Sept 10, 1980

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UNITED STATES OF AMERICA

BEFORE THE NUCLEAR REGULATORY COMMISSION

In the Matter of	
PROPOSED RULEMAKING ON THE STORAGE AND DISPOSAL OF NUCLEAR WASTE	PR-50,51 (44 FR 61372)
(Waste Confidence Rulemaking	

JOINT CROSS-STATEMENT OF POSITION

OF THE

NEW ENGLAND COALITION ON NUCLEAR POLLUTION

AND THE

NATURAL RESOURCES DEFENSE COUNCIL

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INTRODUCTION

The Natural Resources Defense Council (NRDC) and the New England Coalition on Nuclear Pollution (NECNP) have examined the Statements of Position filed by the parties to this proceeding. It is our view that the submissions on behalf of the nuclear industry do not provide a basis for finding reasonable assurance that safe radioactive waste disposal facilities will be available before the expiration of current operating licenses or that spent fuel can be stored safely for an indefinite period until disposal facilities are available. We will discuss primarily the submission of the United Nuclear Waste Management Group - Edison Electric Institute (UNWMG), which is the most comprehensive of the industry filings.

In brief, the following fundamental flaws pervade the UNWMG submissions:

- The industry has subtly but profoundly mischaracterized the central question to be answered by this proceeding and misstated the legal standard that the NRC must apply. Whether or not the NRC can conclude that spent fuel <u>can</u> conceivably be disposed of or stored safely in the time period in issue, as the industry argues, is not enough. The NRC must find that despite the formidable technical, institutional, and societal obstacles, spent fuel <u>will</u> be disposed of safely.

- In the absence of formal NRC criteria for judging the acceptablity of potential disposal options, the industry has proposed standards whose overriding objective appears to be to ensure

expeditious regulatory approval rather than to ensure the protection of public health and safety.

- The industry's attempt to demonstrate that its criteria can, much less will be met suffers from incomplete, non-conservative and deceptive analyses.

- The gaps and uncertainties in current data and research are real and the state of knowledge about potential sites is seriously deficient. The industry has attempted to cavalierly dismiss these by self-serving and unsupported predictions about future results.

The industry argument that spent fuel management for an indefinite period of time is safe and acceptable fails for the following general reasons:

- No technical criteria are provided by which to judge the safety of spent fuel storage for indefinite periods of time.

- The minimal relevant spent fuel storage to date does not provide data sufficient to support a finding of reasonable assurance that spent fuel can be stored for whatever indefinite period of time in the future will be required before acceptable geologic disposal of spent fuel becomes available.

- Neither NRC nor the industry has ever systematically considered the special risks associated with long-term above-ground storage such as the lack of natural barriers to mitigate releases, the susceptibility of such facilities to intentional attack and sabotage and their particular vulnerability to the effects of social and political dislocation. Such factors preclude the use of above-ground storage as a long-term waste management option.

I. The Industry Has Misstated The Legal Standards That Any "Reasonable Assurance" Finding Must Meet.

The underlying purpose of this rulemaking proceeding is to determine whether the continued production of spent nuclear fuel at commercial nuclear reactors licensed by the Nuclear Regulatory Commission "would be inimical . . . to the health and safety of the public." 42 U.S.C. 2133(d). Just as the NRC must make that finding with respect to the operation of nuclear reactors, so it must do so with respect to the disposal of the wastes generated by those reactors. NRDC v. NRC, 547 F.2d 633 (D.C. Cir. 1976) aff'd on this point, Vermont Yankee Nuclear Power Corp v. NRDC, 435 U.S. 519, 55 L.Ed. 2d 460 (1978).

The issue of the safe disposal of nuclear wastes has now arisen because the temporary spent fuel storage pools at nuclear reactors and available away-from-reactor sites are rapidly becoming filled with spent fuel. At the time these facilities were licensed, the nuclear industry and the NRC assumed that spent fuel would be quickly shipped offsite for reprocessing or disposal. In the case that gave rise to this rulemaking proceeding, State of Minnesota v. U.S. Nuclear Regulatory Commission, 602 F.2d 412, 418 (D.C. Cir. 1979), the Court ruled that with respect to the Vermont Yankee and Prairie Island fuel pools at least,

> the court contemplates consideration on remand of the specific problem isolated by petitioners -- determining whether there is reasonable assurance that an off-site storage solution will be available by the years 2007-2009, the expira-

> tion of the plants' operating licenses, and if not, whether there is reasonable assurance that the fuel can be stored safely at the sites beyond those dates.

As indicated in the Notice of Rulemaking, 44 FR 61372, that language serves as the foundation of this proceeding. See NRDC Statement of Position at 9-19 for a more complete discussion of the NRC's mandate in this proceeding. In order to comply with the Court's mandate, the NRC must first determine whether a permanent off-site spent fuel disposal solution will be available by the year 2007. If it cannot make such a finding, it must then determine whether spent fuel can safely be stored at reactor sites or at central storage facilities after that date.[1/] In short, the questions, posed by the Commission are whether a safe disposal method will be available and, if so, when. These are not theoretical questions of academic interest; they must be answered in order to determine whether there is a legal basis upon which the NRC can continue to license nuclear plants. By contrast, the industry poses, and then proceeds to answer, an abstract question: is there one technically feasible method of disposal that can be postulated? Even if answered in the affirmative, this would not provide the confidence required by the Commission

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1/ It is argued in Sections I(C) and I(D), infra, p. 11-15, that a finding that no technical problem precludes use of above-ground storage does not by itself meet the standard.

for the following reasons:

- The industry assumes that the NRC need only find that a disposal facility can be available by the year 2007, rather than that it actually will be available, as the statute and cases require.

- The industry completely fails to address the question of whether adequate disposal capacity will be available when needed.

- A finding that waste can be safely stored does not relieve NRC of the obligation of finding that waste will ultimately be safely disposed of in a permanent manner.

- No evaluation has been made of the liabilities of above-ground waste storage which make it unusable as an indefinite or long-term option.

A. The Issue Before the Commission With Respect To Waste Disposal Is Whether Waste Disposal Facilities Will Be Available Before Operating Licenses Expire, Not Whether Such Facilities Can Be Available.

As noted above, the UNWMG asserts that the NRC need only find that waste disposal can be available by the time existing operating licenses expire. This is reflected in the ultimate conclusion reached in its submission:

> Spent nuclear fuel from licensed facilities can be disposed of in a safe and environmentally acceptable manner. (Emphasis supplied.) 2/

It is also inherent in the entire industry presentation, which is limited to an attempt to show that the technology is in place and the research programs under way to provide

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2/ UNWMG, Vol. 1, p. 3. Note: All citations to Statements of Position filed in this proceeding will follow this format, except that when a party has not previously been identified, its full name will be used initially.

the information needed to develop a single waste repository. 3/ 4/

However, it is clear that the NRC must find not only that a waste disposal facility can be available by the 2007 deadline, but that there is a reasonable assurance that disposal actually will be available. This standard requires a showing that not only are the technology and research capabilities in place, but that the outcome of application of the technology and research programs will result in the siting and construction of the necessary number of repositories by 2007.

The requirement to find reasonable assurance that a facility actually will be available stems from § 103(d) of the Atomic Energy Act, 42 U.S.C. 2133(d), which states, inter alia,

> In any event, no license may be issued to any person within the United States if, in the opinion of the Commission, the issuance of a license to such person would be inimical to the common defense and security or to the health and safety of the public.

The requirements of that section have been distilled into the following standard:

3/ See, for example, UNWMG, Vol. 2, Part III(A), which presents a program for the additional research that must be undertaken to locate a suitable site, without providing any sort of assurance that the research program will provide the answers needed to move ahead. This is discussed at Part IV(B) of this Cross-Statement.

4/ UNWMG, Vol. 1 p. 14-18. See also, the Statements of the American Nuclear Society (ANS), p. 6, the Atomic Industrial Forum (AIF), p. 3, 10-15, Bechtel National Inc. (BNI) and the American Institute of Chemical Engineers (AICE).

> The Commission must have "reasonable assurance" that public health and safety are not endangered by its licensing actions.

Petition for Emergency and Remedial Action, CLI-78-6, 7 NRC 400, 404 (1978).

In order to meet that standard in any licensing action, whether with regard to an individual plant or in a generic proceeding such as this one, the NRC must make a reasonable and reasoned prediction of future events. The treatment of unresolved safety hazards offers an instructive analogy. In Virginia Electric and Power Company (North Anna Nuclear Power Station, Units 1 and 2), ALAB-491, 8 NRC 245 (1978), the Appeal Board distinguished between the treatment of unresolved safety hazards at the construction permit stage and the operating license stage. Whereas construction may be allowed to go forward in the face of unresolved hazards on the premise that "there is still time to find a solution and build it into the plant's design," the same cannot be said of the operating license stage. To the contrary, in order to obtain an operating license, an applicant must establish that the lack of a generic solution to the unresolved safety issue does not "call into question the safety of current operation." Id. at 248-249. It may be that the unresolved safety issue has been resolved as it applies to that particular plant, or that some compensating measure has been taken to address the problem. In either case, it must be enough to demonstrate to the NRC that there will be no hazard from plant operation.

As applied to the context of the hazards of nuclear waste, the NRC is at the operating license stage, not the construction permit stage. Just as the issuance of an operating license allows a utility to engage in a potentially hazardous activity, so a finding of "reasonable assurance" here would allow the nuclear industry to continue producing hazardous nuclear wastes. In each case, the NRC must find not only that there are research programs underway to assure that the public health and safety is not endangered by the hazardous activity, but that the public health and safety actually will be protected. UNWMG patently fails to make this showing.

UNWMG discusses the research and development program which can lead to the establishment of one "reference case" repository. It assumes that all unresolved questions will be resolved favorably so that a safe repository can be built. However, it has not addressed the fact that research and development programs do not always obtain confirmatory results, and often raise new questions and more uncertainties. There is simply no basis in the historical record to support the UNWMG's simplistic optimism regarding the resolution of major technical and institutional issues.[5] The UNWMG prediction allows no margin for the inevitable missteps that will occur, as they have in the past. If difficulties

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[5] NRDC, p. 20-27.

are encountered in resolving any one of the many outstanding technical, institutional or social issues, the theoretical path to success charted by UNWMG could be blocked indefinitely. The most that can reasonably be concluded from this research and development program is that nothing known thus far precludes moving to the next stage of the research program. This is the general purport of the findings of the United States Geological Survey (USGS)[6] and the Interagency Review Group (IRG).[7] This conclusion does not eliminate the possibility that the results of future research will indicate only that a less than satisfactory or acceptable disposal solution is possible or that development may be stopped in its tracks for an unknown period of time.

The Commission may no longer rely on the soothing assurances of the nuclear industry; those assurances have earned a skepticism bred out of a history of almost unrelieved failure. NRDC's direct submission detailed this history, and it will not be repeated here.[8] It is noted to support the conclusion that the industry bears a heavy burden of proof to justify a finding that waste repositories will be completed when needed -- a burden which the industry

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6/ USGS, p. 4, 15, 20.

7/ Report to the President by, the Interagency Review Group on Nuclear Waste Management (March 1979), p. 42. (Hereafter referred to as IRG Report).

8/ NRDC, p. 20-27.

submissions clearly fail to satisfy.

B. The Industry's Presentation Fails To Consider Repository Capacity

As noted above, if the NRC is unable to find a reasonable assurance that a waste repository will be available by 2007, it must address the question of whether spent fuel can and will safely be stored indefinitely at reactor sites until disposal becomes possible. It necessarily follows, therefore, that in order to avoid the requirement that it examine indefinite spent fuel storage, the NRC must determine not only that a repository will be in place, but also that there will be adequate repository capacity to accommodate all of the spent fuel at reactors whose licenses have expired. To the extent that adequate capacity does not exist, spent fuel storage will be required and must be addressed by the NRC.

Despite the necessity for the NRC to consider potential repository capacity, both the Department of Energy (DOE)[9] and the UNWMG[10] have insisted that the NRC need only consider a reference case and find that disposal can be accomplished through any single method. Neither makes any attempt to suggest that the capacity of this reference repository will be adequate. By contrast, NRDC has shown that perhaps as many as nine repositories will be needed to accommodate the spent fuel generated by existing plants and by those projected to come on line by the year 2000.[11]

9/ DOE, p. I-5.

10/ UNWMG, Vol. 1, p. 6.

11/ NRDC, p. 85.

