the one preferred) is not really a viable option. Thus the fallacy

12
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of bifurcation present itself as rational, but it is really invalid and illogical as a means of decisionmaking. The DOE bifurcation consists of its considers only two options, either to build the proposed Yucca Mountain facility or to take no action at all (DEIS, 1999, 7-1). Yet obviously the US cannot take no action. It has to do something with nuclear waste, as even the DOE admits: "The future course that Congress, DOE, and the commercial utilities would take if Yucca Mountain did not receive a recommendation as a repository site remains highly uncertain" (DEIS, 1999, 7-1) Hence, for the DOE to consider only two options, using Yucca Mountain or taking no action, is to use a thoroughly unjust and illogical method in the EIS. This method would be analogous to offering the people a ballot on which there was only one candidate. One could vote for or against the candidate, but since there was only one candidate, the voter would know that she were being railroaded. It is significant that the DOE DEIS thus uses the same fallacy of bifurcation that has been used, repeatedly, in fascist and dictatorial regimes that want to give the appearance of rationality and democracy, in their elections, even though there is little of either. |

(5) DOE's Practicing Theological Geology

13
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Such examples of DOE's offering logical fallacies and opinions rather than science, promises rather than empirical data, continue throughout the DEIS, most notably in the area of assessing geological parameters relevant to environmental impacts at the site. For example, the DOE says that "volcanic activity in this area has been waning in the recent geologic past and...the probability of volcanic activity as a repository-disturbing event is low" (DEIS, 1999, p. 5-16). Likewise, with respect to earthquakes, the DOE admits that "earthquakes have occurred in the Yucca Mountain geologic region of influence, and are likely to occur in the future" (DEIS, 1999, 5-16). The DOE also admits that it has inadequate data regarding factors such as "drift seepage and percolation to depth," "dripping onto waste packages," integrity of the "waste package barrier," "integrity of the spent nuclear fuel cladding," and "transport in the unsaturated zone" (DEIS, 1999, 5-18).

In order to address each of these empirical problems -- volcanism, earthquakes, drift, drips, packaging, and transport -- the DOE says that it will update the models of each of these problems. Yet it concludes, correctly, that "because of the long periods simulated, the complexity and variability of the a natural system, and several other factors, the performance modeling must deal with a large degree of uncertainty" (DEIS, 1999, 5-19). However, when the basic difficulty is that one has little empirical data, as the DOE admits on the same page as the previous quotation, then modeling cannot resolve fundamental empirical problems, because the models themselves are based on subjective probabilities and alternative conceptual frameworks. As such, the models can be evaluated only for consistency, not for correctness or empirical fit; indeed if there were empirical data, the DOE would not be using models in the first place. The DOE, however, says that it will attack such empirical difficulties by using "alternative

13
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conceptual models" (DEIS, 1999, 5-19). Yet, without empirical data, such models can only be tested via validation and verification—both of which bear no relationships whatsoever to the empirical world. They check merely consistency with other theoretical models (Shrader-Frechette 1993, 103-160). The DOE recognizes this fact, because it concludes, "the use of alternative conceptual models, while often necessary to characterize some types of uncertainty, is not always as exact as desired" (DEIS, 1999, 5-20). The DOE finally admits that, despite all its pretense of modeling, in the face of inadequate data, that it is relying on opinions. It says: "Based on expert judgment (and to some extent the finite time and resources that could be applied to the analysis effort), the analysis used a best estimate of the more likely ranges of model behavior and parameter ranges....Because of this narrowed range of models and parameters, the results are conditional, meaning that they depend on certain models and parameters being held constant or having their variance restricted. One such condition is the specific design of the repository and the waste packages in the reference design of this EIS (DEIS, 1999, 5-20).

In thus relying on opinions and models, rather than empirical data, the DEIS reveals very little about what is likely to happen, in the next million years, if the US uses Yucca Mountain as a repository. Instead of doing science, the DEIS is closer to doing theology, examining not facts but beliefs, hopes, and wishes. It is doing "theological geology," not real science.

