UNITED STATES OF AMERICA
NUCLEAR REGULATORY COMMISSION

IN THE MATTER OF:	)	
	)	
PROPOSED RULEMAKING ON THE STORAGE AND DISPOSAL OF NUCLEAR WASTE	)	PR-50, 51 (44 F.R. 61372)
	)	
	)	5 Sept 80
	)	
	)	
(Waste Confidence Rulemaking)	)	

CERTIFICATE OF SERVICE

I, the undersigned Priscilla C. Grew, state that I have this day served, pursuant to the rules of the NRC, a true copy of the enclosed Cross-Statement on the Secretary of the Commission and on the Presiding Officer of these proceedings, which Cross-Statement is to be filed and served by the Commission on all parties.

1. Samuel J. Chilk
   Secretary of the Commission
   U.S. Nuclear Regulatory Comm.
   Washington, D.C. 20555

2. Marshall E. Miller, Esq.
   Presiding Officer
   U.S. Nuclear Regulatory Comm.
   Washington, D.C. 20555

This the 5th day of September, 1980.

Priscilla C. Grew
PRISCILLA C. GREW

DS03
S 0/1

UNITED STATES OF AMERICA

BEFORE THE

NUCLEAR REGULATORY COMMISSION

In The Matter of

GENERIC PROCEEDING ON CONFIDENCE IN STORAGE AND DISPOSAL OF NUCLEAR WASTES	)	Docket No. PR 50-51 44 FR 61372

CROSS-STATEMENT OF POSITION OF
THE CALIFORNIA DEPARTMENT OF CONSERVATION

The California Department of Conservation (DOC) as a participant in this Proceeding, has examined the statements of position submitted in July 1980 to the NRC by other parties in this Proceeding. DOC presents its commentary and conclusions as to the nature and significance of the principal findings and arguments present in those statements which bear upon the principal question considered in the Proceeding: Is there adequate showing by Department of Energy to establish confidence that nuclear waste disposal facilities will be in place and available by 1997 to 2006, capable of meeting Environmental Protection Agency (EPA) performance standards?

The DOC position in regard to the confidence associated with high level radioactive waste disposal was presented in its Statement of July 7, 1980. In that document DOC addressed eight principal issues in the areas of geological and seismological implications of the waste disposal policy outlined by the U.S. Department of Energy (DOE). In this cross-statement of September 1980, DOC comments on the position taken by other parties

in the July filing. For each of these issues, the following discussion includes DOC's basic conclusion, and commentary on significant relevant points.

A reference list of the 28 Participants whose July 7, 1980 Position Statements were received by DOC follows this cross-statement. All were reviewed in the course of preparing this commentary, but only the relative few that, in the judgment of DOC, contain significant information relevant to eight issues are referred to in commentary. Many of the position statements not referred to in this commentary also addressed those issues to various degrees, both supportive and dissenting, but were not judged to provide new or different information.

DOC Issue No. 1:

There is no certainty that a waste disposal facility will be operational by the year 1997 to 2006, and will be located in a geologic medium which meets EPA performance standards and NRC regulations.

Discussion:

DOE has demonstrated that no definite answers presently exist in regard to successful design and establishment of a repository in a specific geologic medium during the required time frame. Upon determination of a satisfactory medium for waste disposal, it will become necessary to locate a series of particular sites which possess other satisfactory geologic characteristics and demonstrate adequate performance during the next 10,000 years.

According to Geologic Disposal of High-Level Radioactive Waste - Earth-Science Perspectives by J.D. Bredehoeft, et al., USGS Circular 779, 1978, page 6, "the uncertainties associated with hot wastes that interact chemically and mechanically with the rock and fluid system appear very high".

The DOE discussion of the prospect for long-term waste retention in numbers of rock types (DOE 1980, pages II-57 to II-76), does not provide assurance that a satisfactory medium will be identified in a sufficiently timely fashion to assure that a mined repository will be operational in the 1997 to 2006 time frame.

Supportive Points to DOC Position Offered by Other Participants:

Support 1:

The National Resources Defense Council (NRDC, 1980, page 4) stated that, "DOE has not developed a plan which will meet even the NRC's draft performance criteria for geologic repositories. In numerous instances, DOE's program objectives are in conflict with the NRC's criteria."

We concur with the NRDC in this assessment of the DOE program. The proposed NRC Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste (10 CFR-60) lists conditions which are considered to be presumptive that the site will not meet the performance objectives. DOE has not incorporated any identification of unfavorable geologic characteristics into the site selection process.

The following three statements are considered support for the DOC position that to assure certainty that a facility will be operational, the geologic medium at that site must be tested and determined to be suitable. Until the site selection process has progressed to the point

where in situ tests can be conducted, there is no rationale for predicting when the testing can be concluded.

Support 2:

As pointed out by the United States Geological Survey (USGS) (1980, page 6), "Detailed in situ tests are needed to perform risk assessment, and until this has been done, no site can be judged suitable for waste disposal".

Support 3:

The USGS (1980, page 28) also notes in considering the Hanford site, that "Careful attention must be given to the problems of repository construction and safety in a brittle, highly fractured, and water-bearing sequence of rocks."

Support 4:

As noted by the American Institute of Chemical Engineers (1980, page 6), "We must remember that assurance that a site is suitable will not be established until the underground portion of that site is virtually fully developed."

Dissenting Points to DOC Contention Raised by Other Participants:

Dissent 1:

Bechtel (1980, page 4) described the tests of the salt at Lyons, Kansas, as "...sufficient to establish the safety of salt repositories."

DOC believes that the tests at Lyons can better be described as "state-of-the-art, 1970". There is now general recognition of major uncertainties regarding the viability of using salt formations as waste repositories, for example the Report to the Congress by the Comptroller General of the United States, Nuclear Energy Dilemma: Disposing of Hazardous Radioactive Waste Safely, (EMD-77-41, 1977).