Indeed, even the Atomic Industrial Forum admits that as many as five repositories may be required by the year 2040.[12] In the absence of any showing that repository capacity will be great enough to meet these needs, there is, on this point alone, no basis for confidence that adequate repository capacity will be available when needed.

C. A Finding of Safe Indefinite Spent Fuel Storage Is Not Enough to Support Continued Reactor Operation.

Since the nuclear industry and DOE have mischaracterized the nature of the finding the Commission must make, and since, as discussed below, their factual presentations do not support a finding of "reasonable assurance" that a respository will be in place when required, the NRC must address the question of whether spent fuel can be stored safely for an indefinite period of time. The industry[13] has presented factual arguments, which we refute at Part V of this Cross-Statement, for the proposition that spent fuel can be stored safely for an indefinite period of time. They have not, however, addressed the legal point that a finding in their favor on that issue would not assure the protection of the public health and safety and would not, therefore, be sufficient to allow continued reactor operation and continued production of nuclear wastes.

12/ AIF, p. 3.

13/ In particular, UNWMG, Vol. 4, and the Tennessee Valley Authority (TVA).

The NRC may not license a reactor unless it knows that all safety issues are resolved to the point that it can have a reasonable assurance that the reactor will be operated safely. It cannot accept partial resolution of an unresolved safety issue if it leaves open a potentially unacceptable threat to the public health and safety. Similarly, the NRC cannot accept indefinite spent fuel storage as a partial resolution of the generally unresolved nuclear waste safety issue.

Indeed, reliance on indefinite storage in the absence of a disposal solution has been severely criticized by EPA. When surface storage of spent fuel and solidified high level waste was suggested by the AEC in 1972 as the Retrievable Surface Storage Facility (RSSF), EPA rejected it for two primary reasons: (1) the costs of developing RSSFs would make them attractive for longer term storage than was originally intended and (2) concentrating on surface storage would distract the AEC from its primary goal of providing safe ultimate disposal:

> A major concern -- the employment of the RSSF concept -- is the possibility that economic factors could later dictate utilization of the facility as a permanent repository, contrary to the stated intent to make the RSSF interim in nature.14/

14/ Jet Propulsion Laboratory, "An Analysis of the Technical Status of High Level Radioactive Waste and Spent Fuel Management Systems," JPL Publication 77-69, 1977, p. 6-44.

These concerns still apply to suggestions that surface storage is an acceptable concept in waste management. The Statement of the State of Ohio in this proceeding commented specifically on the undesirable potential for surface storage to continue to postpone a safe solution to waste disposal.[15/]

In summary, a finding that radioactive waste can be stored safely for any period of time could delay the point at which a repository was actually required. However, it cannot delay the point at which the NRC must have a "reasonable assurance" that a safe repository will eventually be available. That point is now.

D. No Evaluation Has Been Made Of The Liabilities of Above-Ground Waste Storage Which Make It Unusable As An Indefinite Or Long-Term Option.

It is apparently assumed by the nuclear industry that, in the event the Commission cannot say with reasonable assurance if or when long-term waste disposal facilities will be available, it may continue licensing on a showing that no technical problems preclude the storage of waste above-ground for an indefinite period of time. As will be discussed in some detail in Section V, below, NRDC and NECNP challenge the technical basis for a finding that above-ground storage is safe. However, even if the Commission were to accept the industry's position, it does not go far enough to establish that long or indefinite-term above-ground storage is acceptable.

Always acting on the assumption, supported by national policy, that the radioactive waste generated by reactors

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15/ Ohio, Section II-F (pages not numbered).

would be placed in a permanent disposal facility relatively expeditiously, NRC has never considered the broader liabilities of above-ground storage as a long-term option. In the event that there is not confidence that geologic disposal will be implemented in the near future, above-ground storage by default has become a long or indefinite-term proposition. The National Environmental Policy Act, 42 U.S.C. §4332, requires NRC to analyze the unique risks posed by above-ground storage before it may rely indefinitely on that "solution."

As compared with geologic disposal, long-term storage poses a number of obvious and substantial problems. For example, storage above-ground is without the inherent protection offered by natural barriers to release of radioactive material. In addition, above-ground storage facilities are far more vulnerable to intentional acts of sabotage and attack than a geological repository. Moreover, they are more vulnerable to the effects of social and political dislocations such as war than are subsurface facilities (essentially passive geologic repositories). Indeed, the probability appears much greater that such social dislocations will occur than that an unforeseen geologic event will threaten the integrity of a well-designed and sited geologic repository.

For these reasons, above-ground waste storage for any indefinite and unbounded future is an unsatisfactory option,

even if the industry could otherwise prove that spent fuel pools are capable of maintaining their integrity for many years. The NRC must have reasonable assurance on the basis of current evidence that safe and permanent geological disposal facilities will be available by a date certain.

II. The Industry Ignores Draft NRC Criteria To Propose Its Own Self-Serving Standards.

At this stage in the development of proposals to dispose of nuclear wastes, there are no final Federal standards that can be considered to be the definitive, binding criteria against which the NRC must judge whether a repository will be in place by 2007. There are, however, draft criteria that have been published by the NRC.[16/] A conservative approach to the question of whether it is reasonably probable that a waste repository will be in place at any time in the future would surely require that the NRC at least measure developments to date against the draft NRC criteria, and, in addition, to all other criteria that may govern the establishment of a repository.

Remarkably, both DOE and the nuclear industry[17/] essentially ignore the NRC draft criteria. Instead, they propose their own less stringent standards. The DOE criteria were criticized at length in the Statements of Position of both NRDC and NECNP. The standards proposed by the nuclear industry

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16/ 45 F.R. 31393-31408, May 13, 1980.

17/ UNWMG, ANS, and AIF, among others.

will be discussed below.

The UNWMG proposes two general standards by which the NRC should judge the acceptability of a waste repository: (1) a comparison between the hazards of a waste repository and variations in the levels of natural background radiation, and (2) a comparison between a waste repository and a naturally occurring uranium ore body.[18] The first is an entirely invalid approach to judging the acceptability and safety of a waste repository, while the second is potentially useful but poorly developed and misapplied by the UNWMG.

A. Natural Background Radiation Or Variations Thereof Is An Inappropriate Standard To Judge The Acceptability Of A Waste Repository.

As one means of judging the acceptability of a waste repository in the absence of formal NRC standards, the UNWMG proposes that a repository be considered acceptable if it could in theory be constructed so as to pose a radiation hazard no greater than the costs associated with exposures comparable to variations in natural background radiation.[19] This approach is fundamentally flawed.

The basis for the UNWMG's argument that risks comparable to those posed by variations in natural background radiation is an appropriate standard is the fact that people appear to ignore or at least to accept variations in background radia-

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18/ UNWMG, Vol. 2, p. I-29-30.

19/ Id., Vol. 2, p. I-14.

tion levels in making decisions in their daily lives. As the industry has so often in the past, the UNWMG cites examples such as living in Denver or flying at high altitudes as evidence that society has accepted the radiation levels involved in those activities or considers the radiation levels de minimus such that they can be ignored.

In effect, the UNWMG is arguing that since society has weighed the costs and benefits of some activities and been willing to accept the hazards of natural background radiation, the NRC should accept those same hazards for exposures from waste repositories. This approach is unacceptable. To appreciate why, it may be useful first to review some basic considerations of benefit-cost theory.

Any standard for acceptable risks, whether established by an individual to govern his own actions or by an agent of those who will face the risks, such as the NRC, is based in part, formally or informally, on an analysis of the costs and benefits related to the proposed action. Only if costs can be limited to an acceptable level compared to the benefits to the individual or society would the results favor taking the action in question. For any such analysis to be valid, it must take into account all of the benefits and costs, but must not include in the accounting benefits or costs that are irrelevant to the action. But even if the benefit-to-cost ratio is positive and greater than the benefit-to-cost ratio of alternative courses of action, the proposed action may not be acceptable, for example,

because of inequities in the distribution of the benefit and cost streams. If the inequities are large the benefit-cost methodology becomes a totally inappropriate tool for decision making.

Setting aside the equity question for the moment, risks associated with variations in natural background radiation are a cost that is independent of the proposed action - generating nuclear electricity and waste. Even if the decisions cited by the UNWMG constituted knowing acceptance of increased natural background radiation levels in undertaking those activities, that in no way indicates that the same hazards are therefore acceptable from a waste repository. While the risks of variations in natural background radiation levels theoretically represent costs relevant to the decision to move to Denver, for example, those same radiation levels are not relevant to the decision to build a waste repository. In deciding to move to Denver, one has the choice of accepting the hazards of increased background radiation levels or not. If the benefits of moving to Denver are great enough, the radiation levels will be accepted. By contrast, natural background radiation levels represent a constant risk in the context of deciding whether to build a waste repository. Whether or not the repository is built, the natural background radiation hazard will remain. The question is not whether those levels are acceptable, but whether it is acceptable to increase those levels by construc-

tion of a waste repository. In reaching that decision, the fact that increased levels were acceptable to someone moving to Denver is completely irrelevant. The cost-benefit analysis that resulted in a decision to accept radiation levels in Denver is not based on the same standards, does not serve the same purpose, and does not take into account the same costs and benefits as those involved in a decision concerning a waste repository. The fact that certain radiation levels and their accompanying health hazards were acceptable in that case is no more relevant to a decision about a waste respository than is the fact that individuals accept a certain risk of death from automobile accidents. By the same logic, the NRC could just as easily choose 50,000 deaths per year as an acceptable figure since society appears to accept that figure for the use of automobiles. Clearly that is beyond the realm of reason.

This difficulty could be avoided if it could be argued that variations in natural background radiation represent a de minimus level, and thus, if the cost associated with waste disposal were maintained below this level they could be ignored in the benefit-cost accounting. But variations in natural background are not de minimus. While the risks to any individual may appear small, when the risks are accumulated over a large population and long periods of time the cumulative costs can be exceedingly large -- certainly too large to justify exclusing from consideration.

To suggest that even variations in natural background radiation exposure are de minimus, or acceptable, is

totally at variance with virtually the complete record of public concern with radiation from, for example, nuclear weapons testing (25 mrem/yr in northern latitudes), and nuclear power plants, and at variance with the history of radiation protection standards development.[20]

The 1972 BEIR Report estimates that 100 mrem/yr (natural background levels) to the U.S. population causes between 650 and 16,000 genetic effects (300 to 5000 serious cases), and between 1800 and 8800 cancers, and increases the overall incidence of ill health by 3%.[21] Tamplin and Shafer argue that when the 1972 BEIR Report is corrected to account for more recent data, the estimated number of cancers and genetic disorders is approximately 10 times greater than the upper limit of the 1972 BEIR Report estimates cited above.[22] Archer analyzed the effects of background radiation and concluded that it could be responsible for 40% of the normal cancer incidence.[23]

Finally, there is the equity consideration. Even if variations in natural background radiation were considered

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20/ See Cochran, Thomas B., et. al., "Radioactive Waste Management," NRDC Report prepared for DOE, April 1979, Part 1, pp. I-16 to 27.

21/ NAS BEIR Report, "The Effects on Populations of Exposure to Low Levels of Ionizing Radiation." Washington, D.C., November 1972, pp. 1-2. These numbers are derived from values given in the BEIR Report for 5 rem/generations (i.e., 170 mrem/yr).

22/ Tamplin, Arthur R. and Elizabeth Shafer, "Biological Effects of Radiation," An Information Bulletin from NRDC's New York City Energy Project, June 3, 1980.

23/ Archer, Victor, E., "Geomagnetism, Cancer, Weather, and Cosmic Radiation," Health Physics, Vol. 34, March 1978, pp. 237-247.

de minimus, or acceptable by society today, a conclusion we believe to be erroneous,[24] this does not imply that it would be considered so by those that will be the bearers of the costs -- the future generations.

In this regard, it is significant that the level of permissible radiation exposure for members of the public has been reduced by a factor of 300 in the past 30 years.[25] It is more reasonable to predict that this trend will continue than that future generations will accept our current standards. This is true even of natural background radiation levels since diseases caused by background radiation will undoubtedly become a larger proportion of the total number of diseases as we become better able to prevent adverse health conditions of all sorts. As this occurs, society is likely to give far more attention than it does today to seeking ways of reducing background radiation levels. Accordingly, it cannot be argued that all affected parties will agree or can agree that variations in natural

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[24] Even assuming UNWMG were otherwise correct in interpreting the evidence, it could not be considered relevant here since natural background radiation levels are undoubtedly viewed as baseline risk that must be accepted precisely because it is natural and essentially unavoidable. The same cannot be said of any human activity that actually increases radiation levels beyond those to which people would otherwise be exposed naturally.

