A-95-12
IV-D-38

Department of Energy
Washington, DC 20585

U.S. Environmental Protection Agency
Central Docket Section (6102)
ATTN.: Docket A-95-12
401 M Street, S.W.
Washington, DC 20460-0001

Re: **Docket No. A-95-12; Comments on the Proposed Environmental Protection Standards for Yucca Mountain, Nevada**

Dear Mr. Clark:

This letter provides the U.S. Department of Energy's (DOE) views on the U.S. Environmental Protection Agency's (EPA) proposed Environmental Protection Standards for Yucca Mountain, Nevada, published at 64 Fed. Reg. 46,975 (Aug. 27, 1999). DOE appreciates EPA's responsibility under section 801 of the Energy Policy Act of 1992 (the EnPA) to develop site-specific standards that will be the sole standards applicable to the Yucca Mountain Site. The release of the proposed rule is an important step in fulfilling that responsibility to ensure adequate protection of public health and safety.

EPA's standards will play a pivotal role in achieving the long-standing policy of the United States to properly dispose of high-level radioactive waste (HLW) and spent nuclear fuel (SNF) in an underground mined geologic repository. The Nuclear Regulatory Commission (NRC) must implement EPA's standards in its regulations for licensing a repository at the Yucca Mountain site, and DOE must be able to comply with those NRC regulations in order to construct a repository. If EPA were to select unrealistic, unnecessarily conservative, or non site-specific standards, the result could be the rejection of an otherwise suitable site, and the *de facto* rejection of the geologic disposal option without commensurate benefit to the protection of public health and safety. Such rejection would not avoid the consequences of radioactive waste management, but it would require resort to a different and currently undefined approach.

EPA proposes three disposal standards that a repository must meet for a period following closure. First, an Individual Protection Standard (IPS) limits exposure to future populations in the vicinity of Yucca Mountain. Second, a Groundwater Protection Standard (GPS) limits groundwater contamination to levels at or below EPA's Maximum Contaminant Levels (MCLs) for drinking water. Third, a Human Intrusion Standard requires a separate assessment of the effects of human intrusion upon the resilience of the Yucca Mountain disposal system. EPA also proposes a separate storage standard that would limit doses to the general population for the pre-closure period.

EPA's proposed 15 mrem/year all-pathways IPS dose limit is extremely rigorous. DOE believes a 25 mrem/year all-pathways standard is more reasonable and fully adequate as the generally applicable standard for all nuclear facilities. The proposal does not provide a convincing rationale as to why a more stringent standard is necessary for Yucca Mountain. Accordingly, DOE believes that a 25 mrem dose limit is appropriate as the only standard necessary to protect human health and safety.

DOE is particularly concerned with the proposed GPS. While DOE supports the general goal of protecting individuals from exposures through any potential pathway including groundwater, the proposed GPS is redundant and unnecessary for the protection of public health and safety because the IPS adequately protects human health and safety without the need for another standard. The IPS fully considers exposures through all possible pathways to the hypothetical receptors, including direct exposure, drinking of contaminated water, eating food irrigated with contaminated groundwater or grown in contaminated soil, and exposure to airborne releases.

There is no specific legal requirement in Section 801 of the EnPA for EPA to promulgate a separate groundwater standard. Moreover, in fulfilling its responsibilities under the EnPA, the National Academy of Sciences (NAS) made no recommendation for a separate groundwater standard as part of their comprehensive findings and recommendations. The proposed GPS does not appropriately apply the maximum contaminant levels (MCLs) for radionuclides, which were promulgated pursuant to the Safe Drinking Water Act (SDWA) and for a different purpose. The MCLs under the SDWA apply "at the tap," after treatment, rather than to groundwater sources. Many of the radionuclides at issue for the potential repository are not specifically addressed by the MCLs. Application of the MCLs would render differing and inconsistent exposure levels depending on the radionuclide, and, in some instances, would render exposure levels that differ from the IPS. Under these circumstances, the proposal does not appear to articulate a rational basis for the proposed GPS.

DOE believes that EPA's proposed 10,000 year period of compliance is reasonable and appropriate for this site. A significantly longer time period for assessing compliance would be unprecedented, unworkable, and probably unimplementable. As discussed in EPA's preamble, there is significant uncertainty whether quantitative performance assessment can produce meaningful projections over periods of tens of thousands to hundreds of thousands of years. Further, we agree with EPA's statement in the preamble that there is no policy basis for the acceptable level of confidence necessary to determine compliance using such long-term projections.

EPA proposes two alternatives for the evaluation of impacts of human intrusion, without indicating any preference for either alternative. DOE believes that the assumed human intrusion scenario is based on a highly improbable and inherently inconsistent set of assumptions including hypothetically drilling for water from on top of a mountain above the repository through a robust waste package and then continuing to the water table. This scenario is too implausible for a quantitative dose limit to a hypothetical individual and could potentially lead to a suboptimal design or unwarranted disqualification of the site. DOE recommends rejection of this alternative.

DOE agrees that a human intrusion analysis is appropriate but recommends that the results be considered by decision makers as only an indicator of resilience of the repository rather than a "go- no go" quantitative limit. Consistent with this view, DOE believes that EPA should select the second proposed alternative.

The EnPA makes EPA responsible for establishing public health and safety standards for the Yucca Mountain site. Consistent with the statutory direction of the EnPA, EPA should adopt reasonable, site-specific standards to provide adequate protection for individuals. Some of the proposed standards, however, are unrealistic and unnecessary to protect public health and safety. EPA should reject these unrealistic and unnecessary proposed standards because they would impede the important national interest in the safe disposal of spent fuel and high-level waste, including the significant amounts that have already accumulated, without any appreciable additional protection of public health and safety.

DOE appreciates the opportunity to comment on the proposed rule. If you have questions concerning these comments or the more detailed comments that are attached, please contact me.

Sincerely,

Ronald A. Milner

for Lake H. Barrett, Acting Director
Office of Civilian Radioactive
Waste Management

Enclosures

TAB A

DOE Comments and Responses to EPA Questions Regarding Proposed Individual Protection Standard ("IPS")

I. Use of a Dose Limit versus a Risk Limit

The Energy Policy Act directs EPA to establish standards that prescribe the maximum annual effective dose equivalent to individual members of the public. NAS recommended that EPA establish a risk-based, not dose-based, standard. EPA proposes to establish a dose-based individual protection standard and requests comment on whether a risk- or dose-based approach is more appropriate, as follows:

> *EPA Specific Request for Comment # 1, p. 47010/2:*
> *The NAS recommended that we base the individual-protection standard upon risk. Consistent with this recommendation and the statutory language of the EnPA, we are proposing a standard in terms of annual CEDE incurred by individuals. Is our rationale for this aspect of our proposal reasonable?*
>
> *Related request for comment, p. 46984/3:*
> *Finally, section 801(a)(1) of the EnPA specifically calls for a dose-based standard. Most commenters supported this by asking for a dose-based standard rather than a risk-based standard. Accordingly, we are proposing a standard expressed as a limit on dose. We are requesting comments upon the proposed form of the standard, including whether the standard should be expressed as risk.*

DOE Comment:

A risk-based approach or a dose-based approach each have potential merits. However, given the current statutory framework for establishment of Yucca Mountain site standards, EPA should adopt an individual protection standard that prescribes a maximum annual effective dose equivalent.