Dissent 2:

Bechtel (1980, page 4) also comments, "Shale has been the subject of research programs, including in situ heater experiments in the Eleana and Conasaugu formations." However, the Interagency Review Group (IRG) Report on Alternative Strategy for the Isolation of Nuclear Waste (TID 28818, 1978, Appendix A, Page 74), describes these tests as simple preliminary field heating tests in two shale units, to determine methods for measuring their temperature sensitivity and to obtain data on their pre-and post-heating conditions. These tests have revealed potential problems if those formations were to be used as disposal site "host rocks", including inhomogeneities, phase changes, and difficulties with mining and keeping the working open (Ibid,page 75).

Dissent 3:

Bechtel also states (1980, page 4), that "None of these repository test programs has revealed to date any unexpected results bearing on the overall safety or structural design of a repository."

The DOC contends, based on the IRG report (IRG 1978, Appendix A), that the tests performed thus far have revealed substantial unexpected (i.e.new) results, many of which have a negative bearing on the overall safety or

structural design of a repository. The presence and migration of brines in salt, the decrepitation of certain rocks when heated, volumetric changes associated with heating and phase changes, and the estimated 20% of the Eleana argillite at the Nevada Test Site that is a highly plastic material that deforms to close unsupported openings (IRG 1978, Appendix A, page 75) are examples of test results which have negatively impacted previously held ideas of safety and construction.

DOC Summary:

The conclusion reached in DOC's July 7, 1980, Position Statement (DOC 1980, pages 9-10) remains valid:

> The geologic medium best suited to a repository site is not yet identified and its determination is proving to be a difficult, complex, and time-consuming assessment. There is no reason to believe at this time that this problem will be solved within the requisite time frame (DOC 1980, page 10).

DOC Issue No. 2:

There is no assurance that 10,000 years is an appropriate time for storing nuclear waste in a mined repository which can meet NRC regulations and EPA performance standards, unless significant integrity is achieved beyond this time period.

Discussion: (DOC 1980, page 10):

DOE has specified that a "disposal system provide reasonable assurance that wastes will be isolated from the accessible environment for a period of at least 10,000 years with no prediction of significant decreases in isolation beyond that time" (DOE 1980, page II-9). Many other criteria for site selection and repository design are dependent on this critical isolation time period.

Although radioactivity decreases by four orders of magnitude in the first 10,000 years (DOE 1980, pages II-7-15), residual radioactivity makes the waste still unacceptable to the accessible environment. DOE should clearly define the radiation hazard from high-level wastes for specified periods beyond 10,000 years. Further, chemical toxicity effects (which do not decay over time) should be addressed, in the context of a need to maintain permanent isolation.

Supporting Points to DOC's Position Raised by Other Participants

Support 1:

The State of New York proposes a 1,000,000 year isolation period (NY 1980, page 5). They point out that "plutonium must be isolated from the environment for 250,000 years before it becomes harmless", and list 16 other components of high level wastes with half-lives much

longer than plutonium (NY 1980, page 20). "Because nuclear waste contains such long-lived substances, DOE has acknowledged the need to isolate nuclear wastes for up to 1,000,000 years (DOE 1979, page 1.9)" (NY 1980, page 20).

Support 2:

The California Energy Commission points out the lack of "universal agreement" regarding the question of isolation period because of differences in"...radionuclide content of the waste, site specific characteristics of geochemistry, biological pathways to man, and population densities and social factors far into the future." (CEC 1980, page 6).

Dissenting Points to DOC's Position, Raised by Other Participants:

Dissent 1:

The Utility Nuclear Waste Management Group - Edison Electric Institute (UNWMG-EEI) considers the "time period of major interest and concern for containment of highly radioactive wastes" to be only 500 years (UNWMG-EEI 1980, Vol. 2, page IV-1). Their reasoning is that "beyond these times the potential for exposure of populations from these wastes via the water-borne (most likely) pathway is comparable to or less than that from the naturally occurring uranium ore..." (UNWMG-EEI 1980, Vol. 2, page IV-1). DOC finds this reasoning invalid because: (1) as was reported in UNWMG-EEI 1980, Vol 2, page I-6, "spent fuel is more concentrated than the ore by about a factor of 2500", and (2) there are components in spent fuel such as radioactive daughter nuclides, which are different and significantly more toxic than are found in naturally occurring ore.

Dissent 2:

The Oklo site in Gabon, Africa (a uranium ore deposit which went "critical", producing components similar to those found in spent fuel) is cited as an argument for the unimportance of isolation, because most of the nuclear reaction by-products were reported not to have migrated (UNWMG-EEI 1980, Vol. 3, pages 2-10, 11, 12). Recent work (Brookins, 1978), however, has shown that some radioactive elements have indeed migrated. Moreover, since the Oklo reaction took place 1.8 billion years ago, there is no direct and wholly convincing way to measure the contamination to the biosphere over that time span. DOC believes the Oklo situation does not provide irrefutable evidence of adequate isolation of nuclear wastes to provide safe levels of radiation to the biosphere.

DOC Conclusion:

The issue of the appropriate isolation time to be considered in regulatory criteria and performance standards needs further attention (DOC 1980, page 11). This conclusion is reaffirmed and strengthened by the presentationscited and the discussion.

DOC Issue No. 3:

The potential effects of future climatic changes limit the capability of documenting that a proposed high-level waste repository can meet NRC regulations and EDA performance standards. DOE must include such determinations in its plans to have an acceptable repository developed by 1997 to 2006.

Discussion:

Climatic changes (e.g. glaciation, advancing seas, accelerated runoff and erosion) although long-range in nature, could affect the geologic integrity of a disposal site over an appropriate geologic time frame required for confinement. This is true even considering a 10,000 year span.