(6) DOE's Assuming That What You Ignore Can't Hurt You

14
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on page 11

Throughout the Yucca Mountain DEIS, the DOE ignores factual events that are difficult, if not impossible to know, and then, despite these omissions, invalidly concludes that the impact from the proposed waste facility will be low. Consider some of these omissions: "The impact of such human intrusion was not included directly in the final presentation of results....the probability of human intrusion occurring was not modeled" (DEIS, 1999, 5-16). After ignoring crucial variables, such as human intrusion, that could cause massive environmental impacts, the DOE notes that it will use "insight based on the best information and scientific judgments available" in its analyses (DEIS, 1999, 5-17). Likewise the DOE says that, regarding radiological impacts on populations over long periods of time, "the DOE does not have the means to predict such changes quantitatively with great accuracy; therefore, the analysis does not attempt to quantify the resultant effects on overall impacts" (DEIS, 1999, 5-17).

DOE's ignoring key considerations, about which it is ignorant, is especially problematic because the very things about which it is most ignorant are those things to which conclusions about repository safety are most sensitive, and even the DOE admits this. For example, the DOE considers approximately 20 parameters and then assesses its confidence in its models' accuracy, as well as the sensitivity of the repository safety/performance, relative to each of these parameters. Interestingly, the DOE

14
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admitted that its confidence in its models for water seepage into drifts, in its models for transport of radionuclides through the unsaturated zone, and in its models for transport of radionuclides through the saturated zone, all were "low," even though the significance of these parameters, for repository safety/performance, respectively, was "high," "high," and "medium" (DEIS, 1999, 5-22). If the crucial factors that affect repository safety are those about which DOE confidence is low, then how is it that the DOE can allege that the proposed repository will have no significant environmental impacts? Obviously, if the DOE claims about low confidence are to be believed, then they are not consistent with its claims about low impacts from the proposed repository.

Moreover, the DOE admitted that the peer review panel gave 145 pages of suggestions for improvement of its analyses, and then noted that "all of the suggestions are being addressed" (DEIS, 1999, 5-23). If even the peer review panel was critical of DOE efforts, then one wonders why the public should be railroaded into approval of the Yucca Mountain facility before all the concerns of the peer review committee have been dealt with. Indeed, these corrections should all have been completed before the DEIS was even submitted. To submit it prior to such correction is to show that DOE's decision -- about moving forward on Yucca Mountain -- is completely independent of what expert scientists say. Since when are projects submitted for approval on the basis of a promissory note, a promise to remedy poor science that should not even have occurred in the first place? The peer review committee noted that "the report of the DOE failed to provide a statement of the 'probable behavior of the repository' as requested by Congress" (DEIS, 1999, 5-23). If the peer review committee is correct, that DOE has not accomplished the Congressional mandate, then there is no reason, other than bias, that the DEIS should be presented for approval. |

15 | Similarly, one wonders why the DEIS should spend an entire chapter describing "management actions that the Department of Energy (DOE) would consider using to reduce or mitigate adverse impacts" at the site (DEIS, 1999, 9-1). What good is it to know that there are management actions that DOE "would consider"? To evaluate, adequately, the safety of a facility, presumably one would want to know what mitigating actions DOE would commit to performing under a variety of circumstances. For the DEIS to claim merely that certain actions will be "considered," when the government has a history of claiming sovereign immunity and of not compensating victims of government imposed radiation damage (Shrader-Frechette, 1994), is not reassuring. No one really cares about the "mitigation measures under consideration for inclusion in project plan and design" (DEIS, 1999, 9-2). The fact that the DEIS would state such measures as "under consideration" rather than as "guaranteed," also makes the reader, and any potential radiological victim, wary. Again, the DOE appears to have issued another promissory note, in the DEIS, when what the reader wants is some guarantees and some facts. |

Apart from all these logical fallacies and scientific problems with the empirical quality

16

of the DEIS, there are a number of ethical shortcomings in the DEIS. Some of the most important of these shortcomings are that the DEIS violates considerations of environmental justice, ignores duties to future generations, and relies on the DOE to secure the safety of the proposed facility. Consider each of these ethical problems in turn.

(7) DOE's Ignoring Environmental Justice and Committing the Fallacy of Composition

Native Americans, especially the Shoshone and the Paiutes, would be treated unjustly, if the Yucca Mountain project continued, both because of factual reasons and because of the ethically invalid way that the DOE has defined "environmental injustice." Consider first the invalid definition. The DOE asserts that

17
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on page 13

The environmental justice analysis brings together the results of analyses from different technical disciplines that focus on consequences to certain resource, such as air, land use, socioeconomics, air quality, noise, and cultural resources, that, in turn, could affect human health or the environment. If any of these analyses were to predict high and adverse impacts to the human population in generation, then an environmental justice analysis would determine if those impact could occur in a disproportionately high and adverse manner to minority or low-income populations (DEIS, 1999, 4-81; see also, for example, 8-58).