DOE Rationale:

In considering the issues raised by this and other comments, DOE believes EPA must formulate its responses in light of its statutory authority. Specifically, section 801 of the Energy Policy Act of 1992 (EnPA) is EPA's sole source of authority for establishing public health and safety standards for the Yucca Mountain site. Section 801 is clear that these standards must be site-specific and focus on protecting public health and safety through prescribing maximum doses to individuals.

EPA correctly notes that the EnPA mandates that the standards for Yucca Mountain be expressed in terms of the updated dosimetric concept known as maximum annual "effective dose equivalent." NAS, however, recommended a risk-based standard for the Yucca Mountain site. NAS based its recommendation, in part, upon its finding that "[a] risk-based standard would not have to be revised in subsequent rulemaking if advances in scientific knowledge reveal that the dose-response relationship is different than that envisaged today." (NAS, p. 4.)

Regardless of the potential merits of a risk-based standard, the EnPA requires a standard based on the maximum annual *effective dose equivalent* to *individual members of the public* in

the accessible environment. Consequently, DOE supports a dose-based individual protection standard, as mandated by the EnPA.

II. Appropriate Level of Protection

EPA proposes an annual dose limit of 15 mrem (CEDE) and requests comment on the reasonableness of that limit. Separately, NRC has proposed a limit of 25 mrem (TEDE) in its 10 CFR Part 63 rulemaking.

> *EPA Specific Request for Comment # 2, p. 47010/2:*
> *We are proposing an annual limit of 150 uSv (15 mrem) CEDE to protect the RMEI and the general public from releases from waste disposed of in the Yucca Mountain disposal system. Is our proposed standard reasonable to protect both individuals and the general public?*
>
> *Related request for comment, p. 46985/2:*
> *In summary, based upon our review of the guidance, regulations, and standards cited above, and the NAS Report, we are proposing a standard of 150 uSv (15 mrem) CEDE/yr for the Yucca Mountain disposal system. We request comment upon the reasonableness of this level of protection.*
>
> *Related request for comment, pp. 46983/2:*
> *The storage standards in 40 CFR 191.03(a) are stated in terms of an older dose-calculation method and are set at an annual whole-body-dose limit of 25 mrem/yr. The proposed storage standards for Yucca Mountain use a modern dose-calculation method known as "committed effective dose equivalent" (CEDE). Even though today's proposal uses the modern method of dose calculation, we believe that the proposed dose level essentially maintains a similar risk level as in 40 CFR 191.03(a) at the time of its promulgation . . . The difference between these dose calculation procedures presents a problem in combining the doses for regulatory purposes. However, we have begun a rulemaking to amend both 40 CFR Parts 190 and 191. That rulemaking would update these limits to the CEDE methodology. We anticipate that we will finalize the amendments to parts 190 and 191 prior to the finalization of this rulemaking. If that does not occur, we would need to address the calculation of doses under the two methods in another fashion. For example, we could require that the doses occurring as a result of activities outside the repository be converted into annual CEDE for purposes of determining compliance with the storage standard. We request comments upon such an approach.*

DOE Comment:

DOE recommends 25 mrem (TEDE) for individual protection for the Yucca Mountain site and objects to an annual dose limit of 15 mrem (CEDE).

DOE Rationale:

As the appropriate standard for repository performance after closure, EPA should propose a limit on doses to members of the general public that is within acceptable levels. International guidance indicates that an annual dose constraint of 100 mrem from all sources of radiation, excluding background radiation, is protective of public health and safety. (NAS, pp. 40-41.) It is appropriate to limit a specific source (such as a geologic repository following closure) to a reasonable fraction of that 100 mrem/yr dose constraint, to ensure that exposure to members of the public from all sources does not exceed 100 mrem/yr.

An annual dose limit of 25 mrem expected committed effective dose equivalent, weighted by the probability of occurrence and including all potential pathways of exposure (but excluding background radiation), represents a reasonable fraction of the 100 mrem/yr dose constraint. It is also within the range of international guidance that allocates doses from high-level waste disposal to within a range of 5 to 30 mrem/yr (NAS, p. 41), and is sufficiently below the public dose limit that the public near Yucca Mountain would not be expected to receive doses from all sources, exclusive of background, in excess of 100 mrem per year. Further, 25 mrem/yr is comparable to the risk range recommended by NAS as a reasonable starting point for EPA's rulemaking. (NAS, p. 5). Consequently, a single, all-pathways standard of 25 mrem/yr would be protective of public health and safety and would obviate the need for a separate, single-pathway limit. It would also be consistent with the 25 mrem/yr dose limit that NRC has established for both decommissioning of nuclear facilities (10 CFR Part 20) and for low-level radioactive waste disposal facilities (10 CFR Part 61).

DOE is concerned that substantial portions of EPA's preamble, as reflected in the proposed standards, may provide the public an incomplete and potentially unrealistic picture of the level of risk that a dose of 15 mrem/year might pose. DOE suggests that EPA provide in the preamble to its final rule sufficient information to place these dose limits into real-life perspective. At a minimum, EPA should clearly state that the average individual exposure in the U.S. to natural background radiation is on the order of 300 mrem per year,[1] which is *twenty times* the proposed 15 mrem/yr individual protection standard EPA proposes for Yucca Mountain. Furthermore, the variation in natural background received by individuals in the U.S. can be approximately 100 mrem higher or lower than this average, due to differences in altitude and soil contents, etc., and much larger variations have been observed in other countries.

Thus, the 15 mrem/yr IPS dose limit which EPA states is necessary to protect public health and safety is dwarfed by – and would therefore play a much smaller part than – the typical American's dose from natural background radiation. EPA has not demonstrated in its proposal that regulating to a level so dramatically below natural background is "reasonable" or "site specific."

DOE would support updating 40 CFR Parts 190 and 191 to use ICRP-30/CEDE methodology for estimating doses for the purpose of comparison with a 25 mrem/yr dose limit. In addition, for estimating the doses from storage, using ICRP-30/CEDE methodology as implemented in Federal Guidance Reports No. 11 and 12 is reasonable.

DOE would also support the expression of dose limits in Total Effective Dose Equivalent (TEDE) instead of Committed Effective Dose Equivalent (CEDE). 10 CFR 20 defines TEDE "as the sum of the deep-dose equivalent (for external exposures) and the committed effective dose equivalent (for internal exposures)". Proposed 40 CFR 197.2 defines Committed Effective Dose Equivalent as the "total effective dose equivalent received by an individual from radionuclides internal to the individual following a one-year intake of those radionuclides." Because the definitions of CEDE and TEDE are not the same, it appears that EPA has introduced the term "Annual Committed Effective Dose Equivalent" in order to achieve consistency, which is confusing. It is important for the EPA standard and the implementing NRC regulations to use similar units.