The proposed multibarrier concept, incorporated in the design criteria for nuclear waste repositories, provides some degree of redundancy in the event of the loss of integrity of the repository itself during or after the minimum period of confinement. Even if the waste canisters and the waste packages were to fail to perform, and the waste were to migrate into the host rock, the geologic barriers should retain the waste away from the accessible environment (DOE 1980, pages II-24, 25). However, if significant geologic barriers were to be stripped away by erosional processes due to uncontemplated climate conditions in the future, the waste could be transported into the biosphere and, consequently, the system would fail to meet regulatory standards.

To avoid this potential problem, the repository must be located at an appropriate depth to assure safety from surface erosion. To calculate the minimum acceptable depth to accommodate this factor at any specific site, it is necessary to determine the denudation rate in that specific

area, and to extrapolate into the future. A change in climate would directly affect the denudation rate and the ground water regime (glaciation, increased percolation rate from rainfall, submersion under lakes, etc.).

Supporting Points to DOC's Position, Raised by Other Participants:

Support 1:

The State of New York (NY 1980, pages 47, 48) reports that "continental reglaciation has 'a very high probability of occurring within the time period of concern,' and could bring with it faulting, flooding and dramatic changes in climate (EPA/520/4-78-004, page 38)." They point out that "the effects of a shift from arid to rainy climate upon the hydrologic regime of a repository has been 'largely ignored in current risk assessments of repositories such as Hanford and the Nevada Test Site.' (Ibid.) If the top of a salt dome repository were accessible to sea-water, a large quantity of salt could dissolve and the waste could be exposed" (NY, 1980, page 39).

Dissenting Points to DOC's Position, Raised by Other Participants:

Dissent 1:

The Utility Nuclear Waste Management Group - Edison Electric Institute (1980, Vol. 2, page III-A-8) submits that "erosion at the rate which has occurred in the Grand Canyon region of the Colorado River would require much more than a million years to reach the depths that typically are proposed for a mined repository. (Smith and Balderman 1980). Furthermore, regions can be identified where the relevant geologic processes have operated very slowly and without significant change in rate for periods so much longer than the time of concern for the repository that

the uncertainty of the required continued performance is very small" (Ibid.) "Areas subject to severe erosion by glaciers can be avoided either by choosing climates not subject to glaciation or else by appropriately choosing the topography of the site (Stottlemyre, 1979)" (UNWMG-EEI 1980, Vol. 3, page 2-28).

DOC wishes to point out that DOE in its position statement (DOE 1980) has not characterized any candidate sites as to climatic change criteria, and it would appear that the predictive methodology needs further development to adequately forecast climate changes, future areas of glaciation, or denudation rates. Techniques must be developed and these factors must be considered in the site selection process.

DOC Conclusion:

The conclusion reached in DOC's July 7, 1980 Position Statement (DOC 1989, page 13) remains valid:

> The performance of high-level waste repositories should be modeled on worst case bases which assume significant increases in precipitation and, where appropriate, glaciation scenarios. It remains to be established that some of the candidate sites will be acceptable, given possible future changes in climate. Modifications of both hydrologic conditions and erosion rates must be considered.

DOC Issue 4:

The hydrologic conditions of potential nuclear waste repository sites must be well enough characterized to assure that the sites comply with NRC regulations and EPA standards. This capability must be developed and implemented in time for establishment of operational facilities by 1977 to 2006.

Discussion: (DOC 1980, pages 14-17):

"Knowledge of ground water hydrology is, perhaps, the most important requirement for understanding the long-term behavior of a mined geologic repository. The transport of radionuclides away from the waste-emplacement zone by moving ground water is, by far, the most likely mechanism by which radionuclides might migrate from a repository to the biosphere" (DOE 1980, pages II-76, 77).

The pertinent characteristics of ground water systems listed by DOE 1980, pages II-76, 77 are:

1. Locations and dimensions of water-bearing strata.
2. Existence of aquifers and aquitards.
3. Hydraulic gradient, the driving force for ground water flow.
4. Porosity, permeability, and transmissivity of the rock mass surrounding a repository.
5. Rates and locations at which the ground water system is discharged and recharged.
6. Length and direction of potential flow paths (natural or man-induced) from a repository to the biosphere.
7. Travel time from a repository to the biosphere for individual radionuclides.

8. Ground water ages in the vicinity of a repository.
9. Ground water chemistry and its relation to waste rock interactions.
10. Postulated effects of future climates on ground water conditions as deduced from paleoclimatology.

The hydrologic characteristics listed above by DOE provide a considerable challenge, both from the standpoint of the setting of performance standards, and in the problem of data collection. Although hydrologic observation can provide pertinent ground water flow characteristics in many areas, the state-of-the-art is not yet well-enough advanced to adequately describe the regime of deep, nuclear waste repositories such as some of the sites considered in Section II D.3 of DOE, 1980, for the purpose of performance assessment.

Such fundamental factors as ground water flow paths commonly are controlled, not by the mean permeability of the host rock, but by the occurrence of zones of anomalously high permeability, which may be extremely difficult to identify and characterize. Data from observation wells provide only averages, and rarely indicate irregularly placed permeable zones, if they are present. Data from laboratory sample testing methods are accurate and reliable in their normal uses for water well testing; they are not reliable in testing the deep near-impermeable conditions of potential disposal cavities.

The science of computer modeling is well advanced in its applications to predicting hydrologic conditions. Both the mathematical and analog computer techniques may be used to model ground water flow. DOE has described many available models in DOE, 1980, Section II.F.1.2, pages II-207-213. At present, these computer models are not comprehen-

sive enough to simulate the hydrology of a complex system such as an actual potential disposal site. None of these computer models, furthermore, are any better than the data upon which they rely for site specific application. Slight miscalculation or mismeasurement of hydrologic variables can produce errors outside the limits of reliable prediction. Often, the hydrologic environment is too complex, heterogeneous and anisotropic to be modeled rigorously.