[25] K.Z. Morgan, "Cancer and Low Level Ionizing Radiation," Bulletin of the Atomic Scientists, September 1978, p. 32.

background radiation constitutes an acceptable hazard.[26]

B. The "Ore Body" Standard As Proposed By The UNWMG Is Vague And Compliance Unverifiable.

NRDC and NECNP do not challenge the basic concept that a waste repository may be judged acceptable if it poses hazards comparable to those of the natural ore body from which uranium is mined. Indeed, NRDC proposed such an approach in its Radioactive Waste Management Report to the Department of Energy.[27] If the cumulative risk to future generations from waste repositiries is comparable to the risk from the original ore body, one can argue that future generations have been treated equitably. This would be consistent with the mandate of the National Environmental Policy Act to prevent degradation of the environment. 42 U.S.C. § 4331 (b)(3).

However, the reference "ore body" as proposed by UNWMG is largely undefined except by its concentrations of uranium (0.2%) and thorium[28] and is used solely for comparing selected hazard indices, not actual risks. As will be

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[26] The fact that a numerical radiation standard cannot be fairly established as a result of these problems of intergenerational equity does not mean that there is no preferred method to establish an acceptable standard. To the contrary, it is one of the primary justifications for a well-defined "ore body" approach and for reliance on defense-in-depth to maximize protections.

[27] NRDC, Radioactive Waste Management, prepared under DOE Contract ER-78-C-01-6596 (1979).

[28] UNWMG, Vol. 2, p. I-14-23.

shown in the following section this is not an acceptable means for determining compliance with standards, and thus the standard as proposed is largely useless for regulatory purposes.

III. The Industry's Approach to Establishing Criteria for the Performance of Geologic Waste Repositories is Unworkable and Violates the Defense-In-Depth Concept Adopted by the NRC Staff.

UNWMG adopts two analytical methods with which it attempts to demonstrate that the NRC can have confidence that geologic repositories can be operated safely. The first is a toxicity or "retention" index, which is utilized to compare the toxicity of a waste repository with a natural uranium ore body.29/ The second is a probability/consequence risk assessment approach which relies heavily on mathematical modeling. 30/ Both are used to argue that the period during which the repository must retain a high degree of integrity is only some 500 years, rather than the much longer period that would be indicated by the half-lives of the radionuclides. The risk assessment approach is also used to argue that site-specific data and other information that are not yet available are unnecessary in order to preduct whether a repository will protect the public health and safety.31/

Both of these methods are subject to shortcomings so substantial that they cannot properly be used to judge the acceptability of a waste repository. To the contrary, a conservative defense-in-depth approach must be used to assure repository safety.

29/ UNWMG, Vol. 2, p. I-14-23.

30/ Id., Vol. 3.

31/ Id., p. 2-23-27

A. The Toxicity Index and Risk Assessment are Invalid Analytical Methods in This Context

Both the toxicity index and the risk assessment approach constitute an attempt to quantify the likely risks of a waste repository so that those risks can be compared to some purportedly acceptable safety standard. Both methods fail for the same reasons: the lack of data and uncertainties in the data base related to repository performance do not allow the accurate prediction of potential risks.

1. The UNWMG index ignores relevant considerations and misstates the duration of repository hazards.

The primary objective of UNWMG's use of the toxicity index approach is to provide a means of comparing repository hazards with ore body hazards, with the goal of determining when the repository hazards have decreased through decay to the point that they are equal to or less than ore body hazards. It purports to do this by comparing the total toxicity of each body of radioactive material and then simply following the decay in the repository to the point that the total toxicity equals that in the ore body. UNWMG concludes that this cross-over point is at approximately 500 years.

This method of comparing radioactive waste to a natural ore body is invalid for four fundamental reasons:

- The use of a toxicity index alone ignores the significant differences in the pathways by which people may be exposed.

- The toxicity index ignores relative concentrations of isotopes in spend fuel as compared to natural ore bodies.

- The Minimum Permissible Concentration (MPC) values from which the toxicity index is derived are subject to such uncertainties that the index itself is meaningless.

- The NRC Staff has rejected this approach in developing its own criteria for geologic disposal.

(a) The toxicity index ignores exposure pathways.

The toxicity or hazards index selected by the UNWMG to compare the toxicity of the radioactive waste to the toxicity of uranium ore is a measure of the quantity of water in which the radioactivity must be diluted in order to meet Federal radiation protection standards (10 C.F.R. 20). This and similar toxicity indices do not meaningfully reflect the relative hazards of waste and ore because they ignore the pathways by which people may be exposed to the material. Pathway effects are crucial to determining the relative risk of exposure because of differences in release rates, selective absorption, and time delays in transport of the various radionuclides. Furthermore, use of MPC values for concentration in water totally ignores pathways involving airborne releases and inhalation.[32/]

(b) The toxicity index is not corrected for relative isotope concentration.

32/ Id., Vol. 2, p. I-15.

Just as the relative risks associated with radioactive releases must take into account the pathways by which exposures may occur, the risks are also a function of the concentrations of the radioactivity. If, for example, one took a given quantity of uranium ore and diluted it in the sea, ingestion of a given volume (or mass) or sea water would be less hazardous than ingestion of the same volume (or mass) of the original ore. Similarly, ingestion of a gram of uranium ore is far less hazardous than ingestion of a gram of spent fuel.

Although UNWMG admits that spent fuel is more concentrated than uranium ore by a factor of approximately 2,500,[33/] the toxicity index selected by UNWMG fails to take this into account. Indeed, it specifically attempts to avoid doing so on the basis of the preposterous claim that concentration is unimportant "when considering the protection of public water supplies."[34/]

To account for the important concentration variable, a frequently quoted toxicity index is the ingestion hazard per unit of mass reviewed by the Study Group on Nuclear Fuel Cycles and Waste Management of the American Physical Society (APS Study Group).[35/] This study showed that even recycled fuel would not become "equivalent" to the uranium ore for at least 1,000,000

33/ Id., p. I-6.

34/ Id.

35/ 50 Reviews of Modern Physics, No. 1 Part II (January 1978), p. S111. (Hereafter referred to as APS Study).

years.[36]

> [T]he hazard index for spent fuel remains above that for the natural ore body for about 10,000 years, whereas that for HLW drops below the ore in about 300-500 years.[37]

Following its discussion of the toxicity or hazards index the UNWMG claims to offer "a new approach to considering the relationship of nuclear waste to the ore body, one which takes into account all of the pathways by which many could ingest radioactive materials which might return to the accessible environment."[38]

By use of this "new approach" -- the so-called retention quotient" -- UNWMG claims to show that even for spent fuel the cross-over period is about 500 years, rather than 10,000.[39]

First, the approach is not new; it is essentially the same as UNWMG's hazards index.[40] Second, it, like the hazards index does not account for pathway differences.

36/ The UNWMG, like the APS Study Group, calculates the toxicity index for wastes from reprocessing plants, assuming that that plutonium and uranium in spent fuel are recycled, even though UNWMG admits that had they used reprocessed spent fuel--the once through fuel cycle--the cross-over point would be more like 10,000 years as opposed to 500 years. Vol. 2, p. I-15.

37/ UNWMG, Vol. 2, p. I-15.

38/ Id., Vol 2, p. I-15-18.

39/ Id. at I-21.

40/ Defined previously at Id., p. I-15.

The UNWMG defines its hazards index as[41]

$$HI = E_i \frac{Qi}{MPCi}$$

where: HI = Hazard Index, cc/tonne
Qi = Quantity of Isotope i, Ci/tonne
MPC_i = Maximum Permissible Concentration, C_i

Its retention Quotient is defined as:[42]

$$RQ = E_i \frac{Qi}{Dfi}$$

where:

RQ = reciprocal of the fraction of the total inventory which must reach a receptor (man) in order to give that receptor the annual dose limit selected

Q_i = total inventory of isotope i in repository or ore body, curies

DF_i = isotopic dose factor, curie of isotope i required to produce selected annual dose.

Both the hazards index and the retention quotient express the relationship between the amount of radioactive material ingested and the dose received. Thus, both should yield comparable results if the input data are correct and the calculations properly done. In fact, if the maximum permissible organ doses under existing federal radiation protection standards or guidance were the same for all organs, including the whole body,[43] then the MPCi values in the hazards index equation would be directly proportional to the respective Dfi values in the retention quotient equation. The proportionality constant would simply be the quantity of water a standard man drinks in a year.

41/ Id. at I-15.

42/ Id. at I-18.

43/ This is not, of course, the case.

Thus, the only differences between the result generated by the hazards index and the retention quotient approaches should be due to the following. Although the Qi values in the two equations above are defined differently -- one is normalized on a per tonne basis -- this does not effect the calculation of the cross-over point and is therefore unimportant to the discussion that follows:

1. The hazards index properly accounts for differences in permissible organ doses by use of the MPCs, whereas the retention quotient does not;

2. Small differences may result from the fact that the MPCi values are rounded off to one significant figure, and

3. The computer model used for the retention quotient calculation may use different assumptions -- i.e., new data -- to calculate the intake required to produce a given dose (the maximum permissible organ dose).

Thus the fact that use of UNWMG's hazards index generates a cross-over point for spent fuel of 10,000 years, while use of its retention quotient results in a 500-year cross-over point for the same spent fuel indicates that either one or both of the calculations is dramatically inaccurate. We suspect the latter is the case. In any case, even if the two approaches yielded comparable results, the retention quotient approach is subject to precisely the same infirmities described above with regard to the hazards index.

The fundamental point of this discussion is not to suggest that a cross-over point should be established at some particular date, but to demonstrate that the hazard or toxicity index approach is "not a meaningful criterion for assessing the hazards of radioactive management."[44/] As the UNWMG exercise proves, the analysis is so subject to self-serving manipulation as to be useless.

(c) The Minimum Permissible Concentration values from which the toxicity index is derived are subject to enormous uncertainties.

The toxicity or hazards index is defined in terms of "maximum permissible concentration" (MPC) values (10 C.F.R. Part 20) for radioactive materials. However, some of the key MPC values are subject to orders-of-magnitude uncertainties and cannot be considered sufficiently reliable for this purpose. For example, Morgan has argued that the MPC values for plutonium inhalation are in error by a factor of 240[45/] and the NRC Staff, while arguing that Morgan's corrective factor of 240 is too high, concedes the error is at least a factor of six and possibly as high as 12.[46/] In addition, Larsen and Oldham argue that the MPC of

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44/ APS Study, Supra.

45/ Morgan, K.L., "Suggested Reduction of Permissible Exposure to Plutonium and Other Transuranic Elements," Am. Ind. Hyg. Assn., J 36, 567 (1975).

46/ Nuclear Regulatory Commission Staff Response to Natural Resources Defense Council et al. Request for Admissions Relating to Contentions Seven and Eight (dated Sept. 1, 1976) at 8-15, and NRC Staff Response to NRDC et al.'s Request for Admissions Relating to Contentions 7 and 8c (dated Nov. 12, 1976), U.S. Energy Research and Development Administration, Project Management Corporation, Tennessee Valley Authority (Clinch River Breeder Reactor Plant), Docket No. 50-537.

plutonium in drinking water "appears to be too high by several orders of magnitude"[47] for reasons entirely unrelated to those cited by Morgan. The propagation of these and similar uncertainties in the MPC values of other isotopes through use of the toxicity index produces extremely great uncertainty in the end result -- the time at which toxicity from spent fuel is alleged to be equivalent to the hazard from an ore body.[48] It is nonconservative, if not arbitrary, in the extreme.

(d) The UNWMG's approach is nonconservative and fundamentally inconsistent with the principles of defense-in-depth.

Well before the UNWMG submitted its Statement of Position in July, the NRC Staff had proposed criteria for regulating the geologic disposal of high-level radioactive waste that contain no mention of or reliance on the toxicity index type of approach proposed by the UNWMG,[49] although that approach is not new to the literature. Rather, the NRC Staff recognized the impossibility at this stage of quantifying repository risks in any simple way and instead proposed to assure safety by adhering to the principle of multiple barriers, each of which is subject to minimum performance standards, and each of which is carefully chosen, designed and constructed to assure that it can stand as an independent barrier unaffected by the possible failure of

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47/ Larsen, R.P. and Oldham, R.D., "Plutonium in Drinking Water: Effects of Chlorination on Its Maximum Permissible Concentration," Science, Sept. 15, 1978, p. 1008-1009.

48/ It should be noted that the band of uncertainty is not distributed equally. That is, it is far more likely that the errors in UNWMG's analyses tend to minimize the hazards and shorten the cross-over time than to over-state the hazards.