[1] Americans typically are exposed to an additional 60 mrem per year from man-made exposures, primarily medical procedures.

III. Use of a Critical Group Approach versus the RMEI

NAS recommended that EPA use a probabilistic critical group approach for individual protection. EPA proposes instead that protection be assessed using a reasonably maximally exposed individual ("RMEI"). EPA requests comment on whether the proposed RMEI approach is reasonable or whether a critical group approach should instead be used:

> *EPA Specific Request for Comment # 3, p. 47010/2:*
> *To define who should be protected by the proposed individual-protection standard, we are proposing to use an RMEI as the representative of the rural-residential CG. Is our approach reasonable? Would it be more useful to have DOE calculate the average dose occurring within the rural-residential CG rather than the RMEI dose?*
>
> *Related request for comment, p. 46988/3:*
> We are also requesting comments upon the alternative of adopting the CG approach rather than the RMEI. Comments supporting the CG approach should address the level of detail EPA's rule should include on the parameters of the CG.

DOE Comment:

DOE believes that a probabilistic critical group approach is appropriate for the Yucca Mountain site. However, DOE does not object to use of a RMEI, provided that the RMEI scenarios, assumptions, and parameters are reasonable.

DOE Rationale:

The NAS recommended that EPA use a critical group concept that accounts for both the probability of exposure and the consequences of exposure. (NAS, pp. 5-6, and 49-54; and Appendix C). Consistent with those recommendations, DOE believes that a probabilistic critical group approach is appropriate for the Yucca Mountain post-closure standard.

The critical group approach to human health protection was originally developed by the International Commission on Radiological Protection (ICRP) and is used extensively in this country and elsewhere in the world. EPA recognizes the ICRP as a "bod[y] of non-governmental radiation experts." (Preamble, p. 46984/2).

The basic approach is relatively straightforward. It involves identifying a relatively homogenous population group whose living habits and location are representative of those individuals expected to receive the highest doses, and determining compliance by comparing the regulatory limits to the average dose to the members of this group. (ICRP Publications 26 (1977) and 43 (1985)).

A major reason ICRP developed this concept was to assure that assessment of compliance "should not be unduly influenced by the discovery of one or two individuals with extreme habits." (ICRP 43). To that end, the ICRP recommends use of present knowledge and cautious, but reasonable, assumptions regarding lifestyle, locations, eating habits, and other factors. (ICRP 46; NAS, p. 6). This same thought was expressed by NAS, in stating that "the appropriate objective is to protect the vast majority of members of the public while also ensuring

that the decision on the acceptability of a repository is not unduly influenced by the risks imposed on a very small number of individuals with unusual habits or sensitivities. The situation to be avoided, therefore, is an extreme case defined by unreasonable assumptions regarding the factors affecting dose and risk . . ." (NAS, p. 5). Finding the critical group approach consistent with this objective and noting that it is used extensively internationally, NAS recommended that EPA utilize this approach in the Agency's Yucca Mountain standards. (NAS, p. 52).

There is also relevant regulatory experience in this country and abroad in using a critical group approach. For example, NRC uses a critical group concept in assessing compliance with certain standards for radionuclide releases from nuclear facilities. For example, the Commission uses the critical group approach in its radiological criteria for license termination at 10 CFR Part 40, Appendix A, and 10 CFR Part 20, Subpart E, and its Part 61 guidance. In its proposed standard for Yucca Mountain, 10 CFR § 63.115, NRC specifies the use of a probabilistic farming critical group. Following the NRC lead, the critical group approach has been adopted in state regulations (*e.g.*, Texas' decommissioning standards).

As EPA notes in the preamble (pp. 46987/3–46988/1), the critical group approach is utilized extensively in other countries to protect public health and safety. For example, Canada, the European Community (EC), the United Kingdom, Switzerland, and the Czech Republic all use the critical group approach to radiation protection of the public. There is a broad international acceptance of the critical group approach for protecting public health and safety, particularly for a geologic repository.

The RMEI concept proposed by EPA is also conservative, because the probability of the individual living above the contaminated plume is assumed to be one. DOE does not object to the use of the RMEI concept, provided that the RMEI scenarios, assumptions, and parameters are reasonable. The RMEI concept, as proposed by EPA for the Yucca Mountain standard, would have DOE use surveys of people in the Amargosa Valley as a basis for diet and lifestyles. DOE supports the use of such methods to describe diet and lifestyle.

IV. Use of Current Lifestyles And Specification of Parameter Values for RMEI

EPA proposes use of current population lifestyles for the IPS and specifies two parameter values: the approximate location of the RMEI (§197.21(a)), and the daily amount of water that the RMEI drinks (§197.21(c)). EPA requests comment on this approach and whether the agency should specify values for other parameters, as follows:

> *EPA Specific Request for Comment # 4, p. 47010/2:*
> *Is it reasonable to use RME parameter values based upon characteristics of the population currently located in proximity to Yucca Mountain? Should we promulgate specific parameter values in addition to specifying the exposure scenarios?*
>
> *EPA Specific Request for Comment # 5, p. 47010/2:*
> *Is it reasonable to consider, select, and hold constant today's known and assumed attributes of the biosphere for use in projecting radiation-related effects upon the public of releases from the Yucca Mountain disposal system?*
>
> *Related request for comment, p. 46990/2:*
> *As stated earlier, the method of calculating the RME is to select average values for most parameters except one or a few which are set at their maximum, that is, high-end, values. We believe that the Lathrop Wells location and a consumption rate of two liters per day of drinking water from the plume of contamination represent high-end values for two of these factors. The Commission may identify additional parameters for which to assign high-end values in projecting the dose to the RMEI. To the extent possible, NRC should use site-specific information for any remaining factors. For example, NRC should use the most accurate projections of the amount of contaminated food that would be ingested in the future. Projections might be based upon surveys which indicate the percentage of the total diet of Amargosa Valley residents which is from food grown in the Amargosa Valley area.*
> *We particularly request comment upon whether . . .*
> *(3) Lathrop Wells and an ingestion rate of two liters per day of drinking water are appropriate high-end values for parameters to be used to project the RME.*
> *We also request comment upon the potential approaches and assumptions for the exposure scenario to be used for calculating the dose incurred by the RMEI.*

DOE Comment:

EPA should adopt its proposed approach and allow the use of current lifestyles and diet in determining the characteristics of the RMEI (or critical group). DOE should be allowed to use surveys of current residents in the Amargosa Valley as a basis for determining receptor diet and lifestyles. NRC would determine the appropriateness of these surveys.

DOE does not object to EPA specifying a parameter value of 2 L/day for drinking water consumption or a hypothetical location for the RMEI in the range of 20 to 30 km from the repository. However, other parameter values should not be specified in EPA's standards and should instead be determined during the licensing process.