Supportive Points Raised by Other Participants:

Support 1:

The California Energy Commission (CEC) states that "Efforts to construct and validate mathematical models of repository performance are in a formative stage" (CEC 1980, page ii). They quote Bredehoeft (1978, page 3) in pointing out that "...some key geologic questions are unanswered, and answers are needed before risk associated with geologic containment can be confidently eveluated... We consider a variety of possible interactions among the mined opening of the repository, the waste, the host rock and any water that the rock may contain. Many of these interactions are not weil understood, and this lack of understanding contributes considerable uncertainty to evaluations of the risk of geologic disposal of high-level waste." CEC contends, and DOC concurs, that the DOE's Draft Earth Science Technical Plan (DOE/USGS 1980, Appendices A, B) provides evidence that data gaps still remain in several general areas including hydrology and sorption (Reference CEC, 1980, page 10).

Support 2:

Concerning the question of modeling, CEC states: "Models necessary to reliably predict the thermal-mechanical response of a repository and its coupling to the hydraulic-chemical behavior of aqueous solutions are not yet available" (CEC 1980, page 54). They quote the USGS (Response, page 5,) "In the radionuclide transport model, there is a vast amount of data yet to be collected on the flow path and its properties -- especially on chemical effects between the medium traversed and the waste under nonequilibrium and nonisothermal conditions. Included are such effects as ion exchange, precipitation and solution under various conditions of Eh and pH and surface chemical effects in fractured media." Furthermore, CEC says that "existing models generally ignore competition of the migrating particles for sorption sites since they treat the movement of each chemical species independently from all others" (CEC 1980, page 55).

Support 3:

The Wisconsin Geological Survey (WIS) says that,
"It is felt that the basic data input to models is probably not possible to determine on a generic basis, and may in fact be exceedingly difficult to acquire at any particular site." (WIS 1980, page 2). Also "...continued work remains to be done to adequately identify the relationships between stress and fracture hydrology" (WIS 1980, page 3). Regarding sorption, WIS points out that "the 'distribution coefficient K_d' is not thermodynamically defined and its calculation and use do not permit an accurate understanding of solute/solvent interactions" (WIS 1980, page 5). WIS also points out that one of the geophysical survey methods (electromagnetic) mentioned by DOE (1980, pages II-92-94) does

"...not work well where a shallow, horizontal clay layer is found (sub-horizontal conductors)..." (WIS 1980, page 7).

Support 4:

Wisconsin draws attention to recent failures to adequately model ground water hydrology (WIS 1980, pages 9, 10) as was also pointed out in the DOC statement (DOC, 1980, page 16). The predictions of ground-water flow at the Idaho National Engineering Lab facility using the proposed DOE model were proved to be incorrect -- an order of magnitude higher than predicted (WIS 1980, page 9). It was explained in Robertson (1974) that the discrepancy lies in DOE's assuming in the model study, that for hydrologic analysis purposes, the rock can be considered as a coarse porous granular material, when in fact it is a fractured basalt and not analagous.

Support 5:

The New England Coalition on Nuclear Pollution (NECNP) quotes DOE's admission (DOE 1980, pages II-95-96) that "...present measurement techniques for hydraulic conductivity in nearly impermeable rocks may be in error by up to a few orders of magnitude..." (NECNP 1980, page 17). The Coalition feels that DOE has only "a vague idea of the hydraulic characteristics of the various sites, but it is unable to determine the specific performance of hydrologic systems in a manner that will allow a conclusion that a site is qualified for a waste repository." (NECNP 1980, page 22). DOC agrees with NECNP on the issue of hydrology.

Support 6:

NECNP reiterates several major uncertainties mentioned by the USGS (Bredehoeft, 1978) including: the chemistry of the radioactive materials in the water flow, and ground water age dating methodology (NECNP 1980, pages 115, 116). DOC agrees with NECNP that these uncertainties present major difficulties to adequate testing and modeling of ground water behavior at any potential repository site.

Support 7:

The State of New York submits that "...models for predicting the long-term performance of geologic repositories are still under development and will not be available for years, and that data on specific sites to use in the models are incomplete" (NY 1980, page 52). New York also points out that in situ tests, that are so essential to assure a safe repository, are also likely to ruin the site by breaching the integrity of the candidate repository and permitting water intrusion (NY 1980, page 62). They quote DOE (1980, page 3.1.238), "Standard techniques for analyzing geologic formations in a non-destructive manner are not available" (NY 1980, page 63). New York also discusses the uncertainties in predicting the heat emanating from the wastes, which can affect overlying aquifers and ground water flow (NY 1980, pages 79, 80).. Furthermore, they point out that helium and radon, released through radioactivity decay, and other gases produced by radiolysis, can lead to the development or reopening of fissures that would result in the escape of radioactive materials to the surface (NY 1980, pages 81, 82). New York's findings corroborate DOC's views that nuclear wastes may alter the hydrologic characteristics of a geologic environment.

Dissenting Points to DOC's Position, Raised by Other Participants:

Dissent 1:

Bechtel National, Inc., states that the modeling of release of the waste into the surrounding geohydrology and the subsequent migration of the nuclides with their eventual release to the biosphere at the Waste Isolation Pilot Plant (WIPP) site "provided confidence in the overall safety analysis" (Bechtel 1980, page 3). DOC wishes to point out that this modeling was performed by a theoretically derived, structure-imitating model, using input data extrapolated from a few points to the entrie hydrologic basin, and its results unverified by actual measurements (DOE 1979, pages 9-28-128).

Dissent 2:

The Utility Nuclear Waste Management Group and Edison Electric Institute feel that, while neither seismic reflection profiling nor core drilling can provide all the necessary characterization data alone, the two exploration methods in concert will provide sufficient data (UNMWG-EEI 1989, Vol. 2, page III-A-5). DOC believes that the use of both methods will still leave many questions unanswered. Also, as UNWMG-EEI states (1980, Vol. 2, page II-A-5), drilling destroys the integrity of the repository environment. UNWMG-EEI points to the National Waste Terminal Storage (NWTS) program which includes research to improve exploration techniques, with emphasis on geophysical methods (UNWMG-EEI 1980, Vol. 2, page III-A-12). DOC does not consider future research as a basis for confidence today.