49/ 45 F.R. 31397, May 13, 1980.

other components of the system. The industry's toxicity index approach is completely at odds with the basic principles inherent in the defense-in-depth approach. It is fundamentally non-conservative. Nor does it provide any information whatever concerning whether the NRC Staff draft criteria will be met in the time period at issue in this proceeding. It is virtually useless to the NRC in deciding whether there is a reasonable assurance that a waste repository will be in place by the year 2007.

2. Risk assessment is an unreliable method for determining repository safety.

The UNWMG asserts that mathematical modeling will be used to ensure the safety of repository operations:

> "No nuclear waste repository will be licensed without firm assurance that its operation is unlikely to harm the health and safety of the public. This assurance will be based in large part on the results of site specific studies performed using models of waste transport."50/

These models will be used to assess the risk from a waste repository.

Since the UNWMG's reliance on models is similar to the position taken by DOE in its Statement, NRDC's criticism of DOE's modeling efforts also applies to the UNWMG's position. As stated in NRDC's Statement of Position:

> "[The] design and utilization of risk assessment models depends, at a minimum, upon the following: an understanding of the processes which will influence the

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50/ UNWMG, Vol. 3, p. 3-2.

> migration of nuclides in the event of failure of the repository; empirical and experimental data characterizing the environment, the waste and the interaction of the two; estimates of the probability of occurrence of natural geologic events and engineering failure; and the characterization of potential future scenarios.
>
> The deficiencies in available data and current knowledge about all of these factors prevent the preparation of an accurate model which can correctly represent the risks of long-term storage."51/

These fundamental problems with developing reliable models are discussed at length in NRDC's statement. Below we duscuss additional areas which demonstrate that reliance on risk assessment does not ensure repository safety.

(a) A wide range of credible repository failure scenarios must be tested.

Risk assessment as a means of determining hazard has been seriously questioned by the NRC in its recent repudiation of the Reactor Safety Study.52/ However, both UNWMG and DOE advocate continued risk assessment work as a basis for determining repository safety. In order to utilize this approach, all possible accident or hazard sequences must be predicted. The difficulty of performing this exercise was demonstrated by the New Mexico Environemtal Evaluation Group (EEG) a group funded by DOE to conduct an independent evaluation of the potential radiation exposure to people from the

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51/ NRDC, p. 60

52/ NRC Statement on Risk Assessment and the Reactor Safety Study Report (WASH-1400) In Light of the Risk Assessment Review Group Report, January 18, 1979.

proposed Waste Isolation Pilot Plant. In an attempt to utilize risk assessment methods the EEG was compelled to convene a meeting of 35 experts from the geotechnical community to discuss geological and hydrological pathways which could provide a basis for failure scenarios. 53/ This effort resulted in suggestions of at least 4 new scenarios. It is clear that other yet to be identified scenarios also exist. The UNWMG consideration of risk assessment does not begin to address the problem of scenario identification.

Indeed, unlike the EEG response, DOE's common response is to analyze what it considers worst case failure scenarios and assume that if the risk from its worst case is found acceptable, then this assures repository safety:

> The hazards of geologic isolation have also been studied and qualitatively characterized using hazard indices and consequence analysis .... Consequence analysis is the deterministic estimation of the effects of a postulated worst case accidental release of radionuclides. Consequence analysis has shown that if major catastrophic natural or man-caused events occur which breach the containment integrity of a repository, the radiological consequences are small compared to the direct destruction and loss caused by the primary event. 54/

53/ Environmental Evaluation Group, Health and Environment Department, State of New Mexico, "Geotechnical Consideration for Radiological Hazard Assessment of WIPP - A Report of a meeting held on January 17-18, 1980," April 1980. (Hereafter referred to as EEG Report).

54/ Department of Energy, "Draft Environmental Impact Statement - Management of Commercially Generated Radioactive Waste," Volume 1, p. 3.1.64, 1979.

It is clear that DOE cannot determine a priori which cases will be worst case events. DOE's entire approach to scenario analysis is based on invalid assumptions regarding worst cases.

(b) The UNWMG does not acknowledge that the parametric data needed for reliable model results is incomplete.

The UNWMG Statement boldly asserts that risk assessment analyses are based on "a very large pool of data" and "wealth of experience and years of in situ testing."55/ The UNWMG appears to have ignored the conclusions of the USGS, the IRG and the EPA ad hoc panel which document the need for better and more complete parametric data particularly in the area of hydrologic transport models.56/ DOE acknowledges that parametric data in this area are needed:

> One problem is the assembly of sufficient data to be able to adequately describe the actual hydrology of the far-field region around a repository. The determination of effective permeabilities and fracture connections, although difficult, is possible. 57/

The unquestioning confidence that the UNWMG expresses in its own reliance on risk assessment seems unsupported and ill-founded. Indeed, the UNWMG appears to dismiss inaccuracies in the available parametric data by noting that these inaccuracies are small relative to the much larger uncertainties associated

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55/ UNWMG, Vol. 3, p. 1-10.

56/ See NRDC, p. 62-63.

57/ DOE, p. II-212.

with factors which cannot be measured quantitatively:

> Although there are uncertainties associated with the measureable elements of the data base, they are small relative to the uncertainties inherent in the immeasurable data. 58/

This statement is obvious evidence that all the data being used suffer from inaccuracies which are significant to the outcome of the model.

> (c) Mathematical models may not be sufficient to show compliance with performance standards in a licensing action.

The NRC in its advance notice of proposed licensing criteria for high level waste repositories expresses doubt regarding the utilization of mathematical models for determining the acceptability of a proposed waste repository:

> The lack of empirical data on the performance of engineered barriers or the inability to obtain credible data may preclude the development or use of credible quantitative models in the showing that either the uncertainties are addressed properly in the performance standards or that performance standards are met in a particular licensing action.59/

The UNWMG ignores this fact in its reliance on models to prove that a waste repository will meet the applicable standards.

Not only does UNWMG base its confidence in safe waste disposal on potentially inaccurate risk assessments, but it

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58/ UNWMG, Vol. 3., p. 2-24.

59/ 45 Fed. Reg. 31398, May 13, 1980.

ignores the fact that the NRC may not allow the results of a model to be the evidence that a repository is safe.

3. The UNWMG's Choice of Intrusion Scenarios is Unreasonably Limited.

As noted above, the use of a "cross-over" point as the touchstone of standard-setting for repository performance is not legitimate, and a 500 year cross-over point is wholly without support and extremely nonconservative. UNWMG has layered more factually insupportable nonconservatisms into their presentation by simply assuming that, even within the first 500 year period, the only means by which human beings might be dangerously exposed is if one individual should stumble across the reposi te.60/ Although no evidence is provided to just , ignoring the range of other possible scenarios, one infers from the discussion that a more massive and deadly human intrusion is assumed to be prevented by surveillance of the repository and by the existence of records.61/

Numerous examples are cited of human records preserved over long periods of time.62/ There is, of course, no dispute that many such records have been preserved. However, it is equally indisputable that a great many more ancient documents have been lost or destroyed or become unavailable for other reasons. Under these circumstances, reliance on records is

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60/ UNWMG, Vol. 2, p. I-3, Vol. 3, p. 2-32. The writers propose to provide no protection for the errant individual.

61/ It is far from clear why surveillance and records are assumed to be effective against a mass of people but penetrable by one individual. One would logically expect the opposite.

62/ UNWMG, Vol. 3, p. 2-33-36.

little more than wishful thinking.

There is one particularly instructive example. The Gorleben salt dome in the Federal Republic of Germany, presently under consideration for use as a repository site, is located very close to and probably passes under the East German border. Virtually, none of the records related to the hydrology and geology of that formation are available to the West Germans. This illustrates dramatically the disruptive effect that social and political events beyond the control of contemporary planners can have in just a very few years. Over the great length of time during which a repository poses risks, it is obvious that human records cannot be relied upon to survive presently unforseen events.

EPA has recognized this. It has proposed the following criterion:

> The fundamental goal for controlling any type of radioactive waste should be complete isolation over its hazardous lifetime. Controls which are based on institutional functions should not be relied upon for longer than 100 years to provide such isolation; ratioactive wastes with a hazardous lifetime longer than 100 years should be controlled by as many engineered barriers as are necessary.63/

The current emphasis on salt as a disposal medium -- also UNWMG's "reference case" -- makes reliance on records to exclude human intrusion particularly unreliable. Salt is a valuable resource often found in conjunction with other

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63/ 43 F.R. 53262, 53263, November 15, 1978 (emphasis added).

valuable resources 64/ Salt formations are likely to be explored. For example, two-thirds of all salt domes on the U.S. Gulf Coast theoretically suitable for a repository have been explored within approximately the last 150 years. 65/ This would indicate that the chance of one breach of the geologic confinement of a repository in a salt dome is likely to be 66% in a time span of only 100 years.

Presumably as an alternative to reliance on surveillance and records, UNWMG baldly asserts that "sensible people would not use nearby ground and surface waters unless they had been tested for radioactivity." 66/ Such an assumption is callous and unsupported. Even today, testing for radioactivity is not a common mining practice and would not be a part of testing and mining for salt

In summary, UNWMG has provided no reasonable basis to support its assertion that human intrusion into a repository is not a matter of concern even during the 500 year period to which it has limited its presentation. On the contrary, it is

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64/ U.S. Environmental Protection Agency, St te of Geological Knowledge Regarding Potential Transport of High-Level Radioactive Waste From Deep Continental Repositories, Report of an Ad Hoc Panel of Earth Scientists, EPA/40-78-004, p. 40 (Referred to as EPA Ad Hoc Report).

65/ Ninety-five of 150 mineable domes have been developed. Uses include production of petroleum above the domes, production of rock salt or brines from the salt core's storage of LPG or oxide oil isolation caverns within the salt, and production of sulphur from overlying top rock units. Rede-Gegenraede, Symposion der Miedersachsischen handesregierung zur grund satz lichen sicherneit stechniscren Realisierborkert anes integriertion nuklearen Entsorgung --SZ entrums, March 31, 1979, p. 197, testimony of Thomas Cochran.

66/ UNWMG, Vol. 3, p. 2-33.

more plausible to predict, at a minimum that salt formations will be explored by future generations. The "worst case" intrusion scenario could be far worse that what UNWMG suggests; UNWMG has made no attempt to identify it.

IV. The State of Current Knowledge on Repository Siting And Unresolved Technical And Institutional Problems Preclude Finding Reasonable Assurance That A Waste Repository Will Be Functional By 2007.

The UNWMG Statement of Position minimizes the need for precise knowledge concerning potential sites and belittles the conclusion of credible independent authorities[67] that serious uncertainties remain to be resolved before the feasibility of geologic disposal is demonstrated. It is our view that these uncertainties preclude a finding of reasonable confidence that a repository will be functioning by 2007.

Although the UNWMG presentation is somewhat disjointed, its discussion of the available evidence may be found in Parts II, III, and IV of Volume 2 and Part 3.5 of Volume 3. Our general criticisms can be summarized as follows:

- The UNWMG mischaracterizes and misuses site-related experience to date in an effort to compensate for the lack of success in locating an acceptable repository site.
- While dismissing the gaps and uncertainties in existing knowledge as "alleged" the UNWMG presents only a theoretical program for the research and development that must be carried out before there can be reasonable assurance that a waste repository will be in place.
- UNWMG has grossly over-simplified and misinterpreted the Oklo "natural reactor" phenomenon, which provides no support for its position.
- UNWMG has essentially ignored institutional obstacles to proper comple-

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67/ See IRG Report, p. 42.

tion of necessary research and development and to actual repository siting and construction.

A. The UNWMG Has Mischaracterized And Misused The Results of Site-Related Experience to Date.

In its discussion of disposal system alternatives,[68] and in its discussion of evidence from past experiments,[69] the UNWMG leaves the general impression that site-related experience to date shows a pattern of consistent development toward construction of a repository, with no important obstacles along the way. The primary vehicles for this argument are the experience of Project Salt Vault (PSV) in Lyons, Kansas, and the Waste Isolation Pilot Project (WIPP) in New Mexico. Analysis of each project establishes that far from demonstrating the feasibility of geological disposal, as the UNWMG asserts, they were both failed attempts to find an acceptable repository location.

Moreover, the Lyons and WIPP experiences are paradigms illustrative of the degree to which long-range research and development programs are vulnerable to disruption from both technical and institutional problems unforeseen at their inception. They provide the strongest evidence that there is a great distance between the making of plans and their achievement and compel the Commission to scrutinize the newest of the industry's plans -- its "reference case"--

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[68] UNWMG, Vol 2, Part II.