DOE makes this same move throughout the DEIS. It argues that a particular impact will be low, based on the DOE's theoretical models and opinions, then says because the general impact is low, therefore the impact on native Americans will be low (see, for example, DEIS, 1999, 5-49) . Or it says that, "because there would be no large cumulative impacts...there would be no disproportionately high and adverse impacts to minority and low-income populations" (DEIS, 1999, 8-91). This account of environmental injustice essentially claims that, if the DOE admits that any impacts on the general population are large, then (and only then) it will examine the impact on minorities and low-income groups. This strategy is both logically and ethically flawed, however, as well as scientifically flawed. It is logically flawed because it commits the fallacy of composition, a fallacy that consists of assuming that, if there are impacts of a certain type on a subset (part of a group) of people, therefore there are impacts on the whole set (the whole of a group) of people. Obviously, as any student of logic knows, such reasoning is false. There could be a massive impact on native Americans, for example, as a result of Yucca Mountain, without there being any obvious and massive effect on the population as a whole. Hence, if one waited for a whole-population impact, as DOE proposes, then DOE is likely to miss many adverse environmental-justice impacts, precisely because of the narrow way that DOE has defined "environmental justice" and then reasoned about it, in ways that use the fallacy of composition.

17
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This fallacy of composition is also ethically flawed because, unless the DOE admits that certain impacts are large, it will investigate no environmental-justice issues at all. There is an ethical problem with this strategy because the magnitude of an impact is separate from the equity of its distribution. The first consideration is one of utilitarian ethics, whereas the latter consideration is one of egalitarian ethics (Shrader-Frechette, 1993, 90-94). By considering only the former, the DOE adopts a utilitarian ethics that fails to take account of equity (Shrader-Frechette 1993). Such a strategy is also ethically flawed because it relies on the DOE to define an impact as large before taking account of it ethically. In the case of an inequity, the potential perpetrators ought not be able to define what is and is not inequitable, while the alleged victims have no voice in what constitutes a an important impact.

From a factual and scientific point of view, DOE's questionable account of environmental justice is troubling because the DOE admits that, with respect to transportation, native Americans theoretically will bear much of the risk of the waste transport because "portions of some routes would cross or be adjacent to Native American tribal lands." (DEIS, 1999, 6-137). Given this admission, only the allegedly low radiation exposures claimed by the DOE would prevent native Americans from bearing a disproportionate impact from Yucca Mountain.

Not only does the DOE assume that a large general-population impact is a necessary condition for a disproportionate impact on Native Americans, but the DOE also commits the fallacy of the appeal to ignorance in its assessment of environmental justice and transport accidents relevant to Yucca Mountain. It notes, repeatedly, in chapter 6 of the DEIS, that it has not yet chosen the transport routes to be taken, the transport modes (rail or truck) to be used, and the transport casks to be employed. It also admits that "portions of some routes [of waste casks] would cross or be adjacent to Native American tribal lands" (DEIS, 1999, 6-137). Despite all these unknowns, the DOE claims that "DOE has identified no subsection of the population that would be disproportionately affected by transportation related to the Proposed Action" (DEIS, 1999, 6-34). Of course not. If the routes are not yet chosen, then one cannot tell the degree to which they would cross tribal land or the degree to which poor people and minorities would be living near the routes chosen. Hence, because of the unknowns in the DEIS, it would be impossible to determine a Native-American transport impact. Essentially, the DOE has argued that it does not know the transport routes, modes, and casks, and therefore "DOE has concluded that no disproportionately high and adverse impact would be likely on minority or low-income populations from the national transportation of spent nuclear fuel and high-level radioactive waste to Yucca Mountain" (DEIS, 1999, 6-34,35). This is a classic instance of the logical fallacy of the appeal to ignorance: person A is ignorant of any X, therefore there are no X. From one's ignorance about something, one cannot logically draw any conclusions about it. To do so is to reason invalidly, and this is precisely what the DEIS has done.