Dissent 3:

UNWMG-EEI (1980, Vol. 2, page III-G-7) admits that a major potential uncertainty in existing models is their inability to predict far-field performance. However, since the results of virtually every model show human exposure levels significantly below background, UNWMG-EEI is confident of adequate safety (Ibid). DOC does not find sufficient confidence in models which were not based on detailed site-specific information, and therefore are not subject to verification. DOC also does not believe that having an extensive program for improvement of models underway, is evidence of confidence now, that the far-field predictions will be made more accurate.

DOC agrees with UNWMG-EEI's admission that other problems exist which require further study: The buildup of non-radioactive gases (1980, Vol. 3, page 2-28), brine migration (1980, Vol. 3, page 2-30), and release of water of hydration (Ibid.).

DOC Conclusion:

DOC's conclusion regarding Issue No. 4 remains essentially as expressed in our July 7, 1980 Position Statement (DOC 1980, page 17):

> We advocate that DOE consider the following questions which in our opinion, remain open.
>
> 1. Can hydrologic parameters, such as permeability, ground water residence time, recharge rates, head differentials, thermal effects, path geometry, radionuclide sorption rates, and travel time, be characterized with sufficient reliability to assure successful performance of a developed deep waste repository in the 1997 to 2006 time frame?

2. Can the effect of possible climatic changes on hydrologic factors be sufficiently modeled to assure that a developed nuclear waste repository can meet NRC regulations and EPA performance standards by the 1997 to 2006 deadline?

3. How can we be certain when sufficient hydrologic variables are known to reliably model repository performance?

DOC Issue No. 5:

A fail-safe system of monitoring the performance of the repository must be devised and installed at the time the repository goes into operation. The system must be capable of detecting all symptoms of malfunction that might occur in the repository during and after the operational period.

Discussion:

Besides fail-safe reliability, the required monitoring system must record any effects of malfunctions before the repository has irreversibly failed. The monitoring system should remain reliably active during the entire operational life of the site, when it is receiving waste (estimated duration is 40-50 years). After it is decommissioned, the monitoring should be continued for a predetermined period. DOE reports (DOE, 1980, page II-18) that EPA has recommended a period up to 100 years.

In order to ascertain the overall performance of the repository, sensing and reporting equipment must be emplaced prior to the first consignment of waste, the monitoring equipment must be capable of detecting unplanned leakage of radioactivity or harmful chemical byproducts of the repository, both within the site proper (to warn of human access problems) and surrounding it (to warn of toxic emanations as fluids into the ground water, or as gases into the air).

There must be assurance that monitoring systems are capable of meeting the stringent performance standards that will be required. Past history has shown the performance of this type of equipment to be poor, particularly in salt deposits. Presently, available

instrumentation for this type of monitoring cannot last longer than ten years in a salt environment (Gnirk, Paul, 1979, Laboratory and In Situ Testing of Salt for Radioactive Waste Repository Analysis and Design, paper presented to Society for Engineering Systems Analysis Northern California meeting, San Francisco, May 24, 1979).

Supportive Points to DOC's Position, Raised by Other Participants:

Support 1:

It is generally agreed in the participants' statements that monitoring of each repository is necessary and desirable, and that monitoring should detect potential problems -- not just those that have already developed. As noted by NECNP (page 117), it is not clear as to just what must be monitored, since if releases can be detected, failure has occurred.

Support 2:

UNMG-EEI (Vol. 2, page III-G-1) says, "It should be noted, however, that any monitoring for the escape of radioactivity from the waste packages, or even from the repository complex itself, will have to be done without significant compromise to the integrity of the repository." They suggest monitoring temperature and radiation from instruments left in the closed repository, and other instruments located at some distance, to record migrating radioactivity. Their other suggested monitoring, i.e., "...periodic resurveys of the surface to observe the depth and areal extent of subsidence associated with closure of the subsurface cavities," (UNMWG-EEI 1980, page III-G-5) and "...measurement of activity levels in biological indicator species,"

(Ibid, Vol 2, page III-G-6) point out the deficiencies of current radiation-monitoring technology. DOC agrees with UNWMG-EEI on the need for monitoring that would not compromise the repository, but feels their proposed methodology would not indicate a potential problem, but rather, would indicate a failure that had occurred.

Dissenting Points to DOC's Position, Raised by Other Participants:

No participant specifically stated that monitoring was not needed. However, this issue was not given consideration by many participants.

DOC Conclusions:

The conclusion reached in DOC's July 7, 1980 Position Statement (DOC 1980, page 19) remains valid:

> The considerable uncertainties in the current technology of monitoring, and the critical need for a fail-safe monitoring capability, underscore the urgency of this requirement to record conditions during the operation and "early" (i.e., at least the first 100 years) storage phase of waste disposal repositories. DOE has not adequately discussed this issue in DOE 1980. The following question remains open: Can DOE provide certain assurance that an effective, reliable monitoring capability, which includes adequate design parameters to incorporate concerns such as those expressed above, will be developed and operative by 1997-2006, when the repository must be in operation?

Issue No. 6:

Expertise must be available to completely and permanently seal shafts, boreholes, and exploratory openings used to develop and to characterize sites. Decommissioned repositories must be sealed to prevent communication between the repository and hydrologic or gaseous pathways to the biosphere.

Discussion:

The DOC has uncertainty as to the completion of the design and evaluation studies of penetration seals and backfill material within the time frame necessary to meet the goal of achieving an operational repository by 1997 to 2006. This uncertainty is based on the following:

1. The long-term effects of heat and radiation on the integrity of the seal materials was not obtained in past experiences such as in oil and gas exploration. Without considering the effect of heat and radiation, no realistic appraisal can be made as to the long-term stability of the seal material.