[69] Id., Vol. 3, Part 3.5.

with particular skepticism.

With respect to the Lyons site, UNWMG argues that:

> Subsequently, more detailed investigation of the proposed repository location environs identified a number of exploratory oil and gas wells and a solution mining operation in the vicinity. This identification coupled with politico-institutional issues led to the conclusion that the Lyons site was not suitable for a Federal waste repository. It is emphasized that the circumstances which led to this conclusion were entirely related to man-made factors. The negative conclusion regarding the proposed site was in no way associated with any lack of viability of the deep geologic repository concept, nor to any basic questions regarding the feasibility of salt formations as a host formation for HLW disposal.[70]

The feasibility of utilizing salt formations for radioactive waste disposal will always be challenged by "man-made" factors such as those which prevented continued development at Lyons. The exploration and solution mining in the vicinity of the PSV site is characteristic of both bedded and salt dome areas in the United States. Indeed, most of the available subsurface data at salt sites currently under consideration by DOE come from past oil and gas exploration.[71] Even if a site was not associated with past exploration activity, the likelihood of future exploration in salt basins or domes is very high.

70/ Id., Vol. 2, p. II-3.

71/ Powers, D.W., et. al., "Geological Site Characterization Report for the Waste Isolation Pilot Plant," Southeastern New Mexico, SAND 78-1596, 1978.

The probability of such exploration in salt deposits is further supported by recent research into the history of common salt.[72] Consumption of salt has grown dramatically from 4.5 kilograms per capita annually in the United States in approximately 1850, to 194 kilograms in 1974. In addition to the increase in absolute amounts consumed, the change in the purposes of consumption is extremely important. Whereas a century ago most salt was used for culinary purposes, today 55% or more is used for the primary purpose of producing chlorine, which is used in an increasing number of applications:

> Between 1930 and 1960, in the span of a single generation, per capita consumption of chlorine-containing solvents in the United States multiplied 21 times, that of "automotive fluids" 24 times, of plastics 17 times, of pesticides 22 times, and of the inevitable "other chemicals" incorporating chlorine no less than 29 times.[73]

This historical trend indicates that salt will become an increasingly important commercial resource in the future, and that salt deposits will be attractive targets for exploration. A Subgroup of the IRG recognized this fact when it concluded that "Although salt is very widespread, it is a potential resource that might increase the risk of human intrusion in a repository."[74] On this ground alone, salt deposits would

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[72] Multhaus, Robert P., "Neptune's Gift, A History of Common Salt," (The Johns Hopkins University Press, Baltimore and London, 1978).

[73] Id., p. 234-235.

[74] Subgroup Report on Alternative Technology Strategies for the Isolation of Nuclear Waste, TID-28818 (Final), Appendix A, "Isolation of Radioactive Wastes in Geologic Repositories: Status of Scientific and Technical Knowledge," October 19, 1978, p. 61. (Hereafter referred to as Subgroup Report)

almost certainly be disqualified as acceptable host media under the draft repository acceptance criteria issued by the NRC Staff. Under the Staff's proposal, a site would be presumed to be unacceptable if

> There are resources which are economically exploitable using existing technology under present market conditions.
>
> There is indication that present or reasonably anticipatable human activities can significantly affect the hydrogeologic framework.75/

Just as Lyons, Kansas, was disqualified as a repository site by nearby human activities, so recent information has disqualified the Palestine salt dome.76/ Over twenty-five years into the civilian reactor program, no salt formation has yet been located suitable for the disposal of radioactive waste. Such history hardly engenders confidence. There is no basis for reasonable assurance that a salt repository will ever be located which is not eventually found to be unsatisfactory due to human activities or site features.

Finally, as NRDC demonstrated in its Statement of Position, far from establishing the answers to all of the technical questions, Project Salt Vault highlighted several generic difficulties with salt, including brine mitigation. This remains the single most troublesome still-unresolved technical issue involved in the use of salt as a disposal medium.77/

75/ 45 F.R. 31401.

76/ NECNP. p. 22-24.

77/ NRDC p. 37-38.

In addition, the PSV experiments were limited both in scope and in time, so that an inordinate amount of extrapolation is required to attempt to apply any of the results to a real repository.[78]

UNWMG focusses on the WIPP site near Carlsbad, New Mexico as one of several potentially viable sites for which preliminary work has been done despite the fact that President Carter has called for cancellation of the WIPP project.[79] UNWMG's response is instructive. It states that the need for cancellation was for entirely "institutional reasons,"[80] as if there are at most some undefined and probably irrational political difficulties with the project. On the contrary, the "institutional" pressures against WIPP were driven substantially by controversy in the scientific community about both the hydrologic conditions and the resource potential of the site.[81] There is a direct causative link between the existence of significant technical questions and the development of scientific, public and political opposition. The continuing potential for such opposition, which can demonstrably bring repository development to a standstill, is exacerbated by the lack of predetermined site selection criteria. In the absence of such objective criteria against which one can measure the

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78/ California Energy Resources Conservation And Development Commission, "Status of Nuclear Fuel Reprocessing And High-Level Waste Disposal," (January 1978), p. 18.

79/ President's Message to Congress, February 12, 1980. p. 3.

80/ UNWMG, Vol. 2, p. II-4.

81/ EEG Report.

acceptability of a selected site, case-by-case technical controversies are both sure to erupt and are likely to paralyze both the scientific and political communities. This factor weighs strongly against finding confidence that a repository will be functional by 2007.

The Interagency Review Group (IRG) recognized, as must the NRC, that the feasibility of geologic disposal cannot be assessed on the basis of hypothetical possibilities. In its references to the IRG Report, UNWMG selected out the following crucial language:

> The feasibility of safely disposing of high level waste in mined repositories can only be assessed on the basis of specific investigations at and determinations of suitability of particular sites.[82]

IRG's conclusions are buttressed by the U.S. Geologic Survey, which strongly emphasized that a valid program of identifying an appropriate site requires that sites be thoroughly tested and that site-specific data are needed in order to make valid predictions concerning the feasibility of locating an acceptable site.[83]

In summary, the credible independent authorities in this field express great caution in describing the current state of knowledge and the conclusions that can be drawn therefrom. Both IRG and USGS link a demonstration of the feasibility of

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[82] IRG Report, p. 42.

[83] USGS, p. 8, 15.

siting a geologic repository directly to experiments yet to be done and information yet to be gathered. In addition, the history of waste disposal experiments bears graphic witness to the fallacy of expecting today's optimistic projections to be translated into reality. No evidence has been presented upon which the Commission can find confidence that all of the outstanding problems will be resolved and a suitable site identified and developed by 2007.

B. The UNWMG's Discussion of a Research and Development Program for a Geologic Repository does not Provide Confidence that a Repository will be Functional in the Future.

Consistent with its operating premise that the industry need only show that a repository can be in place, UNWMG places heavy reliance on a discussion of the current status of disposal technology. Each important section is treated below.

1. Site Identification and Characterization.

The UNWMG presentation on this subject essentially begins with the statement that:

> As a result of these experiences (related to other applications of the relevant technology), the status of existing technology is well advanced, and gaps and uncertainties are largely limited to specific problems that are the topics of ongoing or planned research and investigation. No new technological breakthrough is required to permit site selection.84/

It then proceeds to outline the steps that must be taken to achieve proper site identification, asserting, for example, that acceptable tectonic regions can be identified, after which the emphasis will be "on detailed characterization of subsurface geology and hydrology in order to confirm site stability and to establish that the geohydrologic system would provide containment."85/ We agree that this is generally the course that must be taken. There is, however, nothing whatever in the presentation to indicate that the subsurface geology and hydrology characterizations that have yet to be done will be done or that

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84/ UNWMG, Vol. 2, p. III-A-1.

85/ Id., p. III-A-3.

they will result in a determination that sites under consideration will be found acceptable.

In addition, the continued attention to the Hanford and Nevada Test Site regions as possible repository locations indicates that even the UNWMG's underlying premise that unfavorable regions will be avoided is not correct. Both of those sites lie in a broad zone of tectonism and volcanism resulting from the proximity to the Northern American plate boundary with adjacent plates.86/ In addition, both sites have complex hydrologic conditions.87/ Despite these major drawbacks these sites continue to be leading candidates for the Department of Energy and the nuclear industry. This indicates that even the broad and general directions proposed by the UNWMG are not being followed, and that we can have no confidence that a conservative approach will be taken. Confidence cannot be based on intentions to be conservative, but must rely on site specific information and early rejection of unacceptable conditions.

The industry presentation proceeds to outline the type of work necessary before a site can be identified. With respect to seismic-reflection profiling, it is noted that:

> a combination of geophysical and drill-hole techniques would be appropriate, each one contributing data of unique quality and dimension in complimentary fashion.88/

86/ Atwater, T. "Implications of plate tectonics for the Cenozoic tectonic evolution of Western North America," Geological Society of America Bulletin, V. 81, pp. 3513-3536, 1970.

87/ See USGS, p. 26, 28.

88/ UNWMG, Vol. 2, p. III-A-6.

However, there is nothing in this or any other document to establish that a combination of techniques has been identified sufficient to cover all relevant uncertainties. UNWMG simply asserts that:

> Collective confirmation of all geologic conditions will be made throughout the exploration and operation program.89/

Rather than provide any assurance that it will be possible to have a repository operational in the next thirty years, this discussion demonstrates only that site-selection is sure to be a long and drawn-out process during which it will be necessary to reassess site suitability at each stage as new information is developed.

UNWMG seeks to draw support from the experience of commercial nuclear plants, asserting that the successful siting of many reactors demonstrates that it will not be difficult to locate repository sites, given that the choice of the latter is broader. The analogy is specious. A nuclear power plant is licensed to operate for only 40 years. The geologic conditions during time periods relevant to reactor siting are much more easily predicted than the conditions relevant to a repository. The requirements for repository siting are not comparable to those for siting nuclear reactors, as demonstrated by the need for entirely different siting criteria.90/

89/ Id., Vol. 2, p. III-A-6-7.

90/ Compare the NRC Staff's Draft Criteria for Radioactive Waste Disposal, 45 F.R. 31398-31408, with the NRC's Reactor Siting Criteria, 10 C.F.R., Part 100.

The UNWMG concludes its basic discussion of site selection with the statement that:

> We believe the technology is totally in hand to select sites where geologic stability can be assured for time periods well in excess of that required.91/

The language of this conclusion highlights the hypothetical nature of UNWMG's presentation on site identification and characterization. It makes no reference to any potential site now under consideration. No evidence whatever is offered to suggest that one or more particular sites is acceptable.

Finally, the experience abroad is cited by the industry. It should be noted, initially, that none of the countries mentioned has yet identified a suitable high-level repository site. This includes Sweden, despite the conclusions of the KBS Project, which the industry stresses heavily as having established that the NRC should have confidence in the use of geologic waste repositories.92/ In fact, the KBS Project did not address the question that must be answered by the NRC. Under the Stipulations Law, the Swedish nuclear industry did not have to show that a disposal method actually could be used and would be in place, as is the case here, but only that

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91/ UNWMG, Vol. 2, p. III-A-10. It should be also noted that, with respect to uncertainties in long-term geologic and hydrologic forecasting, UNWMG blithely dismisses four credible studies questioning the ability to reliably make such forecasts, all of which survived substantial internal and external peer review. (See UNWMG, Vol. 2, p. III-A-12, n. 47-50.) Instead, it relies on a new report by the Electric Power Research Institute (Id., p. III-A-13, n. 51).

92/ Id., Vol. 2d, p. III-A-16, 19, ANS, p. 8, AIF, p. 15-20, BNI, p. 4-5.

disposal was theoretically possible.93/ Far from supporting the industry's position in this proceeding, the fact that the Swedish government has agreed that disposal by the KBS method is theoretically possible, but still has not found a suitable site argues against a finding of confidence by the NRC.

Moreover, despite the UNWMG's reliance on their experience, the Canadians are far more cautious than the nuclear industry in this country; they consider site-specific data a requisite for proper analysis of the feasibility of long-term containment.94/ In fact, there is no operating high level waste repository in the world today, and no site selected by any country that has been shown to meet that country's own disposal criteria, no matter how weak they may be. This worldwide experience of failure contradicts arguments of confidence in eventual safe waste disposal.