DOE Rationale:

DOE agrees that it is reasonable to use critical group or RMEI parameter values based upon characteristics of the population currently located in proximity to Yucca Mountain, so long as those values are not influenced by unusual habits or sensitivities of a small number of individuals. There is national and international consensus that basing dose estimates on anything other than a reference biosphere is unduly speculative. The NAS recommended that EPA "rely on the guidance of ICRP that the critical group be defined using present-day knowledge with cautious, but reasonable, assumptions" (NAS, p. 10). It is not possible to predict future societal factors based on scientific analyses. The approach proposed by EPA fulfills the NAS recommendation "against placing the burden of postulating and defending an exposure scenario on [DOE]." (NAS, p. 10).

DOE believes that it is neither necessary nor desirable for EPA to promulgate specific parameter values. The NAS recommended "the use of assumptions that reflect current technologies and living patterns." (NAS, p. 122). As specified in the proposed rule, DOE would use surveys of people in the Amargosa Valley as a basis for diet and lifestyles. Promulgation of specific parameter values would go unnecessarily beyond NAS' recommendations and EPA's mandate to set a standard. The appropriate use and defense of these surveys should be determined in the NRC implementing regulations and during the licensing process.

While DOE agrees with the use of a reference biosphere based on the current lifestyles and diets of people in the Amargosa Valley, DOE does not object to EPA specifying the two parameter values as proposed, namely the 2 L/day drinking water consumption rate and the location of the RMEI or critical group in the range of 20 to 30 km from the repository.

V. The Proposed Location of the RMEI (or Critical Group)

EPA proposes in §197.21(a) that the RMEI be located at the intersection of U.S. Highway 95 and State Route 373, which is about 20 km from the repository. The Agency requests comment on whether this or other locations are reasonable, as follows:

> *EPA Specific Request for Comment # 6, p. 47010/2-3:*
> *In determining the location of the RMEI, we considered three geographic subareas and their associated characteristics. Are there other reasonable methods or factors which we could use to change the conclusion we reached regarding the location of the RMEI? For example, should we require an assumption that for thousands of years into the future people will live only in the same locations that people do today? Please include your rationale for your suggestions.*
>
> ***Related request for comment, p. 46990/2:***
> *As stated earlier, the method of calculating the RME is to select average values for most parameters except one or a few which are set at their maximum, that is, high-end, values. We believe that the Lathrop Wells location and a consumption rate of two liters per day of drinking water from the plume of contamination represent high-end values for two of these factors. The Commission may identify additional parameters for which to assign high-end values in projecting the dose to the RMEI. . . .*
> *We particularly request comment upon whether:*
> *(1) based upon the above criteria, there is now sufficient information for us to adequately support a choice for the RMEI location in the final rule or should we leave that determination to NRC in their licensing process based upon our criteria;*
> *(2) another location in one of the three subareas identified previously should be the location of the RMEI . . .*

DOE Comment:

DOE believes that using the 30 km location for the location of the critical group or REMI represents a cautious but reasonable assumption that is consistent with site conditions.

DOE Rationale:

DOE believes that the commercial farming scenario is sufficiently cautious and reasonable and that use of such a scenario would lead to a different determination regarding location of the RMEI or critical group (*i.e.* 30 km, where a farming community currently exists). However, DOE would not object to the use of the rural residential scenario at the 20 km location, if EPA determines that such additional conservatism is necessary and reasonable for ensuring adequate protection of public health and safety.

Locating the RMEI or critical group closer than 20 km would be unreasonable. For example, downgradient locations closer than 18 km would lie within the territorial confines of the Nevada Test Site (NTS), a heavily guarded and federally owned and restricted area that was dedicated a half-century ago by the public for use in perpetuity for this Nation's nuclear weapons development and testing. The United States Government is committed to maintain such

ownership and control of the NTS for as long as necessary. Further, if Yucca Mountain is licensed by the NRC as this Nation's permanent repository for HLW and SNF, this Nation presumably would re-dedicate in perpetuity those geologic and environmental settings within and near the NTS necessary to achieve isolation consistent with NRC technical criteria. Based on the foregoing, it is implausible and highly speculative to project a commercial farming community in such areas, and it is unjustifiable and unreasonable to base any regulatory decision on such a scenario.

Many of the reasons why a location closer than 18 km is unreasonable also apply to the area between 18 km (the NTS boundary) and EPA's proposed location of the RMEI (20 km). For example, the physical attributes of this area are similar to that of the NTS. The location for the NTS was well chosen. The NTS and the surrounding desert areas are arid, remote, exhibit rough topography, and typically have great depths to groundwater. Not surprisingly, these attributes strongly argue against speculating that a commercial farming community would locate itself closer than 20 km.

VI. Use of Either the Mean or the Median for Compliance

EPA proposes using the mean or the median, whichever is higher, of the distribution of doses for assessing compliance with the IPS. The Agency also seeks comment on whether the mean of the distribution is the appropriate basis for assessing compliance with the IPS, as follows:

> *EPA Specific Request for Comment # 9, p. 47010/3:*
> *Does our requirement that DOE and NRC determine compliance with § 197.17 based upon the mean of the distribution of the highest doses resulting from the performance assessment adequately address uncertainties associated with performance assessments?*
>
> *Related request for comment, p. 46988/3:*
> *As a result of the performance assessment, there will be a distribution of the highest potential doses incurred by the RMEI. We are proposing that the mean or median value (whichever is higher) of that distribution be used by NRC to determine compliance with the individual-protection standard. We request comments upon this method of determining compliance with the individual-protection standard.*

DOE Comment:

DOE believes that using the mean or median is an acceptable and conservative measure.

DOE Rationale:

In the type of skewed distributions represented by performance assessment results (that is, results where the extreme high doses affect the average value more than the extreme low doses), the median value is a better representation of the central tendency. However, DOE recognizes that use of the mean value, which will always be larger than the median in these types of distributions, has an established use in regulatory compliance demonstrations.

DOE believes that the uncertainties in performance assessment are best addressed by consideration of the full range of values during the licensing process. The implementing regulator should be allowed to decide, considering this full range, whether there is sufficient confidence that the mean or expected value meets the standard.

TAB B

DOE Comments and Responses to EPA Questions
Regarding Proposed
Groundwater Resource Protection Standard ("GPS")

I. Need for a Separate Groundwater Protection Standard ("GPS").

EPA acknowledges that its proposed all-pathway IPS protects public health and safety. Nonetheless, EPA singles out one of those pathways – groundwater – for a separate standard. EPA requests comment on whether a separate GPS is appropriate or whether a 25 mrem all-pathway IPS adequately protects public health and safety, as follows:

> ***EPA Specific Request for Comment # 13, p. 47010/3:***
> *Which approach for protecting ground water in the vicinity of Yucca Mountain is the most reasonable? Is there another approach which would be preferable and reasonably implementable? If so, please explain the approach, why it is preferable, and how it could be implemented.*
>
> ***EPA Specific Request for Comment #15, p. 47011/1:***
> *As noted by NAS, some countries have individual-protection limits higher than we have proposed. In addition, other Federal authorities have suggested higher individual-dose limits with no separate protection of ground water. Therefore, we request comment upon the use of an annual CEDE of 250 μSv (25 mrem) with no separate ground water protection, including the consistency of such a limit with our ground water protection policy.*
>
> ***Related request for Comment, p. 47007/1:***
> *Although we propose to find that the Yucca Mountain disposal system is not a form of underground injection in the context of the SDWA, we nevertheless consider the ground water protection principles embodied in the SDWA to be important. Therefore, while not applying all aspects of the SDWA, we are proposing ground water protection standards consistent with the levels of the radionuclide MCLs.*
>
> *We request public comment upon the proposal and the other approaches, described below, that are designed to protect ground water resources in the vicinity of the repository. We are concerned that ground water resources in the vicinity of Yucca Mountain receive adequate protection from radioactive contamination.*