17
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on page 15

Additional inequities associated with the proposed Yucca Mountain repository also present problems of environmental justice. The repository proposes to add to the environmental and social burdens that this society already has imposed on native Americans and on Nevadans and hence raises a number of issues of compensatory justice or reparation. Yet instead of reparation or compensation to Nevadans and to native Americans, the DOE proposes to add to their burdens in a variety of ways. Native Americans claim land rights, under US treaty, to the Yucca Mountain lands (DEIS, 1999, 3-9). Although they claim legal power to interpret treaties with Native Americans, the US courts have no ethical power over lands that the US took from Native Americans by force. As a consequence, the US government has no ethical right to impose Yucca Mountain on Native Americans who do not want it. Moreover, Yucca Mountain is part of the holy lands of the Paiute and Shoshone, and they do not want the repository on their holy lands (AIWS, 1998; DEIS, 1999, 3-70, 4-84). The DOE never addresses this argument of the Native Americans in the DEIS. Instead, the DOE merely begs the question of the acceptability of the Yucca Mountain site.

The Yucca Mountain Project also threatens environmental justice because the DOE has denied access and use to these important traditional lands of native Americans, and this denial threatens their cultural survival in a unique and irreversible way, a way experienced by no other Native Americans (AIWS, 1998; DEIS, 1999, 4-84, 85). Moreover, in taking away Native-American use of these holy lands, the DOE has given no rationale for why it believes that it need not take account of the National Historic Preservation Act, the American Indian Religious Freedom Act, Executive Order 13007 on "Indian Sacred Sites," and Executive Order 12898 on "Environmental Justice," all of which could be used to argue against building Yucca Mountain (DEIS, 1999, 11-12, 13, 14).

Although the US DOE invited the participation of the impacted Shoshone and Paiutes in the Yucca Mountain discussions, there is no evidence whatsoever in the DEIS that the US DOE considered the arguments of these peoples, and the US DOE has given no arguments that show why it believes that its ethical claims are superior to those of the Native Americans. In the DEIS, the DOE merely repeated the claims of the Native Americans (see, for example, DEIS, 1999, 4-84 and 85), but never addressed why it believed these arguments were not compelling. At a minimum, if the DOE is to reject the environmental -justice claims of native Americans, the DOE is obliged to explain both (a) what it thinks its rationale is and to detail (b) what considerations of the Shoshone and Paiute would be compelling grounds for abandoning the Yucca Mountain facility. The US DOE has done neither.

Additional environmental -justice issues arise because the Yucca Mountain facility is next to the Nevada Test Site. As a result, Native Americans have already borne more than their fair share of negative environmental impacts from Nevada and from the US because the tribes live directly downwind from the Nevada test site and have

experienced increased radiation-related cancers and ailments as a result of US weapons testing (Shrader-Frechette, 1994). The DEIS (1999, 8-76) does consider the radiological impact of weapons testing and, indeed, even makes the assumption that the migration of radionuclides from testing will be through the same pathways as migration from the proposed repository. Nevertheless, the DEIS never considers this particular environmental-justice aspect of the repository, namely that the same people are likely to bear the worst effects of testing and the worst effects of Yucca Mountain. Because both Nevadans and Native Americans would receive the most negative impacts from Yucca Mountain, if it were built, these minorities are receiving a disproportionate environmental impact from the site, as compared to other Americans. Moreover, they receive these negative impacts not only because of the radiological hazards that they face but also because of the nuclear-related liability they face. Under existing US law, it is not possible for a citizen to sue (the person or group that causes nuclear-related injuries or deaths) for more than approximately one percent of the costs of all nuclear-related consequences of some accidents. Because of the nuclear-exclusion clause in US law, those living near the proposed Yucca Mountain waste facility would face a massive financial risk, even if there is no accident. Knowing that one would not be fully covered, in the event of catastrophe, is both a financial, as well as a psychological and medical risk, apart from whether any severe accidents even take place (see Shrader-Frechette, 1993, especially pp. 96-99). Yet, the DEIS does not even consider this nuclear-liability exclusion, as part of its discussion of environmental justice.