2. Waste Form and Package

The UNWMG beings its discussion of the status of technology with respect to waste form and package by suggesting that:

> since extensive work has been carried out on glass (vitrified HLW) waste forms, it is deemed appropriate to discuss spent fuel as a waste form on the basis of its comparative stability to the reference borosilicate glass waste form.95/

This proposition is immediately suspect in light of recent studies seriously calling into question the viability of

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93/ Personal communication from Dean Abrahamson, University of Minnesota, who was appointed by the Swedish Minister of Energy to review the work of the KBS project.

94/ UNWMG, Vol. 2, p. III-A-16.

95/ Id., Vol. 2, p. III-B-1.

borosilicate glass as a waste form.96/ In addition, it is highly inappropriate to analyze spent fuel as a waste form exclusively with reference to an industry-favored standard, when draft NRC criteria exist under which an analysis can be made.97/

The NRC criteria require, for example, that the Department of Energy evaluate several candidate waste forms and that it carefully assess the likely interactions between the waste forms and the site, taking into account the chemical, physical and nuclear properties of both the waste and the site. UNWMG makes no effort to show that the NRC draft criteria can be met by any waste form. Indeed, to date, no one has undertaken the systems approach of relating the chemical and physical characteristics of the waste form, the packaging, and the host rock. Accordingly, it is not possible to know in what manner compliance with the NRC criteria will be achieved. Surely there is no basis for confidence that borosilicate glass will emerge as a viable waste form.

UNWMG attempts to establish the superiority of the borosilicate waste form by quoting the Panel on Waste Solidification of the National Academy of Sciences Committee on Radioactive Waste Management:98/

96/ National Academy of Sciences, Solidification of High-Level Radioactive Wastes, Pre-publication copy, September, 1978 (hereinafter referred to as NAS Report).

97/ 45 F.R. 31393, 31406-7.

98/ UNWMG, Vol. 2, p. III-B-4.

> The Panel finds that many solid forms are likely to be satisfactory for use in an appropriately designed system ... Furthermore, at least one form -- glass -- because of an extensive developmental effort, is currently adequate for use in a first demonstration system consisting of solidification, transportation, and disposal.

UNWMG failed, however, to include the entire finding of the Panel which goes on to recommend continued research for a better waste form:

> For the implementation of a large-scale solidification program, glass may also be adequate, but, on the basis of our anlysis, it cannot be recommended as the best choice, especially for older DOE wastes. In fact, a modest R&D effort may well provide alternative first or second generation solid forms whose long-term stability and ease of processing are superior to glass. (emphasis in original) 99/

Other independent researchers have been far more pessimistic in their evaluations of the proposed use of borosilicate glass. An EPA panel of five earth scientists noted the likelihood that a glass waste form might well devitrify within as short a time as a decade, at which point leaching of the wastes could become relatively easy. Even in the absence of devitrification, the panel stated that more experimentation is required and concluded that "there is no evidence that incorporation into glass will ensure resistance to significant leaching over time scales of a decade. 100/ Similarly, A. E. Ringwood has explained that procedures for testing the resistance of glass to leaching have

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99/ NAS Report, p. 2.

100/ EPA Ad Hoc Report, p. 6-8.

been extremely naive, and that under forseeable conditions, borosilicate glasses would probably devitrify in a few weeks. He concludes, with respect to the emplacement of glass in salt, that:

> we are dealing with a situation which is not readily predictable in the long-term on the basis of existing scientific principles and practice[101]

In support of its choice of reference case (and presumably, the exclusion of analysis of all other alternatives), UNWMG notes the interest in examining borosilicate glass as a waste form abroad, and that the French have had a vitrification plant in operation since 1978.[102] However, none of these waste forms has ever been demonstrated to be adequate in an operating disposal scheme. In fact, the French have yet to examine their high-level waste subsequent to vitrification.[103] Accordingly, the French experiments prove only that waste can be vitrified, not that vitrified waste will maintain its integrity in a repository environment over the required time.

UNWMG discusses the canisters required to contain spent fuel assemblies, with particular reference to a copper canister proposed by the Swedish nuclear industry and to a thick aluminum

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101/ Ringwood, A.E., Safe Disposal of High-Level Nuclear Reactor Wastes: A New Strategy, (Australian National University Press, Canberra, Australia, and Norwalk, Conn., 1978) p. 13-14, 17. See also, U.S. Geologic Survey, Circular 779, Geologic Disposal of High-Level Radioactive Wastes - Earth Science Perspectives, p. 5; Subgroup Report, p. 25-26; NAS Report, p. 8; and ABS Study, P. S130.

102/ UNWMG, Vol. 2, p. III-B-4-5

103/ NRC Proceedings of the Conference on High-Level Radioactive Waste Forms, December 19-21, 1978, at Denver, Colorado, NUREG/CP-0005, p. 195.

oxide canister.[104] While the massive copper canister has received some amount of favorable comment, the UNWMG presentation itself reveals problems that severely limit its application to the reference case and its usefulness as an example of a "proven" technology. While UNWMG's presentation is built around use of a salt dome, the Swedish canister work involves a granite repository. Therefore, the experience in that host-canister relationship is of limited relevance except to the extent that it indicates that the copper canister is susceptible to corrosion. Corrosion is a substantially greater problem in a salt than in a granite host rock.[105] Although UNWMG suggests temperature control as a means of mitigating the problem of host-canister interactions, it fails to consider the impact that waste dilution or other temperature control methods would have on the entire waste disposal regime.

UNWMG alleges that tests have shown that the thick aluminum oxide canister can withstand groundwater action for hundreds of thousands of years with an ample safety margin and that the durability of such a canister is only slightly affected by the surrounding geological environment,[106] but no information is provided on the environment in which the aluminum oxide

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104/ UNWMG, Vol. 2, p. III-B-5-12

105/ Id., Vol. 2, p. III-B-15.

106/ Id., p. III-B-11

canister was tested, whether high level wastes were actually used in the tests, or whether any effort was even made to simulate the effects of high level wastes. Furthermore, as pointed out by USGS in its Statement of Position, the copper containers might themselves be useful attractions to future generations.[107]

Finally, UNWMG asserts that "all solid waste forms and candidate canister/overpack materials are extensively tested for susceptibility to radiation damange," and concludes that the spent fuel waste form has been shown to be"adequately leach resistant" to meet waste package requirements."[108]

Contrary to this assertion, a symposium at the Lawrence Berkeley Laboratories concluded that there are few data supporting the leach resistance of either spent fuel or borosilicate glass at the appropriate temperatures:

> "There is a considerable body of work on borosilicate glass. Within the realm of geochemistry, there appears to be a lack of leaching data for conditions between about 75°C at atmospheric pressure and 300°C at several hundred bars .... Thus, there are currently few data within the expected temperature range ... Little information is presently available on the phase relations in spent unreprocessed fuel ... Research is in progress in Sweden on the leaching of spent fuel at lower temperatures."[109]

107/ USGS, p. 11.

108/ UNWMG, Vol. 2, p. III-B-17, See also, BNI.

109/ Lawrence Berkeley Laboratory, Geotechnical Assessment and Instrumentation Needs for Nuclear Waste Isolation in Crystaline and Argillaceous Rocks, LBL-7096, (1979), p. 171.

One assumes UNWMG means that these materials must be tested before they are used.

3. Repository Design and Construction.

The UNWMG asserts that "conceptual designs for geologic repositories for spent fuel and HLW have been completed."[110]/ Basically, it is simply an "underground civil structure" similar to other mined cavities and nothing more. We do not argue that the technology is not available to construct an underground civil structure. The point is that no effort has been made to relate this basic design to the fact that the repository will hold highly radioactive wastes for thousands of years, that it will be backfilled, and that it must be kept dry. Accordingly, there is no reason to believe that the "conceptual design" has all of the characteristics required of a waste repository, and thus, no reason to believe that it will be adequate for the time periods required for waste disposal.

4. Repository Closure - Backfilling and Penetration Sealing.

Sealing the repository is one of the most important aspects of waste disposal. Simple sealant failure, rather than human intrusion, may well pose the greatest threat to the public safety, particularly in the near term.

In this area, perhaps more than any other, UNWMG fails to provide a basis for confidence that effective sealing can

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110/ UNWMG, Vol. 2, p. III-D-1.

be accomplished. A single instance is cited in which a seal has held for 30 years. Of course, that seal is in a gold mine, a situation involving none of the complex and interrelated chemical, thermal and physical interactions that will take place in a radioactive waste repository.[111]/

Beyond that experience, the industry can only reference ongoing testing programs that may eventually provide some answers concerning the performance of repository seals and suggest a means of effective sealing. At this stage, no basis for confidence exists.

5. Post-Closure Monitoring and Prediction of Long-Term Repository Performance.

If a suitably conservative approach is taken to the waste disposal issue, it is fundamental that a repository cannot be found acceptable until analytical tools are developed capable of predicting its long-term performance. UNWMG essentially admits that we do not yet have that capability. Prediction must, in part, be done through the use of mathematical models. However, the final development and application of those models has not yet been possible due to the lack of essential site-specific data.[112]/

UNWMG proposes to use concededly unvalidated models, which it suggests may be used because they generate basically equivalent results.[113]/ This is not legitimate.

111/ Id., Vol. 2, p. III-D-3.

112/ Id., p. III-G-5.

113/ Id., p. III-G-7.

C. The Industry Has Grossly Oversimplified And Misinterpreted the Oklo Phenomenon.

Both the UNWMG and the American Nuclear Society (ANS) Statements of Position cite the Oklo "natural reactor" as a successful demonstration of the retention of radionuclides in a geologic environment:

> However, the adequacy of the geologic disposal concept has been successfully demonstrated. Evidence from the natural reactor discovered in the Oklo uranium mine in the Republic of Gabon clearly indicates that geologic barriers alone, under appropriate conditions, can largely prevent waste release.114/

However, these assertions fail to acknowledge two crucial weaknesses in extrapolating the Oklo phenomenon as proof of the geologic disposal concept. First, the existence and recognition of the Oklo deposit as a natural reactor only demonstrates that it is possible under some conditions to retain certain fission products and transuranic elements in the earth. There is no proof or assurance that many other such reactors did not also exist and are now so dispersed as to be unrecognizable. Second, the ability to recognize the natural retention of radionuclides in the earth and the ability to locate a site which can retain radionuclides emplaced by man are two very different exercises and are not analogous.

The recognition of Oklo as a natural reactor came many years after the deposit was first mined by man. This

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114/ Id., Vol. 3, p. 2-10-11, ANS, p. 24.

fact supports the need to consider the real consequences of future human intrusion even assuming successful retention of radionuclides. In any event, the retention of radionuclides at Oklo may well only be partial. Radionuclides with shorter half-lives could have migrated away from the site at the time of reaction, according to Ray D. Walton, Jr. of ERDA.[115] The notable radionuclides possibly released in measurable amounts are cesium 137 and strontium 90. As noted by the UNWMG, these nuclides are the dominant nuclides which must be retained in order to achieve safety in the period immediately following disposal.

> ... protection of the general public is the primary and perhaps only goal of waste disposal. Attainment of this primary goal is initially dominated by the fission product content of the waste, more specifically by the Sr-90 and Cs-137 content.[116]

Therefore, the safety of waste disposal is not well demonstrated by the Oklo reactor.

Furthermore, there is no reason to postulate that this phenomenon occurred only once in the history of the eart and therefore it is reasonable to assume that other natural reactors existed and are now so dispersed they are unrecognizable. This conclusion was drawn by George A. Cowan, the head of the nuclear-chemistry division of the Los Alamos Scientic Laboratory:

> It is entirely possible that chain-reacting ore lodes formed in these areas and have since

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115/ Cowan, G.A., "A Natural Fission Reactor," Scientific American Volume 23, No. 1, 1976, p. 46.

116/ UNWMG, Vol. 2, p. I-3.

> disappeared. They may have been buried under younger sediments, where they are unlikely to be discovered, or they may have been dispersed as a result of geophysical instabilities or geochemical mobility.[117]

The analogy to a repository is even less satisfactory when one considers the radically different set of circumstances posed by a repository than by a natural phenomenon like Oklo. There is no basis for supposing that because Oklo was discovered and was at least partially successful at retaining radionuclides that DOE can locate sites which would provide similar retention. The UNWMG Statement does not offer any understanding of why radionuclides were retained at Oklo and therefore provides no basis for recognizing the site characteristics which will be favorable to retention of waste emplaced by man. Indeed, there is reason to believe that predictions of geologic stability and conditions in the future are highly uncertain. The USGS warns that geology is at best a retrospective science with limited capabilities for predicting the future:

> Earth scientists can indicate which sites have been relatively stable in the geologic past, but they cannot guarantee future stability. Construction of a repository and emplacement of waste will initiate complex processes that cannot, at present, be predicted with certainty.[118]

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[117] Cowan, supra, p. 45.