DOE Comment:

While DOE supports the goal of protecting individuals from exposures through the use of groundwater resources, it believes that a single, all-pathways standard of 25 mrem/year for individual protection over 10,000 years is sufficient to protect groundwater resources in the vicinity of the potential Yucca Mountain repository because groundwater will be a principal pathway for individual exposure. A single, all-pathways standard is sufficient to protect public health and safety without the adoption of a separate GPS. A separate GPS is neither statutorily required nor necessary. Moreover, in fulfilling its responsibilities under the EnPA, the National Academy of Sciences (NAS) made no recommendation for a separate groundwater standard as part of their comprehensive findings and recommendations. If EPA nevertheless decides to include a separate GPS, it must demonstrate a rational basis for the GPS in the context of the Yucca Mountain site and the objectives of the EnPA. Further, certain alternatives in EPA's proposal could, if adopted, make the standard unreasonable and unimplementable.

DOE Rationale:

First, EPA is not required to promulgate a separate groundwater standard for Yucca Mountain. The statutory authority for public health and safety standards for Yucca Mountain is section 801(a) of the EnPA (42 U.S.C. § 10141 note). As EPA notes, section 801(a) of the EnPA calls for a dose-based individual protection standard for Yucca Mountain. (*See* Tab A, No. I.) Indeed, the statutory language goes further – it mandates that the standards for Yucca Mountain be expressed in terms of the updated dosimetric concept known as maximum annual "effective dose equivalent." Specifically, section 801(a)(1) prescribes that such standards "*shall* prescribe the maximum annual *effective dose equivalent* to *individual members of the public* from releases to the accessible environment from radioactive materials stored or disposed of in the repository. Section 801 contains no direction to establish a separate groundwater standard.

Second, for the reasons discussed in Tab A, an all-pathways IPS is fully protective of public health and safety and is consistent with NRC regulations and international guidance on radiation protection. Groundwater protection requirements are redundant and unnecessary for the protection of public health and safety because the individual protection standard fully considers exposures through all possible pathways to the hypothetical receptors, including direct exposure, drinking of contaminated water, eating food irrigated with contaminated groundwater or grown in contaminated soil, and exposure to airborne releases. As NRC has stated, application of a single, all-pathway standard is protective of public health and safety. Similarly, as EPA has determined, application of a single, all-pathways standard is protective of public health and safety. EPA's proposal to single out this pathway for an even more stringent standard ignores that the IPS protects the public from all potential pathways.

Third, the proposed groundwater protection standard is directly contrary to the NAS' findings and recommendations. NAS determined that a groundwater resource protection standard is not necessary to limit risk to individuals. In discussing the differences between its findings and recommendations for Yucca Mountain standards and EPA's 40 CFR Part 191, NAS observed that 40 CFR Part 191 contained a separate groundwater protection provision that had "the goal of protecting ground water as a resource." (NAS, p. 121.) In contrast to Part 191, NAS stated that it was making "no such recommendation" for a separate groundwater standard for the Yucca Mountain site.

Fourth, the proposed GPS does not appropriately apply the MCLs for radionuclides, which were promulgated pursuant to the Safe Drinking Water Act (SDWA) and for a different purpose. Among other things, the MCLs under the SDWA apply "at the tap," after treatment, rather than to groundwater sources. Furthermore, the MCLs are required to reflect treatment feasibility and cost; such issues are not germane to, and have not been considered for, the proposed GPS. The MCLs are generally implemented through sampling and quarterly averaging; these concepts likewise are not applicable to and not incorporated into the proposed GPS. Many of the radionuclides at issue for the potential repository are not specifically addressed by the MCLs. As aptly noted in EPA's preamble to the proposed Part 197 standards, application of the MCLs would render differing and inconsistent exposure levels depending on the radionuclide, and, in some instances would render exposure levels that differ from the IPS. Under these circumstances, the proposed GPS cannot be demonstrated to be rationally related to ensuring

adequate protection of public health and safety in the context of the Yucca Mountain site. EPA intends to require that the concentration of radionuclides within this representative volume be limited to the maximum contaminant levels (MCLs) established to regulate public water systems under the Safe Drinking Water Act (SDWA). In other words, EPA is proposing that DOE demonstrate in licensing a reasonable expectation that the repository will not itself cause the resource (the regional aquifer) to exceed the limits set forth in §197.35. EPA must demonstrate that this approach is a rational method to achieve the objectives of the EnPA.

Fifth, the proposed separate, single-pathway, groundwater standard could, depending on how it was implemented, prohibitively complicate licensing and could result in the rejection of an otherwise potentially suitable site disposal without commensurate benefit to the protection of public health and safety. (For example, there are significant technical, policy, and practical obstacles to the use of a very small representative volume, such as 10 or 120 acre feet/year, as discussed in DOE's additional comments below).

Sixth, DOE questions whether EPA's Groundwater Strategy necessarily supports all aspects of the proposed GPS for Yucca Mountain. EPA cites its Groundwater Strategy as support for its proposal to apply tap-water standards (MCLs) to groundwater 10,000 years into the future. (Preamble at 47000/3.) However, that strategy does not dictate strict, generic imposition of tap water standards for all groundwater or a demonstration of compliance with such standards for 10,000 years. In fact, that strategy is flexible and allows for consideration of site-specific factors. (EPA Groundwater Strategy, p. 5.) Moreover, the strategy reflects consideration of municipal costs and feasibility, which are not applicable to the potential Yucca Mountain repository. There has been no analysis of costs and feasibility to justify the strategy of applying tap water standards to groundwater.