17
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15

DOE's problems with environmental-justice concerns show that it has great difficulty dealing with ethics, and especially, with equity issues. Not only does it repeatedly employ utilitarian ethical assumptions in its analyses, but it fails to consider the actual arguments of the Native American groups at all. Moreover, it admits that some of the repository impacts could have higher, skewed impacts for a few people. Yet it never analyzes the logical consequences of its remarks about skewing, such that it considers the environmental-justice ramifications of the skewing. DOE claims, for example:

The performance results reported in this EIS are highly skewed. In this context, skewed indicates that there are a few impact estimates that are much larger than the rest of the impacts. When a large value is added to a group of small values, it dominates the calculation of the mean. The simulations reported in this EIS have mean impacts that are often above the 90th percentile and occasionally above the 95th (DEIS, 1999, 8-63).

If DOE admits that the performance results are highly skewed, then it ought to consider these large impacts as potential problems of environmental justice. Yet it never does so. Nor does it provide alternatives to the misleading mean figures that it employs in its analyses. Hence the skewed data reveal not only scientific problems with the DEIS but also ethical difficulties.

(8) DOE's Jeopardizing Future Generations

18

The DEIS's presupposition, that it can adequately assess long-term repository effects by examining consequences "for as long as 10,000 years" into the future (DEIS, 1999, 2-74) also is ethically problematic. It jeopardizes duties to future generations, given that the repository impact continues in perpetuity and that the repository would contain radionuclides whose half lives are in the millions of years (Shrader-Frechette, 1993, 42-50). Indeed, as the National Academy of Sciences Committee on Yucca Mountain showed, the proposed site would have serious impacts on the order of a million years into the future (NRC, 1995). Even the DOE has admitted that the impacts from the repository, in terms of radiation doses, will continue to increase, after 10,000 years; its own dose curves, for all its scenarios, show that the radiation doses are continuing to increase up to, and after, 10,000 years (DEIS, 1999, see 5-29, 32, 35). In addition, the DOE explicitly states that "at times greater than 100,000 years after repository closure, damage from falling rocks would be more likely because the waste packages would be corroded" (DEIS, 1999, 5-45). If this is true, then the most massive impacts from the repository are certain to occur after the period for which DOE has done its analysis. And if so, it follows that the DEIS is systematically unfair to members of future generations, namely those who will live later than 10,000 years from now.

(9) DOE's Flawed Past Record

19

In addition to the flaws in logic and scientific method, as well as the ethical shortcomings of the DEIS, there are strong empirical grounds for challenging the claims that the DOE would engage in satisfactory "performance confirmation" to assure "that long-term performance objectives have been met" (DEIS, 1999, 2-37). In other words, given DOE's past behavior, it is doubtful that the "DOE would reduce or eliminate many such [environmental] impacts [from the site] with mitigation measures or implementation of standard Best Management Practices" (DEIS, 1999, 2-74). Likewise it is doubtful that "DOE would minimize the potential for a contaminant spread by managing spills and leaks in the proper and required manner" (DEIS, 1999, 4-22). These empirical grounds for doubt, that DOE would manage the proposed Yucca Mountain site effectively, are DOE's past record of performance at other nuclear sites and DOE's coverup of relevant evidence in the Yucca Mountain case.

Consider first DOE's questionable record at other nuclear sites. According to a recent General Accounting Office (GAO) report, 90 percent of the 127 existing DOE facilities have groundwater contamination, some in excess of 1000 times the allowable limit (Shrader-Frechette 1993, 155). Both boards of the National Academy of Sciences, as well as the US Congress, repeatedly have criticized the US DOE for its bias and mismanagement, as well as for its repeated environmental violations (Shrader-Frechette, 1993, 152-157). Moreover, DOE withheld and covered up important scientific documents from its own peer reviewers and from the state of Nevada

regarding the Yucca Mountain site. The state of Nevada had to go to court to force the DOE to release these site studies, funded with taxpayer monies, to the state where the proposed repository was supposed to be located (Shrader-Frechette, 1993, 139-141). Given all this evidence of DOE bias, coverup, and violation of environmental standards, there is little evidence for the DOE claim that it will manage the proposed Yucca Mountain facility adequately. Indeed, if one goes on past DOE performance, the most reasonable prediction will be that DOE will withhold crucial safety data and that DOE has a 90-percent chance of contaminating the groundwater beneath Yucca Mountain, perhaps to 1000 times in excess of the allowable pollution limit. If DOE was forced to predict its own future behavior on the basis of its past behavior, it could not site Yucca Mountain. Yet DOE should predict its future behavior in precisely this way, because DOE uses past geological and hydrological data for future predictions. It should therefore use all past data, not just selectively ignore the data that show that DOE is likely to do a poor job at Yucca Mountain.