[118] Bredehoeft, J.P. et. al., "Geological Disposal of High-Level Radioactive Wastes -- Earth Science Perspectives" U.S. Geological Survey Circular 779, 1978, p. 12-13.

In sum, the Oklo phenomenon does not prove the success of geologic disposal and does not provide ample information for guiding site selection for geologic repositories.

D. UNWMG Has Disregarded Institutional Obstacles While Acknowledging That They Are Equal In Importance to Technical Issues.

While acknowledging that institutional considerations are equal in importance to the technical issues involved in waste disposal,[119] UNWMG's submission, in four volumes totalling hundreds of pages, devotes but 14 pages to institutional problems, concluding that no overriding obstacles are presented.[120]

The foundation of this optimism is the premise that the government is strongly motivated to achieve a waste disposal solution by the desire to become independent from foreign oil suppliers,[121] the need to continue weapons production for national defense and the need to dispose of wastes already in existence. There is no question that the federal government would like to solve the radioactive waste disposal problems. There is equally no factual basis for assurance that this will translate into an effectively coordinated and managed program any more than it it has in the past. In its Statement

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119 UNWMG, Vol. 3, p. IV-3.

120 Id., Vol. 3 at IV-3-16.

121 It should be noted that nuclear power is capable of making only a miniscule contribution toward the goal of energy "independence." A recent study by G.L. Weil shows that nuclear plants, both those in operation and under construction, substitute primarily for coal, not oil. A 3% drop in gasoline consumption would save as much oil as do all currently operating nuclear plants. Lanouette, W.J., "Nuclear Power Means More Energy, But Does It Mean Less Oil?" National Journal, August 23, 1980, p. 1406.

of Position, NRDC detailed this history of reversals that has characterized U.S. efforts to date.[122] Those efforts were surely motivated by a desire to succeed. Their failure reflects not a lack of will, but the number, complexity, and difficulty of the technical problems which have to be overcome. Motivation cannot substitute for technical solutions.

Indeed, despite the commitment of the federal government, the two agencies with major responsibility for waste management, NRC and DOE, have taken markedly different approaches to the problem. DOE has not even attempted to demonstrate that the NRC criteria will be met by its program.[123] Similarly, the two agencies responsible for establishing regulatory standards for repository performance are significantly behind schedule.[124]

Finally, UNWMG notes the formation of the State Planning Council but fails to consider at all the widespread public opposition to the establishment of waste repositories.[125] Confidence in the implementation of a successful waste management regime by 2007 requires a more serious and thorough consideration of the formidable social and institutional barriers.

122/ NRDC, p. 20-27.

123/ NRDC, p. 30-35.

124/ UNWMG notes that EPA and NRC have not "proceeded with the development of applicable standards and regulations as rapidly as would have been desired," Vol. 2, p. IV-9.

125/ For a more detailed treatment of these issues, see NRDC, p. 65-81 and NECNP, p. 31-33.

V. There Is No Basis For A Finding Of "Reasonable Assurance" That Spent Fuel Can Be Stored Safely For An Indefinite Period After The Expiration Of Existing Operating Licenses.

Since there is no basis for a finding by the NRC that a waste disposal facility will be in place by the time existing operating licenses expire, the NRC must examine the question of whether spent fuel can and will be stored safely either at reactor sites or in away-from-reactor facilities for an indefinite length of time until disposal becomes available.[126] In its Statement of Position, NECNP refuted DOE's claim that the NRC can have confidence in the safety of indefinite spent fuel storage and established that the available knowledge and experience are inadequate to support such a long-term prediction.[127] In addition, NRDC noted the fact, ignored thus far by DOE and the nuclear industry, that the Honorable Mr. Justice Parker, the Inspector at the Windscale Inquiry (the official British hearing on the proposed development of a large scale commerical reprocessing plant in the U.K.) concluded that long-term storage of light-water-reactor fuel "is not prudent with existing design methods."[128]

126/ Even if the NRC were to find that a disposal repository will be available, this examination will be necessary since there is no basis for a finding that repository capacity will be adequate. See discussion, supra at 10-11.

127/ NECNP, Part V.

128/ NRDC, p. 92.

As did DOE, the nuclear industry[129] argues that decades of successful experience with spent fuel storage establishe confidence that storage can continue to be safe for the indefinite future In so doing, the industry fails to recognize that far more complex issues are involved in their proposed reliance on indefinite spent fuel storage than simply whether storage experience has been favorable to date.

We have previously addressed fundamental legal points raised by this proposal. First, if the NRC is unable to make a finding that adequate safe waste repository capacity will eventually be available, as we assert it cannot, a finding of confidence in indefinite temporary storage will not be enough to assure protection of the public health and safety, as required by the Atomic Energy Act, and the production of nuclear wastes must cease.[130] Second, even if the NRC finds that a repository will eventually be available at some unknown future date or at some date significantly beyond the expiration of existing operating licenses, the NRC must undertake a NEPA analysis of the alternatives to aboveground, managed spent fuel pool storage as a means of handling wastes until disposal facilities become available.[131]

129/ Only the UNWMG, AIF, ANS, and TVA address spent fuel storage at any length. This discussion will focus on the UNWMG presentation, which is the most comprehensive of the four.

130/ See, supra, p. 11-13.

131/ See, supra, p. 13-15.

In addition to these points, the NRC may not rely on indefinite spent fuel pool storage because

- it has not developed criteria by which to judge the acceptability of existing fuel storage methods for indefinite long-term storage.
- the existing data and information concerning current and proposed storage methods are inadequate to support a finding that they will be safe for the indefinite future.

A. The NRC Lacks Criteria By Which To Judge The Acceptability Of Long-Term Spent Fuel Storage.

Once the NRC concludes, as it must, that it cannot have a "reasonable assurance" that a waste repository will be in place by 2007 or at any other time in the near future, it is, in effect, confronted with a proposal to store spent fuel indefinitely. This proceeding purports to be the forum in which the NRC will address that proposal. However, the NRC has not developed any criteria by which to judge the proposal. In the absence of such criteria, any approval of the proposal at this stage will, of necessity, be arbitrary and capricious.

The range of issues that the NRC must address in developing acceptance criteria is extremely broad, and is not the subject of this discussion. However, two examples serve to demonstrate that such criteria are needed, and that an ad hoc decision would have little rational basis.

First, how long will safe storage be required? We assert that even if the NRC finds that a disposal facility will eventually be available, it can make no precise prediction of when that will occur. The Atomic Industrial Forum argues that spent fuel can

be safely stored on-site for some undefined number of decades,[132] while the American Nuclear Society suggests that the time required for interim storage may be "up to 100 years."[133] Without some precise definition of the period during which storage will be required, the NRC has no way of judging whether a proposed storage method will be acceptable.

Second, as we have previously discussed,[134] above-ground storage for an indefinite period of time will be susceptible to social and political disruption to a far greater degree and will be more vulnerable in other ways than either short-term storage or geologic disposal. The NRC has never addressed the sorts of measures that may be required to assure safety in the face of these risks. Neither have any of the participants in this proceeding addressed these issues, yet they become crucial as the prospect of an operational geologic repository recedes into the indefinite future. Failure to consider and weigh the long-term liabilities of above-ground storage precludes a finding that it is acceptable.

B. Current Data and Knowledge Concerning Existing Spent Fuel Storage Methods Are Inadequate to Support A Finding that Indefinite Long-Term Storage Will Protect the Public Health and Safety.

Based on its examination of the available evidence, the UNWMG concludes that

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132/ AIF, p. 34.

133/ ANS, p. 29.

134/ See, supra, p. 14.

> spent fuel storage in water filled basins -- either in the reactor's spent fuel pool, a separate at-reactor pool, or an away-from-reactor facility -- is a safe, proven technology capable of storing spent LWR fuel for periods of many decades.[135]

However, a review of the evidence on which that conclusion is based establishes that most of it is only marginally pertinent to the storage of U.S. commercial spent fuel. The legitimate data base is too small to support long-term predictions concerning future performance. In addition, the UNWMG overstates the reliability or implications of its evidence, asserts confidence in untried technologies, and relies heavily on active spent fuel pool management, which severely damages any long-term confidence in safe pool storage.

1. Relevant data are thin or non-existent.

The core of the UNWMG argument is a discussion of what it refers to as 37 years of successful storage experience.[136] In fact, as shown by the UNWMG's figures, the maximum length of relevant storage experience is twenty years, and that has involved only a very few fuel bundles.[137]

The UNWMG's Table 1 purports to show the extensive experience with long-term spent fuel storage. However, of the 133 fuel bundles identified in the table, 107 are constructed with stainless steel cladding, a type of construction that is no longer in use

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[135] UNWMG, Vol. 4, p. 2.

[136] UNWMG, Vol. 4, p. 26.

[137] UNWMG admits this point Id., p. 6, only to use the 37 year figure in later discussion.

to any extent in American commercial reactors. In addition, 25 of the 133 bundles are in storage at a Canadian facility and were discharged from a pressurized heavy water reactor. Their design is also unlike that of American commercial reactors fuel, and the UNWMG has made no effort to explain any similarities or differences. Accordingly, 132 of the total 133 bundles referred to are only marginally relevant to judging the potential for safe storage of American commercial reactor fuel.[138] The representative data base in Table 1, therefore, consists of one zircaloy clad PWR fuel bundle, and even that had a maximum burnup of 6,000 MWD/MTU, approximately 20% of current design exposure, and 12% of projected design exposures.

In addition to the information in Table 1, the UNWMG relies on the fact that

> at least nine Zircaloy-clad fuel bundles from the Canadian NPD reactor have been in storage since 1962 (although these have had little or no burnup)[139]

Again, this experience is of questionable usefulness because of the difference in design of Canadian reactor fuel and because these bundles experienced almost no burnup.

Table 2[140] represents an attempt to provide information on spent fuel that has experienced the high burnup rates typical of most commercial reactor fuel. However, half of the fuel listed

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138/ UNWMG, Vol. 4, p. 8.

139/ This and other information cited below was provided by Dale G. Bridenbaugh of MHB Technical Associates, Inc., an expert consultant to NECNP.

140/ UNWMG, Vol. 4, p. 8.

is of stainless steel cladding design. Further, the table indicates that the burnup maximum applies only to the peak exposure bundle. Other bundles may have experienced substantially less, although there is no mention of the number of fuel bundles involved, making it impossible to assess the significance of the information. In any case, all of the fuel was discharged from the reactors between 1973 and 1966, and therefore provides only a very few years of storage experience.

UNWMG relies heavily on foreign experience. For example, it cites metallurgic examination of stored fuel in Canada, periodic examination of stored fuel in Germany, and alleged favorable experience other countries.[141] However, no details are provided concerning the examinations, the number of fuel bundles or rods involved, or whether the fuel was comparable to current American designs. Without that information, the cited experience is of little use to the NRC. Indeed, UNWMG makes precisely this point in another context when it argues that storage failures in fuel from the Hanford N-reactor and other types of reactors are not relevant to commercial spent fuel because of differences in design and sensitization.[142]

The problem of lack of supporting data or fragmentary and incomplete information pervades the UNWMG presentation. As another example, it is reported that a corrosion study at the

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141/ Id., p. 9.

142/ Id., p. 9.

Morris, Illinois, spent fuel pool indicated extremely small corrosion rates on stainless steel.[143] As noted, stainless steel cladding is no longer in use. Perhaps more importantly, neither the study process nor its results are provided. The UNWMG is also unable to support its claim that uranium oxide pellets are essentially inert to pool water.[144] Even if that is the experience to date, the time periods during which uranium oxide pellets have been exposed to pool water are so limited that they provide no confidence that the pellets will not degrade during indefinitely long-term storage.[145]

2. Evidence is in some cases misinterpreted, and its weight overstated.

In addition to providing scant support for its assertions, the UNWMG has mischaracterized some of the evidence in a manner that leaves a misleading impression. For example, the UNWMG compares the temperature of fuel inside reactors to its temperature after a few weeks in the pool. This is said to demonstrate that the margin of safety increases as spent fuel is cooled over time.[146] However, the relevant comparison is not between fuel temperatures in the reactor and fuel temperatures in the pool, but between initial and later fuel temperatures in the pool.[147]

143/ Id., p. 24.

144/ Id., p. 8.

145/ Bridenbaugh.

146/ UNWMG, Vol. 4, p. 20.