II. Selection of the Representative Volume

EPA proposes 1,285 acre feet per year as the representative volume of groundwater for purposes of assessing compliance with the GPS. EPA solicits public comment on the reasonableness of this amount, as well as other alternative amounts, as follows:

> ***Un-numbered Request for Comment, p. 47001/3:***
> *At one end of a spectrum of approaches to modeling the site ground water system is the assumption that the system can be modeled based upon flow through pores over the area of total system assessments (tens of square kilometers). At the other extreme is the assumption that radionuclides are carried through fast-flow, fracture pathways in the unsaturated zone separately from uncontaminated ground water also passing through the repository footprint. Those radionuclides then are assumed to be carried through the saturated zone in fractures that allow little or no dispersion within, or mixing with, uncontaminated water in the saturated zone. This is essentially "pipe flow" from the repository to the receptor. Although the flow of ground water at the site is influenced strongly by fractures, which should be reflected in the models, we believe that it is unreasonable to assume that no mixing with uncontaminated ground water would occur along the radionuclide travel paths. We request comment upon this approach, including consideration of the practical limitations on characterizing the flow system over several or tens of square kilometers.*
>
> ***Un-numbered Request for Comment, p. 47002/2-3:***
> *We therefore request comment upon a proposed representative ground water volume and upon possible alternatives for the size of the representative volume of ground water. These alternatives are based upon variations in possible lifestyles for residents downgradient from the repository and upon current and near-term projections of population growth and land use in the area.*
>
> ***Un-numbered Request for Comment, p. 47002/3:***
> *As discussed below, it is appropriate to add 10 acre-feet per year for domestic uses resulting in 1285 acre-feet per year . . . We request comment upon whether this approach is the most appropriate representative volume of ground water, or whether other values within the ranges discussed below are more appropriate. We believe that there may be significant technical, policy, or practical obstacles with the use of either very small or very large water volumes.*
>
> ***Un-numbered Request for Comment, p.47003/2:***
> *We are requesting comment upon the use of 4,000 acre-feet as the basis for the Commission to determine compliance with an alternative which specifies this volume as representative of the ground water resource.*
>
> ***Un-numbered Request for Comment, p. 47004/1:***
> *We request public comment upon these approaches. Comments also are requested upon whether it is desirable and appropriate for us to provide more quantitative requirements for the proposed representative volume in the final standards. If so, please provide specifics.*

DOE Comment:

If EPA establishes a GPS, DOE supports the use of a representative volume for assessing compliance with that standard. DOE believes that the representative volume should be large enough so that a significant resource is protected. A volume of 4,000 acre feet/year would satisfy this criterion. DOE believes a representative volume of 4,000 acre feet/year is reasonable to protect and results in a standard that is implementable.

DOE Rationale:

If EPA decides to adopt a GPS, DOE believes the GPS must include reasonable compliance methods.

EPA has proposed a groundwater protection standard in order to ensure that the groundwater "resource" underlying the Yucca Mountain region remains protected for future use. EPA defines this resource based on a "representative volume" of annual water usage. The representative volume is defined in EPA's proposed rule as "that portion of the aquifer … within which is calculated a uniform value of radioactivity or concentration of radionuclides."

The preamble discusses a range of alternatives for a representative volume from 10 acre feet/year to 4,000 acre feet/year. DOE believes that the representative volume should define the resource that is to be protected. The resource to be protected is the amount of groundwater in the aquifer that would be *available* for use by future populations, regardless of who those persons might be and regardless of whether they actually use the groundwater and, if so, how they use it. As EPA states, the aquifer has an "estimated perennial yield" of 4,000 acre feet/year, which is "the annual sustainable quantity of water which could be removed from this sub-basin without significantly decreasing the subsequent water yield and quality in the future." (Preamble at 47003/1.)[1] Thus, a reasonable representative volume would be in an amount not less than 4,000 acre-feet/year.

This representative volume (4,000 acre feet/year) is a reasonable way to define the groundwater resource because it is "not directly linked to any specific use" and, thus, avoids the need to speculate as to future uses of the resource. For example, it avoids speculation as to the number of persons that might use the resource, the types of community(ies) in which those persons live, their lifestyle, the types of crops they might grow, the size of their farms, etc. In addition, estimates of contaminant concentrations in such a volumetric flow rate are reasonably defensible in a rigorous licensing proceeding. As EPA states, "[t]he extraordinary 10,000-year compliance period introduces unresolvable uncertainties that make this situation fundamentally different from the situations of clean-up or foreseeable, near-term potential contamination to which the strategy ordinarily applies." (Preamble at 47002/2-3.) DOE believes that a representative volume of 4,000 acre feet/year has the potential to avoid many significant technical, policy, or practical obstacles posed by the use of smaller projected water volumes.[2]

DOE believes that there are significant technical, policy, and practical obstacles to the use of a extremely small representative volume, such as 10 or 120 acre feet/year. DOE agrees with EPA that 10 acre feet/year is significantly below the limit for which credible calculations can be made, especially considering the extremely long compliance period here (10,000 years post-closure). Similarly, a representative volume of 120 acre-feet would be difficult to model

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[1] EPA also states that the aquifer "theoretically could supply drinking water for several hundred thousand people." (Preamble at 47000/2.)

[2] It is EPA's "intention . . . to develop ground water protection standards that are implementable by the NRC." (Preamble at 47001/3.) Presumably, NRC would be in the best position to determine whether a representative volume is too small to be implementable. While DOE believes that a representative volume of 4,000 acre feet/year could be implementable (assuming EPA does not select extreme alternatives for other aspects of the standards), NRC might consider that volume too small to be implementable. In that case, EPA should place great weight on NRC concerns and should select a representative volume that is large enough to be implementable in NRC's view.

with a sufficient degree of certainty for regulatory confidence and could provide the public a false sense of certainty as to the accuracy of estimated doses.

DOE is concerned that a small representative volume could inadvertently foreclose the geologic disposal option at an otherwise promising site without commensurate benefit to public health and safety. EPA should not impose criteria based upon the technological limits of repository performance and modeling capability without adequate consideration of the sustainability of those arguments in a rigorous licensing proceeding where further conservatism may be introduced into the compliance demonstration.

III. Exclusion of Background Radiation

EPA proposes excluding natural background radiation from the GPS limits for beta- and photon-emitting radionuclides, but including background for the other GPS limits. EPA requests comment on the appropriateness of including or excluding background radiation from the GPS dose limits, as follows:

> ***Un-numbered Request for Comment, p. 47004/1:***
> *We also are proposing to require that DOE combine certain estimated releases from the Yucca Mountain disposal system with the pre-existing naturally occurring or man-made radionuclides to determine the concentration in the representative volume (see Table 1 in the What should the Level of Protection Be? section earlier in this notice for particular cases). This means that the releases of radionuclides from radioactive material in the Yucca Mountain disposal system must not be allowed to cause the projected level of radioactivity at the point of compliance to exceed the limits in section 197.22 within reasonable expectation.*

DOE Comment:

In general, DOE does not believe that that the inclusion of background radiation in GPS limits is a sound risk-management policy at any site. However, if EPA establishes a GPS, DOE could accept EPA's proposal for treatment of background radiation in § 197.35, Table 1.

DOE Rationale:

DOE could accept EPA's proposal to combine estimated releases from the Yucca Mountain disposal system with the pre-existing naturally occurring or man-made radionuclides for radium 226, radium-228, and gross alpha activity to determine the concentration in the representative volume. However, DOE notes that repository performance is not related to background radionuclides. DOE agrees with EPA that the combined beta and photon emitting radionuclides should be omitted from consideration as part of the dose limit because: (1) EPA's limits in other regulatory settings, such as 40 CFR Part 141, include only manmade beta and photon emitting radionuclides, and (2) including such temporally and spatially variable radioactivity would prohibitively complicate the compliance evaluation and is technically and scientifically indefensible.