Apart from the way that DOE has mismanaged its other sites and polluted the environment, DOE is not a credible agency to oversee radioactive waste storage or disposal because of its scientific biases and coverup in the Yucca Mountain case. Indeed, the DOE does not even go through the sham of putting scientific documents, contrary to its own positions, in the bibliography for the DEIS. Only one of the hundreds of scientific documents published by the Nevada Nuclear Waste Project Office (NWPO, 1997) appears in the DEIS (1999) bibliography, and this is short letter providing a list of citizens' concerns. The DOE admitted that the state of Nevada, which opposes the repository as unsafe, has a number of scientific findings that must be evaluated, if the project is to be scientifically grounded, concerns such as the groundwater upwelling in the recent past, as documented by Dublyansky (1999). Yet neither this scientific study, nor hundreds of others from the NWPO appears in the bibliography. This bibliographic bias shows not only that DOE cannot be trusted to evaluate Yucca Mountain credibly but also that it cannot be trusted even to report on Yucca Mountain credibly.

DOE bias in the Yucca Mountain study (DEIS 1999, 7-53) is apparent, for example, in its treatment of environmental-justice issues. On the one hand, throughout the document, whenever it discussed environmental-justice questions likely arising in the event of building the proposed Yucca Mountain facility, the DOE authors simply stated the Native-American point of view opposing Yucca Mountain, and then, without any evidence or discussion, asserted that there would be no disproportionate environmental impacts (see earlier section on environmental justice in this paper) and no significant impact from the repository at all (DEIS, 1999, 5-49). The DOE made both assertions, despite the fact that nuclear waste transport would cut across native American lands, and despite the fact that the site of the proposed repository is on land sacred to the Shoshone and Paiute, as well as contested in a land treaty between the US and the Native Americans. The DOE completely ignored the land claims, the sacredness of the land to the Native Americans, and the fact that many reservations are located near the

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on page 18

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proposed Yucca Mountain facility. Instead the DOE proclaimed, by fiat, that there would be no environmental justice impacts as a result of the proposed repository. This denial is all the more amazing because there is no analysis, whatsoever, of the Native American claims in opposition to the Yucca Mountain facility. On the other hand, when the DOE treats proposed impacts of leaving the nuclear waste onsite, at reactors across the US, instead of moving forward on the Yucca Mountain Project, its bias is evident. Although this (no-action) alternative is more preferable to the Native American community and to potential victims of environmental injustice, the DOE claims that this no-action option could cause environmental-justice problems. It states:

the increased number of facilities required to store the...inventory could adversely affect the nearby public to a degree greater than that for the Proposed Action inventory [siting Yucca Mountain]. As with the Proposed Action inventory, nearby minority or economically disadvantaged communities could experience disproportionately high and adverse human health impacts. In addition financial considerations could make it ore difficult for members of minority or low-income populations to obtain uncontaminated resources or to move away from contaminated soils and water. Because subsistence patterns vary for minority or low-income populations, members of these populations could be exposed to greater than average doses. The result of differing potentials for exposure could result in disproportionately high and adverse impact on minority or low-income populations (DEIS, 1999, 7-53).

This DOE affirmation of environmental-justice problems associated with not building the Yucca Mountain Repository is amazing, given (1) that DOE did not analyze the environmental-justice arguments of the Native Americans who wrote opposing the Yucca Mountain facility(see, for example, DEIS, 1999, 4-8, 5-49, 8-58, 10-4), and given (2) that DOE claimed there were no environmental-justice impacts in the case of building the Yucca Mountain facility . This unargued DOE denial of environmental-justice problems, where native Americans say they exist (if the repository were built), together with the assertion of environmental justice problems, where native Americans say they do not exist(if the repository were not built), is puzzling. The DOE affirmation of environmental-justice problems that would arise if the waste remained where it is, throughout the country, is especially problematic because of three DOE omissions in its short, five-sentence "analysis" of environmental justice in the no-action case. In this analysis, DOE alleged that not building Yucca Mountain likely would cause environmental injustices, but it failed to note that, in this case, (1) the people receiving the benefits from the nuclear electricity would also bear the risks of the waste, which would not be the case if Yucca Mountain were built. The DOE also failed to take account of the fact that(2) the Nuclear Regulatory Commission affirmed that the waste could stay safely onsite, where it is, for at least 100 years, and that, (3) all things being equal, waste disposal is more equitable the more widely it is dispersed, as it would be in the no-action case. Given its failure to examine these three points, all of which

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suggest that the no-action option is more environmentally just than the Yucca Mountain option, the DOE again appears to be begging the question and thus revealing its biases.