147/ Bridenbaugh.

These differences are, of course, far less dramatic. Similarly misleading is the suggestion that

> since longer-term spent fuel storage would not involve significant additional movements of the fuel, the changes for fuel handling mishaps are reduced.[148]

There is no reason to believe that chances for fuel handling mishaps will be reduced below current levels since fuel will continue to be handled in the same way and the same number of times. The most that can be said is that chances for mishaps will not increase simply by storing fuel for a longer period of time.[149] Finally, as it has done throughout its presentation,[150] the UNWMG ignores potential exposure pathways in discussing dose commitments from pool operations.[151] It is inappropriate simply to average total releases over the surrounding population. Some people will receive higher does than others even in the absence of accidents. The possibility of exposure by as a result of accidents or leakage via liquid pathways has also been ignored.

In addition, the UNWMG overstates both the weight and the credibility of its references. For example, the UNWMG implies that a survey of American commerical power reactor fuel has conclusively established that no fuel degradation has occurred in

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148/ UNWMG, Vol. 4, at 27.

149/ It is important to note, however, that this point ignores entirely the increased likelihood of mishaps as a result of the increased technological sophistication required for compacted storage.

150/ See discussion at 26, supra.

151/ UNWMG, Vol. 4, at 29.

stored fuel.[152] In fact, there is no indication that the survey in question involved a close examination and testing of reactor fuel to determine if degradation has occurred. To the contrary, it was apparently simply a written survey in which the author, A.B. Johnson, asked reactor operators whether degradation had occurred. The results may be nothing more than the self-serving responses of the reactor operators and have no apparent scientific or technical basis.[153]

UNWMG claims that

> the conclusions reached by several researchers on the historic experience all affirm the ability to withstand extended periods of storage in water basins.[154]

However, examination of the references cited indicates that two of the three "several researchers" are Canadians citing Canadian experience, and the third is A.B. Johnson, who also derives most of his clad corrosion experience from Canada. For reasons discussed above, the Canadian experience cannot be directly applied to U.S. fuel, nor has UNWMG made any showing as to how and in what manner it can be extrapolated. UNWMG similarly claims that the studies of "several independent investigators" have shown spent fuel storage in pool water to be practicable for many decades.[155] In fact, the "independent investigators" cited by UNWMG are Johnson, and two Swedish authors associated with ASEA-ATOM,

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[152] Id., p. 8.

[153] Bridenbaugh.

[154] Id., p. 10.

[155] UNWMG, Vol. 4, p. 21.

the Swedish nuclear industry. These can hardly be considered to be independent sources.

3. Reliance on Active Pool Management

Although the UNWMG states that "[t]he storage of spent fuel is best characterized by its inactivity,"[156] in fact above-ground storage involves active management, control, and surveillance by the pool operator. Indeed, UNWMG emphasizes that the safety of storage pools is assured by constant monitoring to identify any potential accidents or hazards in time to determine an appropriate remedy.[157] It is asserted that

> In the event that corrosion or degradation of the pool liner, piping, or equipment did occur, it could be remedied by repair or replacement. Pipes and pumps can be easily replaced if needed. Even where the pool liner is damaged, it can be repaired in place and in fact such repairs have been performed.[158]

The position must be rejected for two reasons:

- There is no experience with filled spent fuel pools to indicate that adequate maintenance and repair will be possible.

- Reliance on active management is unacceptable in view of the indefinite period of time for which storage may be required.

Industry has to date periodically drained tanks comparable to spent fuel pools for cleaning and inspection and to allow maintenance and corrective actions to be taken to assure structural integrity and leak tightness. The capacity to perform such

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156/ Id., p. 17.

157/ Id., p. 19-23.

158/ Id., p. 25.

maintenance and repair has been required for at least the Turkey Point and Millstone spent fuel pools, where leaks have actually occurred.[159] This type of operation will become substantially more difficult, if not impossible, once the storage pools become full. There will then be little or no opportunity to perform maintenance, particularly on the pool liner or structural components. Under these circumstances, a leak could cause the liner to corrode from both sides, and could degrade the concrete and gradually damage the structural rack supports.[160] The UNWMG fails to address how the necessary maintenance, relied upon for long-term safety, can be performed in a full pool, or to assess the potential long-term degradation and increased hazard that would result from the inability to perform required maintenance and repair.

Finally, reliance on active storage, monitoring, and maintenance is inappropriate if storage will be required for an indefinite period of time past the expiration of existing licenses. The need for active control places a significant emphasis on the same unreliable institutional factors that led the Department of Energy to establish as a criterion for an acceptable disposal repository that it

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159/ Bridenbaugh. The leaking at Millstone occurred before the storage pool was put into use, and the Turkey Point leak has apparently not yet been corrected, but both indicate the potential hazard.

160/ Id.

should not require active maintenance or surveillance for unreasonable times into the future.[161]

Even the American Nuclear Society has admitted that interim spent fuel storage may be required for as long as 100 years.[162] Based on this criterion alone, the NRC cannot have confidence in the safety of long-term storage of spent fuel.

4. Industry proposals for away-from-reactor storage, new water pool storage techniques, and dry storage provide no support for a finding of confidence that spent fuel can be stored safely.

In order to assure adequate storage capacity pending the completion of an acceptable waste repository, UNWMG proposes the use of away-from-reactor storage facilities,[163] and new water pool storage techniques such as "double tiering"[164] and rearranging fuel rods into closer arrays within canisters.[165] While these proposals might provide adequate capacity, they all rely on the same techniques as the at-reactor pool storage previously discussed. They fail to provide any basis for confidence in safe long-term above-ground water pool storage for the same reasons. Indeed, all three would be more vulnerable to the weaknesses in active pool management. This is true of away-from-reactor pools because they are likely to be viewed as "warehouse" type facilities where there is little to motivate personnel to

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161/ DOE, p.

162/ ANS, p. 29.

163/ UNWMG, Vol. 4, p. 11-12.

164/ Id., p. 15-16.

165/ Id., p. 16.

provide tight security, unlike the case at the site of an operating reactor. It is true of the two capacity increasing techniques because both involve concentration of the spent fuel, which poses greater hazards of excessive heating or melting if required maintenance or other actions fail to provide adequate cooling.

UNWMG also notes the possibility of using passive dry storage,[166] which would at least alleviate the need for active management. However, even if all of the evidence cited by UNWMG is considered relevant,[167] the data base is minescule and cannot support any long-range predictions. More importantly, as with water pool storage, there has been no examination of the question of whether indefinite long-term dry storage would pose even greater hazards than near-term disposal. NEPA requires such an analysis before any reliance may be placed on any sort of indefinite spent fuel storage.[168]

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166 Id., p. 16-17.

167 Most of the dry storage tests to date have been done with Canadian, British, or non-commerical fuels, all different in design from U.S. commerical reactor fuel.

168 See, supra, p. 14.

VI. Conclusion

With the Statements and Cross-Statements of all of the parties in hand, the Commission is faced with radically differing views of the probable course of future development of this nation's radioactive waste disposal program. The views of the parties representing the nuclear industry,[169] and the Department of Energy, are all remarkably similar: They argue, in essence, that no insuperable technical difficulty bars the way to development of a geologic repository. They define the problem as less technically challenging than previously thought, requiring only a few hundred years of containment against a very modest threat of human intrusion, and they assume that all ongoing and planned research will yield favorable results. They conclude that a "reference case" repository can (not will) be operational by 2007.

Arrayed generally on the other side of the question are nine states or state agencies,[170] six public interest

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[169] United Nuclear Waste Management Group - Edison Electric Institute; American Nuclear Society; Atomic Industrial Forum; American Institute of Chemical Engineers; Capitol Legal Foundation; Bechtel Corp.; TVA. Of these, only the first is a serious attempt to provide factual evidence in support of a confidence finding.

[170] They include the States of Ohio, Vermont, New York, Wisconsin, Illinois, and Delaware, the California State Department of Conservation, California Energy Commission and the Wisconsin Geological and Natural History Survey.

groups[171] and several individuals. Although their positions are somewhat less monolithic, it is fair to characterize their view points as dramatically less confident than the industry and DOE. They present evidence showing that the waste in question is more toxic and requires containment for many thousands of years longer than postulated by the industry. They stress the scope and difficulty of the many significant technical difficulties which stand in the way of implementing a final disposal solution and point to a history which features graphic examples of consistently unjustified technical optimism and underestimation of the complexity of the problems presented. They point to the formidable institutional and political obstacles which, far from being irrationally motivated, are the direct consequence of and are fueled by past failures and present scientific and technical controvery. Finally, they conclude that there is not reasonable assurance that adequate high-level waste disposal facilities will be operational at the expiration of current licenses or at any time in the forseeable future.

NRDC and NECNP have set forth their evidence and arguments in some detail and have shown many specific weaknesses

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171/ The New England Coalition on Nuclear Pollution, the Natural Rescurces Defense Council, Environmental Coalition on Nuclear Power, Sensible Maine Power, Mississippians Against Disposal, and Safe Haven, LTD.

in the industry's presentation and in its overall approach. At this point, we wish to offer several principles which should guide the Commission in weighing the submissions of both sides:

1. The burden of proof is squarely on the industry because it seeks approval to continue to create highly toxic and long-lived wastes in the absence of not only any present means to protect future generations from its effects but also of any agreement even on the appropriate technical criteria by which to judge the acceptability of disposal options.

2. All optimistic predictions must be judged with a skepticism bred from the past performance of the proponents of nuclear power. One of the first environmental impact statements ever prepared by the Atomic Energy Commission was done in connection with the waste disposal project at Lyons, Kansas. It contained the following statement:

> The proposed facility will safely contain these wastes for the required period of time without any significant impact on the environment.172/

In 1980, that statement appears either frighteningly naive or disingenuous. It should stand as a reminder that the technical and scientific uncertainties in this area have

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172/ U.S. Atomic Energy Commission, Environmental Statement, Radioactive Waste Repository, Lyons, Kansas (June, 1971), p. 1.

consistently confounded those who wished to minimize them.

3. In setting standards, in interpreting and extrapolating data and in weighing scientific opinion, the Commission must resolve all doubt in the direction of conservatism. Conservatism is cited as the hallmark of reactor regulation: in the area of radioactive waste disposal it is even more important, because the unknowns and uncertainties are greater. The accident at Three Mile Island demonstrated the consequences of complacency in a civilian reactor program which has operated commercially for over 20 years. Waste disposal technology is thirty years behind. Strict adherence to the principles of conservatism is compelled.

4. The Commission should keep in mind the potential consequences of any missteps in the course charted by the industry. UNWMG, which offers the most comprehensive of the industry submissions, adopts a "reference" case -- one theoretical path to success. Any significant disruption of that plan could bring the forward movement to an abrupt halt. Perhaps the most obviously vulnerable point is at site selection. Failure to identify a suitable salt formation would be devastating to the reference case. Yet there is no evidence whatever to support assurance that one will be located.

NRDC and NECNP believe that the current status of U.S. research and development programs in the area of high-level waste disposal does not provide any assurance that repository facilities will be available by 2007 or any forseeable time in the future. At most, experiments to date justify

continuing research. In their zeal to continue the nuclear power program, the nuclear industry and its proponents consistently go beyond what can reasonably be adduced from the evidence. The following language from Judge Tamm's concurring opinion in NRDC v. NRC 178 U.S. App. D.C. 336, 361, 547 F.2d 633, 658 (1976)[173] is an appropriate conclusion:

> NEPA requires the Commission fully to assure itself that safe and adequate storage methods are technologically and economically feasible. It forbids reckless decisions to mortgage the future for the present, glibly assuring critics that technological advancement can be counted upon to save us from the consequences of our decisions.

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[173] In Vermont Yankee Nuclear Power Corp. v. NRDC, 435 U.S. 519, 98 S. Ct. 1197, while reversing that portion of the majority opinion requiring further procedures, the Supreme Court remanded for precisely the inquiry called for in Judge Tamm's concurring opinion.

Respectfully submitted,

NATURAL RESOURCES DEFENSE COUNCIL, INC. and NEW ENGLAND COALITION ON NUCLEAR POLLUTION

By:

Ellyn R. Weiss

William S. Jordan, III
HARMON & WEISS
1725 I Street, N.W., Suite 506
Washington, D.C. 20006
(202) 833-9070

Dr. Thomas Cochran
Ms. Georgia Yuan
NATURAL RESOURCES DEFENSE COUNCIL, INC.
1725 I Street, N.W., Suite 600
Washington, D.C. 20006
(202) 223-8210

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