IV. Use of Limits other than Existing MCLs

If EPA revises the radionuclide MCLs prior to finalization of the GPS, EPA plans to adopt those MCLs into the final Part 197 standards. EPA solicits comment on the appropriateness of incorporating the numerical equivalent of revised MCLs into the GPS, as follows:

> ***Un-numbered Request for Comment, p. 47000/2-3:***
> *However, if those revisions to the MCLs are finalized prior to finalization of the part 197 standards, we plan to adopt those MCLs into the final part 197 standards. If part 197 is finalized first, the MCLs being proposed today would be maintained. We believe that this approach is necessary to provide stability for NRC and DOE in the licensing process. The uncertainty involved in not knowing when a change would occur and what form that change would take could delay the licensing proceeding. We request public comment upon this approach. If you do not consider the proposed approach appropriate, please provide an alternative and rationale.*

DOE Comment:

If there is a GPS in the final rule, the dose limits should be a fixed value no more stringent than those specified in Table 1 in proposed § 197.35. The dose limits should not be tied to any other rulemaking or otherwise subject to revision.

DOE Rationale:

Assuming there is a separate groundwater standard in the final rule, the dose limits in such standard should be fixed values no more stringent than those specified in Table 1 in §197.35. The dose limits should not be subject to revision before or after promulgation of the standard. Incorporating a revised MCL into the final Yucca Mountain standard or its numerical equivalent other than that proposed in Table 1 could create administrative and public confusion. It would also be counter to Congress' direction that EPA's standard be reasonable, site-specific, and necessary to limit risks to individuals.

Further, if EPA revises MCLs for radionuclides, it is statutorily required to establish new limits based upon, for example, a finding that the new limit is "feasible." Specifically, the SDWA directs EPA to establish MCL Goals at a level which "no known or anticipated adverse [health] effects . . . occur and which allows an adequate margin of safety." (42 U.S.C. § 300g-1(b)(4)(A)). Then EPA is to set MCLs as close to the Goals as "feasible," where "feasible" means "*with the use of the best* [water treatment] *technology, treatment techniques . . . available (taking cost into consideration).*" (*Id*., § 300g-1(b)(4)(D) (emphasis added).) In comparison, the EnPA reflects different purposes and requires that standards for Yucca must be site-specific. The promulgation of the drinking water MCLs did not consider the costs, benefits, or feasibility of applying the limits as standards for groundwater.

V. Applicability of the SDWA and MCLs to the Yucca Mountain Site

EPA concludes that emplacement within the repository does not constitute "underground injection" and solicits public comment on that position, as follows:

> ***Un-numbered Request for Comment, p.47006:***
> *Taken together, we believe these distinctions are sufficient to justify nonapplicability of the Class-IV well ban under the SDWA. We request comment upon our position that application of the UIC Class-IV well ban is neither legally required nor appropriate for the Yucca Mountain disposal system. Further, we will not address in this rulemaking the relevance of the Class-IV well ban to underground repositories generally.*

DOE Comment:

DOE agrees that emplacement would not constitute "underground injection" and that the SDWA, and the UIC Class-IV ban do not apply to the Yucca Mountain site.

DOE Rationale:

DOE agrees with EPA's position (preamble, pp. 47004-47007) that emplacement of HLW and SNF in a geologic repository would not constitute "underground injection" and the UIC Class-IV ban does not apply to underground repositories.

EPA previously concluded that emplacement of HLW and SNF in a geologic repository would not constitute "underground injection" and that the UIC Class-IV ban does not apply to underground repositories. For example, in the preamble to EPA's final amendments to 40 CFR Part 191 (58 FR 66398 (Dec. 20, 1993)), EPA noted that the First Circuit in *Natural Resources Defense Council v. EPA*, 824 F.2d 1258, 1270-71 (1st Cir. 1987), did not resolve the underground injection issue. The court stated only that disposal in geologic repositories would "likely" constitute underground injection. Also in that 1993 preamble, EPA reviewed the SDWA, its legislative history, and the regulations governing the UIC program and correctly concluded that underground disposal of containerized radioactive waste in a geologic repository does not constitute underground injection within the meaning of the SDWA or regulations governing the UIC program. (58 FR 66398, 66408-66411 (Dec. 20, 1993)).

Based on the statutory and regulatory provisions discussed above, the differences in the purposes of the UIC program, and the site-specific authority delegated to EPA under the EnPA, the 40 CFR section 144.13 ban against "Class IV" injection wells also does not apply to the Yucca Mountain site.[3] For example, the UIC regulations mandate minimum requirements for State programs to prevent underground injection which endangers groundwater; in contrast, EPA's proposed standards here are directed toward protecting groundwater in the accessible environment site and establishing requirements for performance of the Yucca Mountain disposal system. Moreover, the emplacement of radioactive waste in the Yucca Mountain disposal system is not a form of underground injection. Consequently, the Class-IV well ban does not apply to the Yucca Mountain disposal system. In any event, that ban is not needed here, since, as

[3] As defined in 40 CFR § 144.6(d), such wells include those wells which dispose of radioactive waste into or above a formation that contains a USDW within one-quarter (¼) mile of the well.

EPA concludes, the proposed standards achieve public health and environmental protections comparable to those of the UIC program.

VI. Compliance Distance for GPS

EPA proposes four alternative points of compliance for the GPS, and solicits comments, as follows:

> ***Un-numbered Request for Comment, p. 47009/2:***
> *However, if DOE and NRC determine that the direction of ground water flow or location of the highest concentration is different than now believed because new knowledge is available at the time of licensing, we propose to require the Department to propose to the Commission the location where the highest concentration is projected to be. Any such new point of compliance would replace the one we specify in the final rule only if it is at the same distance from the repository as the original point of compliance and is approved by the Commission. It may be moved only to account for new information regarding flow-direction or the location of the highest concentration. We believe such flexibility will enhance the quality of NRC's licensing decision and will provide greater protection of public health and the environment by taking into account the latest available information. We request comment upon this approach.*
>
> ***Un-numbered Request for Comment, p. 47010/2-3:***
> *To repeat for clarification, the conceptual difference between Alternatives 1 and 4 and Alternatives 2 and 3 is that in Alternatives 1 and 4, we will define an area surrounding the repository outside of which the ground water standards would apply, whereas for Alternatives 2 and 3, we will specify limited areas downgradient from the repository within which DOE and NRC must place the point of compliance.*
>
> *We request comment upon all of the alternatives discussed above. Commenters should address the effectiveness of these or other alternatives for protecting ground water, including consideration of site-specific characteristics and reasonable methods of implementing the alternatives.*

DOE Comment:

A reasonable compliance distance is 30 km from the repository.

DOE Rationale:

For most components of the proposed standards, EPA proposes preferred, site-specific alternatives for promulgation. However, in its groundwater standard, EPA does not state a preference among the four alternative locations where compliance could be assessed. Two of EPA's alternative compliance points are expressed in terms of their approximate distance downgradient from the repository (20 and 30 km). A third option would locate it on the outer boundary of a "controlled area," defined (as in EPA's generic Part 191 standard) to encompass no more than 100 km^2 and extend no more than 5 km in any direction from the repository footprint. A fourth option would also determine compliance at a "controlled area" boundary, but that area would be defined by the combined boundaries of the site, the 5 km area, and the NTS. This would result in the controlled area extending approximately 18 km downgradient from the repository to the current Federal land boundary.