2. The test of cement seals with expoxy resin in bedded salt deposits, discussed on page II-184, 185, is insufficient to provide assurance as to the stability of such seals over a period of 10,000 years, especially when the effects of higher temperature and radiation are not included.

3. A current field test is described on page II-185 as showing effective liquid permeability over a period of 3 months and that testing of this seal and other seals in the same borehole

over the next few years will be continued. How can the results of this test, which is to take place over the next few years, impact on the design criteria which are to be completed in 1982? Can this 3 month test provide design confidence concerning the stability of seals for a period of 10,000 years?

4. Numerous tests are presently underway on waste package system component interactions. On page II-150, DOE states that further tests are being initiated in a bedded salt host rock, using a hot cell with highly radioactive waste forms and that the results from this series of tests will be used for analytical model formulation and verification. DOC questions whether the results of these tests will be provided in time for the location of an acceptable repository.

5. On page II-187, DOE states, "A potential disadvantage of back-filling in the short term is a local increase in temperature... the increase in temperature due to backfilling is not expected to significantly impact the structural stability of the repository..." DOC finds that the potential effects of increased temperatures on the backfill and indirectly from possible changing conditions of the repository do not appear to be dealt with in assuring maintenance of the desirable backfill characteristics for the long term.

6. Studies of emplacement hole backfill materials described in pages II-147-149 have been in progress for many years, and the DOE report states, "Further work in these backfill barriers is

in progress for better characterization and engineering development." But, at this time, no information appears to have been developed that specifies the type of backfill material best used in specific geologic media, and characteristics necessary to withstand thermal stress.

7. In the event of the need to retrieve the nuclear waste (e.g., to respond to unanticipated problems which may be detected during the monitoring process), the design of the backfill material and penetration seals should allow for safe re-entry, maintaining the integrity of the repository. This concept does not appear to have been included in the DOE discussions on this subject.

Supportive Points to DOC's Position, Raised by Other Participants:

Dissent 1:

Expressing confidence that the problems of discovering effective seal materials are being met, the UNWMG-EEI (Vol 2, page III-F-4) notes, "In general, we adequately understand the mechanical and chemical durability of sealing materials and can reasonably show long-term durability of some of these materials for up to several thousand years in some applications." The UNWMG-EEI also says (Vol. 2, page III-F-5), that any uncertainties will be resolved because, "Materials studies will lead to the selection of stable plugging materials (currently, cements are being emphasized) that will meet design requirements."

To evaluate the significance of the UNWMG-EEI statements, and to understand which materials and study applications were giving successful results, DOC examined the ONWI document referred to in

the UNWMG-EEI Position Statement (ONWI-15). Apparently the UNWMG-EEI statement in regard to long-term durability referred to seal materials for relatively benign environments. The research studies discussed in ONWI-15 have a goal of developing stable sealing materials for the harsh environments that might be expected in a radioactive waste repository. One area of proposed research, also discussed in this document, was a study of cements for geothermal wells, which have conditions analogous to those of a nuclear waste repository site located in salt. Those comparable conditions include a depth range from 3000 to 6000 feet, a fluctuating range of high temperatures and heated fluids (primarily brines) with pHs in the range of 4.0 to 5.0. According to ONWI-15 (Page ii-84), the goal of that research is to "develop a cement capable of withstanding a 25 percent brine, and 400 degrees Celsius with a life expectancy of about 25 years. It has been estimated that the current life expectancy of most geothermal cements is 7.5 years, (Kukacka, 1978, personal communication)."

Based on the ONWI-15 information DOC concludes that if a seal that would survive those demanding conditions for 25 years is a still unaccomplished goal, there is little support for confidence that a seal to last 10,000 years will be developed sooner.

Dissent 2:

UNWMG-EEI (Vol 2, page III-F-4) referes to "alleged" gaps and uncertainties in the long-term performance of the seal system in the environment, apparently implying that those "gaps and uncertainties" are not serious obstacles to confidence that seal systems problems will be satisfactorily overcome in an appropriate time scale. Their reasoning is that the need has been recognized and is reflected

in ongoing and planned research, and that these activites will lead to the design of suitable seals. DOC, on the basis of the ONWI-15 report on seal research, contends that these gaps and uncertainties are real and serious.

Inasmuch as research which is underway does not meet the current need for sealing shafts and boreholes, and, planned research apparently will depend for its success on scientific breakthroughs which may not be achieved for many years, there is no reasonable basis for confidence at the present time that the sealant materials problems will be resolved in the desired time frame.

DOC Conclusion:

The conclusion reached in DOC's July 7, 1980, Position Statement (DOC 1980, page 23) remains valid:

> The Department of Conservation concludes that, since tests of backfill material and penetration seals are still being conducted, DOE has not demonstrated the confidence necessary to assure the completion of these studies in time to develop the expertise and the design criteria prior to site construction.

DOC Issue No. 7

Retrievability of nuclear wastes from the disposal respository is a critical capability that must be built into the repository selection, design, construction, and operation. DOE has little or no discussion of this issue in the DOE 1980 filing.

Discussion (DOC 1980, page 23-24):

Retrievability is significant from two aspects: 1) if any departure is detected in the safe performance of the repository, it may be necessary to remove part or all of the waste emplaced there up to that time; 2) if by reason of technological development, or political or military policy, the decision is made by some future administration to recycle any repository waste, it would be essential to be able to remove and reprocess it. The several site evaluation factors dealing with the permanence and the integrity of the repository site should include retrievability of stored, unreprocessed waste as a significant requirement. This consideration also should be applied in selection of the design of the waste storage containers, their placement within the repository site, and any backfill plans.