21
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on page 20

One of the more flagrant examples of DOE bias occurred in 1992. When the DOE issued its Early Site Suitability Evaluation in 1992 (Yunker, Andrews, et al., 1992), and concluded that Yucca Mountain was a suitable site for permanent nuclear waste disposal, the study received massive criticism, including criticism from the DOE's own peer reviewers (Yunker, Albrecht, et al, 1992). These DOE peer reviewers included Ph.D.s in geology and hydrology from the top institutions in the US. They unanimously warned, in their "Consensus Statement":

Many aspects of site suitability...predictions involving future geologic activity, future value of mineral deposits and mineral occurrence models...rates of tectonic activity and volcanism, as well as mineral resource occurrence and value, will be fraught with substantial uncertainties that cannot be quantified using standard statistical methods (Yunker, Albrecht, et al., 1992, B-2).

Confronted by the top geologists and hydrologists in the US, who said that Yucca Mountain safety could not be predicted in the long-term future, the DOE promptly covered up the massive volumes of the Early Site Suitability Evaluation when its peer reviewers said that what the DOE wanted to do (show safety) could not be done. This coverup continues to the present, and neither the ESSE nor the report of the 14 distinguished peer reviewers, on the ESSE, appears in the DEIS. This is not surprising, as the peer reviewers' consensus statement contradicts the findings of the DEIS.

Even more interestingly, after the distinguished Ph.D.s in geology and hydrology, the DOE peer reviewers, severely criticized the DOE Yucca Mountain efforts and said the studies could not be credibly done, the DOE appointed a 50-person team to write the DEIS (1999, 13-1 through 13-7). Of these 50 persons, although there were several geologists, not one had a geology degree higher than the bachelor's. Moreover, half of the 50 DOE DEIS authors were engineers, and presumably predisposed to say that the facility could be built. After all, that is what engineers do. They build things. There was not one medical doctor on the DEIS 50-person team, and not one public-health expert, and not one hydrologist, even with an undergraduate degree. Nevertheless, the main worries of the Yucca Mountain project are health-related radiological exposures and groundwater migration because of geological and hydrological conditions. It thus appears that the DOE could not handle Ph.Ds in hydrology or geology, the Ph.D. peer reviewers of the ESSE, and that the DOE also could not "handle" medical and public-health experts, so it simply excluded these people from the DEIS. In fact, of the DEIS authors, by far the largest specialty was engineering, which was represented by more than double the number of the next highest specialty (biology) of the DEIS project team. Because the DEIS authors do not include a single hydrologist, with even an undergraduate degree, because its geologists have only undergraduate degrees, and

21
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because the DEIS authors include no medical doctors and no public-health experts, at all, this DEIS document is not scientifically credible. It illustrates well why a National Academy of Sciences panel warned, in a classic volume on risk assessment, that assessors must not only get the science right, but they must get the right scientists (NRC, 1996). The DEIS did not get the right scientists. And it looks as if it was no accident that the DEIS did not get the right scientists for the task.

As if the under-education and under-representation of geologists, hydrologists, medical doctors, and public-health experts were not bad enough, DOE also took steps to insure that no hydrological or geological experts interfered with its plan to build Yucca Mountain. The DEIS states very clearly that all reviewers of the DEIS came from various DOE offices, and that there were no external reviewers (DEIS, 1999, 13-7,8). Presumably DOE could not withstand the sort of review that happened when experts from places like MIT said its project could not be accomplished, as happened in its badly flawed ESSE. But if outside experts, including those at the National Academy of Sciences, have been critical of the Yucca Mountain Project (NRC, 1995; see Shrader-Frechette, 1993), and if the DEIS has had no genuine external review, then why should the American public be told that the document is a reasonable one? Why should this document even be offered for decisionmaking? It does not come even close to providing scientific, logical, or ethical grounds for pursuing the Yucca Mountain repository. The document is a scientific disgrace. |

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