Supporting Points to DOC's Position, Raised by Other Participants:

Support 1:

The NRDC points out that, although the NRC draft repository performance criteria (10 CFR - 60) require a 50-year period of retrievability, there is no evidence in the DOE program that it can be accomplished (NRDC 1980, page 31). They quote EPA (1978, page 43) "Retrievability of HLW (High Level Waste) in other rock types (other

than salt where there would also be migration of the canisters) is not so much a question of locating the canisters because they have bodily moved elsewhere, but being able to collect all of the waste because corrosion and leaching might so disintegrate the canisters that much of it is dispersed."

Support 2:

The State of Minnesota (MINN) also finds retrievability a problem. They quote EPA (1978, page 3), "Retrieval may only be feasible so long as an active crew is kept at the repository site, perhaps then for only a relatively short number of years, 5 to 10, while the repository is being filled" (MINN 1980, page 8). And quoting DOE (1980, page II-283) "Both limited and total retrieval are unlikely events, the latter being the least likely" (Ibid). MINN's position on this issue is consistent with that of DOC.

Support 3:

WIS asks "What plans are underway for retrieval should minor amounts of closure occur on the waste system that might be locked into the host medium?" (WIS 1980, page 4). DOC finds no answer to this question in DOE (1980) and feels that it should be answered before confidence can be gained in geologic dispcsal of nuclear waste. Participant Marvin I. Lewis also notes that retrievability requires additional review (Lewis 1980, page 4).

Support 4:

The State of New York observes that not only has no methodology for assuring retrievability been developed, but, "no final decision has been made as to how many years retrievability is necessary" (NY 1980, pages 97, 98). DOC feels that these issues must be resolved before confidence can be placed in the geologic disposal of nuclear wastes.

Dissenting Points Raised by Other Participants:

Dissent 1:

The Utility Nuclear Waste Management Group and Edison Electric Institute claim that "the feasibility of removing backfill from the rooms, ventilating rooms to attain operational temperatures, and retrieval or recovery of the waste have been established through engineering studies." (UNWMG-EEI 1980, Vol. 2, page III-D-11). DOC wishes to point out that the above mentioned procedures have never been proven in actual practice, and has little confidence that it can be.

DOC Conclusion:

DOC's conclusion remains the same as expressed in our July 7, 1980 Position Statement (DOC 1980, page 24):

> Retrievability is a factor which is critical to the safe performance of a nuclear waste repository, and DOE should provide further discussion of retrievability than it has in DOE 1980. This issue should be carefully examined by an independent interdisciplinary committee of technical specialists.

DOC Issue No. 8:

The DOE has not found any candidate site without significant geologic problems. What is the certainty that sites will be found which have geologic conditions acceptable for a repository?

Discussion (DOC 1980, page 24-25):

DOE (1980, page I-4) contends that the immense problem of locating an adequate site, using criteria yet to be developed, can be accomplished by 1997 to 2006.

The experience that has been gained in the DOE study of six (6) candidate repository sites has shown difficult geotechnical problems in all geologic aspects studied thus far. In addition to the known problems, DOE has not yet obtained information on all of the study areas, so that other unknown geotechnical problems may remain to be detected and have to be dealt with.

The task of the DOE is to locate a site within a rock type that has been demonstrated to be a satisfactory medium for waste disposal. This overall task consists of several major sub-tasks, all of them made more difficult by the time constraints.

Supportive Points to DOC Position, Raised by Other Participants

Support 1: The USGS is confident that safe disposal can be achieved, but they are unable to determine when such disposal will be available (USGS 1980, page 4). They note, "There are many social and institutional questions that must be resolved in order to begin to identify potential sites, to gain access for their characterization, and to carry out the licensing process" (USGS 1980, page 5). This points up DOC's contention that the geologic

problems are formidable enough but many earlier problems will have to be resolved before the geologic work can be started.

Support 2:

With regard to the amount and level of effort which has been expended in the search for potential sites, and the amount yet to be done, the USGS notes that exploration, ". . . was begun relatively recently, and much geological, geophysical and hydrologic study remains to be done to locate potential sites" (USGS 1980, page 24). Further, at the Nevada Test Site the current attention is on welded tuff, but exploration was only recently begun. Studies in the Salina Basin are at an early state (USGS 1980, page 28). Several broad areas in Ohio and New York have been identified for additional study, but no work is underway at this time. At Hanford, the proposed host rock is the approximately 3,000 feet deep Umtanum basalt flow which is receiving attention at present, including some drilling (USGS 1980, page 27).

These reports substantiate that efforts to test geologic suitability for disposal sites are barely into the reconnaissance stages.

DOE admits to a lack of geologic data, but states that the appropriate research is being undertaken. The Interagency Review Group believes, without specific documentation, that the requisite technology is at hand to ". . . identify potential repository sites for further investigation" (IRG 1980, page 42), but that does not give assurance that potential sites will indeed be identified, and then be demonstrated to be suitable. Several participants (WIS,NRCD) raised serious doubt that the sites now being investigated will meet the proposed NRC criteria when they become available.

The New England Coalition on Nuclear Pollution sums up the situation: "In effect, DOE is saying that it is studying so many things in so many places that there must be an answer" (NECNP 1980, page 30). DOC cannot accept that as sufficient assurance of ultimate success.

Under the established DOE procedure (DOE 1980, page III-22), once a site suitable for further exploration has been located, that further exploration must be started. In situ testing of specific sites has been declared a necessity by many of the participants in this hearing, including AICM (1980, page 6), USGS, CEC, NECNP, and NRCD. The USGS (1980, page 5) states, "Generic assessment can achieve only limited credibility". They also say (USGS 1980, page 8) "A valid comparison of geologic systems will require in situ testing at all or virtually all sites compared".

A major significance of the constricted time frame is that specific sites cannot be chosen to conform to EPA performance standards and NRC criteria unless those documents are publicly available -- and so far, they are not. Then, the time required to develop a suitable selected site into a repository, is generally conceded to be on the order of 10 years. In situ evaluation of a potential site will take several years, and may result in its rejection.

The New England Coalition on Nuclear Pollution expressed the point well: New information could disqualify any of the potential sites, and undoubtedly several of the present candidate sites will be rejected during the selection process (NECNP, 1980, page 20).

Dissenting Points on DOC's Position Raised by Other Participants:

Dissent 1:

The Utility Nuclear Waste Management group believes that a repository could be operational before 1997 if alternative sites were evaluated without unnecessary subsurface investigations and if the first repository were in salt (UNWMG-EEI 1980, Vol. 2, page IV-2). The American Institute of Chemical Engineers believes that a safe disposal site can be constructed, and that the DOE time frame is much too slow (AICM 1980, page 4). They also acknowledge that, "We do not appear to be any closer now to the

operation of such a repository than we were in 1970" (AICM, page 5).

It is AICM's contention that the time table for establishing a repository is too conservative, and that it could be speeded up. This is also expressed by UNWMG-EEI (Vol.1, pages 2-3), where they state that disposal facilities could be operational earlier than the time indicated by DOE. It is their opinion that the schedule is principally dependent on policy decisions as to the extent of review prior to the selection of a site.

DOC Conclusion:

The conclusion reached in DOC's July 7, 1980 Position Statement (DOC 1980, page 25) is strongly reinforced by other particpants, and remains valid: No documentation has been submitted by DOE or other parties that any of the identified geological candidate areas will be developable by 1997-2006. The vague assumption that the expanded National Waste Terminal Storage program, because it includes a larger area for consideration, provided the confidence necessary to believe that the timetable will be met is unacceptable.

The USGS (1980, page 35), while confident that radioactive waste can be safety disposed of, believes that a prediction of the time when such facilities will be available will be imprecise and premature until many of the key issues have been addressed.

The site selection process has not even been properly started yet, and therefore cannot possibly demonstrate confidence now, that a repository will be available by the period 1997 to 2006.

Summary Statement

The principal thesis of the DOC position as stated in the July 7, 1980, submittal has not changed: ". . . while it may be possible for the DOE to locate, develop, and open a high-level waste disposal facility which

complies with NRC regulations and EPA performance standards in the 1997 to 2006 time frame, DOE has not provided assurances beyond a reasonable doubt that such will be the case. We contend that, in fact, there are a number of uncertainties that can make achievements by this time frame open to serious question". A summary of DOC's conclusions which support the DOC position is the following:

- DOC concurs with the conclusion of several of the participants that comprehensive site-specific studies must be conducted before confidence is established in locating a geologic repository. Unanswered questions relating to hydrology, erosion, climatic processes, retrievability, and monitoring are serious issues which will cause major uncertainties in the adequacy of geologic repositories. Sufficient site-specific studies are needed to assure that no uncertainties remain in significant technical problems.

- DOC finds that any discussion of a minimum isolation time of wastes in a repository should not be based on decay rates alone. The basis for isolation time at any particular site should be the result of the worst case analysis of engineering and geologic scenarios (including failure of barriers, and other uncertainties) to determine that any waste reaching the biosphere will not cause radiation or toxic level concentrations above normal for the site.

- DOC concludes that neither DOE nor any of the participants in this hearing has presented irrefutable documentation showing that a geologic repository will be available for disposal of nuclear waste between 1997 and 2006.

Respectfully submitted,

Priscilla C. Grew

Priscilla C. Grew

Department of Conservation
1416 Ninth Street, Room 1320
Sacramento, California 95814

DIRECTOR

September 5, 1980

REFERENCES

Bredehoeft, J.D., et al., 1978, "Geologic Disposal of High-Level Radioactive Wastes-Earth-Science Perspective," U.S. Geological Survey Circular 779, Foreword by William A. Radlinski, Acting Director, U.S. Geological Survey.

Brookins, Douglas C., 1978, Oklo reactor re-analyzed, Geotimes, March 1978, pp. 27, 28.

D'Applonia Consulting Engineers, Inc., 1979, The Status of Borehole Plugging and Shaft Sealing for Geologic Isolation of Radioactive Waste, Office of Nuclear Waste Isolation, Battele Memorial Institute. (ONWI-15, 1979).

Federal Register, 10 CFR Part 60, Technical Criteria for Regulating Geologic Disposal of High-Level Radioactive Waste, Advance Notice, May 13, 1980. Vol. 45, No. 94, p. 31393. (10 CFR - 60)

Interagency Review Group on Nuclear Waste Management, 1978, Subgroup Report on Alternative Technology Strategy for the Isolation of Nuclear Waste, Draft: U.S. Department of Energy, Washington, D.C. TID-28818 (IRG 1978).

Report of an Ad Hoc Panel of Earth Scientists, 1978, State of Geological Knowledge Regarding Potential Transport of High-Level Radioactive Waste From Deep Continental Repositories, EPA/520/4-78-004, prepared for the U.S. Environmental Protection Agency. (EPA/520/4-78-004 1978).

Report to the Congress by the Comptroller General of the United States, Nuclear Energy's Dilemma: Disposing of Hazardous Radioactive Waste Safely, EMD-77-41, 1977.

Robertson, J.B., et al., 1974, The Influence of Liquid Waste Disposal on the Geochemistry of Water at the National Reactor Testing Station, Idaho, USGS Open File Report IDO-22053.

Smith, J.L. and Balderman, M.A., 19[illegible], Geologic Processes and Site Evaluation for Radioactive Waste Repositories (Draft). Report prepared for Electric Power Research Institute.

Stottlemyre, J.A., et al., 1979, "A Conceptual Simulation Model for Release Scenario Analysis of a Hypothetical Site in Columbia Plateau Basalts" (Draft), Pacific Northwest Laboratory, August 1979.

U.S. Department of Energy, 1979, Draft Environmental Impact Statement, Waste Isolation Pilot Plant, 2 volumes: DOE/EIS-0026-D (DOE 1979).

U.S. Department of Energy, 1969, Draft Environmental Statement, Management of Commercially Generated Radioactive Waste, DOE/EIS 0046-D, April 1969 .