DOE recommends the 30 km option, based on the likely location of withdrawal of a significant amount of the groundwater resource. That is, the most significant amount of the resource would be withdrawn where the water table is closest to the surface – at 30 km. DOE recognizes that EPA arrived at the 30 km option based upon the Agency's consideration of site-specific factors, as is required for a site-specific standard.

If EPA takes a "controlled area"[4] approach, EPA should provide DOE the flexibility to establish a point of compliance that is located on the boundary of a "controlled area" and that is up to 30 km from the repository footprint. The specific compliance distance and size of the controlled area would be determined by NRC based upon site-specific factors.

Obviously, the very restrictive, generic 5 km / 100 km^2 option in EPA's proposal (Alternative 1) ignores site-specific factors. In fact, in the preamble EPA acknowledges that the 5 km / 100 km^2 option "would not provide explicitly for consideration of site-specific factors in determining the size of the controlled area." EPA suggests that the generic (Part 191) 5 km controlled area "would not extend substantially beyond Yucca Mountain itself" and, thus, "would have the effect of providing natural topographic constraints on access to groundwater." (Preamble, p. 47009/3.) However, DOE believes that the 5 km option does not recognize site-specific factors that affect where groundwater is likely to be withdrawn and which are recognized in the 30 km option. Also, EPA should not limit the controlled area to 5 km because the groundwater compliance point could prevent DOE from using the entire withdrawn geologic repository system in the licensing process, if distances beyond 5 km were permanently withdrawn for a repository.

Regardless of whether it utilizes a controlled area approach to groundwater protection, EPA should clarify in the final rule that a groundwater standard would not apply to groundwater closer than the point of compliance. This would be consistent with the First Circuit's holding in *NRDC v. EPA*, where the court recognized that Congress in the NWPA anticipated that geologic disposal would inevitably lead to some groundwater contamination and that some portion of the geological setting – *i.e.* the repository system -- would be dedicated to isolation of that contamination from the general public. In other words, the groundwater within the geologic repository system is part of the dedicated geologic containment system. The NWPAA and EnPA represent a continuation of that same Congressional intent to dedicate a portion of the environment – including groundwater – as part of the repository system. By establishing a point of compliance, EPA would in effect be establishing the minimum distance between the geologic repository system boundary and the repository footprint. Of course, this would not foreclose the Nation from dedicating a larger area as part of the repository system if it so chooses.

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[4] NAS did not recommend a groundwater standard. However, it discussed the concept of a controlled area in the context of an individual protection standard. NAS found that, while defining an exclusion zone (a/k/a controlled area) serves a useful compliance assessment purpose, "*[b]eyond the repository footprint*, however, there seems to be no practical purpose for defining a larger exclusion zone for the form of the standard we recommend." (NAS, p. 104) (emphasis added). NAS' position was based, in part, on its stated concern that "there is no scientific basis for assuming that institutional controls can be maintained for more than a few centuries" or for "assuming that human activity can be prevented from occurring in an exclusion zone." (NAS, p. 104). Thus, NAS concluded there is no *scientific* basis for EPA's controlled area concept and, thus, no *scientific* reason not to require compliance with the individual protection standard within that controlled area if that is where the individual(s) would otherwise be located. However, NAS left the policy and compliance assessment decisions to EPA.

VII. Consideration of Groundwater Mixing

EPA requests comment regarding the consideration of mixing of groundwater, as follows:

EPA Specific Request for Comment # 12, p. 47010/3:
What approach is appropriate for modeling the ground water flow system downgradient from Yucca Mountain at the scale (many kilometers to tens of kilometers) necessary for dose assessments given the inherent limitations of characterizing the area? Is it reasonable to assume that there will be some degree of mixing with uncontaminated ground water along the radionuclide travel paths from the repository?

DOE Comment:

EPA's standard must allow consideration of groundwater mixing.

DOE Rationale:

DOE believes that an acceptable approach to groundwater modeling should be determined by the implementing regulator as part of its rulemaking and the licensing process. DOE agrees that the position and dimension of the plume of contamination should be determined using average hydrologic characteristics along the radionuclide travel paths. DOE not only agrees that it is reasonable to assume that mixing of uncontaminated water occurs along the radionuclide travel paths, but DOE's site characterization studies demonstrate that such mixing occurs.

VIII. Dosimetric Information And Methods

DOE Comment:

The proposed groundwater standard would utilize dosimetric information and methods published in International Commission on Radiological Protection *Publication 2* (ICRP-2). However, ICRP-2 is outdated and was specifically superceded by the more current data and methods in ICRP-30. Thus, if there is a separate groundwater standard, it should, instead, utilize ICRP-30.

DOE Rationale:

The ICRP is an international organization that draws upon a broad spectrum of expertise within the international scientific community to reach a reasonable consensus about the outcomes of exposures to radiation and develop recommendations for radiation protection. Those recommendations provide a consistent technical basis for regulatory standards world-wide. EPA recognizes the ICRP as a "bod[y] of non-governmental radiation experts." (Preamble at 46984/2.)

ICRP-2, published in 1959, included biokinetic data, metabolic models, and other information available at that time regarding the intake, retention, and effects of radionuclides in the body. In 1976, in promulgating its man-made beta-gamma emitter maximum contaminant level (MCL), EPA utilized ICRP-2. EPA acknowledged that the information in ICRP-2 was "obsolescent," but noted that "the ICRP is developing new dose models." (Background Document for National Interim Primary Drinking Water Regulations, EPA Document No. EPA-570/9-76-003, Appendix B, pp. 137-138, 152). EPA committed in that MCL rulemaking that, when ICRP published the newer data and recommendations, "the Agency will revise the [MCL] to permit the use of [those] newer data." Id. at 137-138. Those newer data and dose models were published in 1979 as ICRP-30.

In ICRP-30, the ICRP declared that because “[n]ew information on the effects of radiation on the body, on the uptake and retention of radioactive materials in body tissues and better data on radioactive decay schemes have accumulated in the intervening period [since ICRP-2 was issued in 1959] . . . those factors have made it necessary . . . to publish [ICRP-30]." (ICRP-30, Part 1, p.1). In ICRP-30, ICRP specifically stated that “[t]his report supercedes ICRP publication 2.” (ICRP-30, Part 1, cover page). Since its original publication in 1979, ICRP-30 has been periodically supplemented and updated (e.g., Supplement to Part 1 in 1979; Part 2 in 1980; Supplement to Part 2 in 1981; Part 3 and Addendum to Parts 1 and 2 in 1981; Supplement A to Part 3 in 1981; and Part 4 in 1988).

In fact, in its published proposed revisions to the radionuclide MCLs, EPA itself proposes to adopt the dosimetric methods and data in ICRP-30 into its revised MCLs (which EPA had committed to do in 1976). See Proposed Rule, 56 Fed. Reg. 33,050 (July 18, 1991). That proposed rulemaking is replete with statements of EPA's intent to use the updated science of ICRP-30. For example, EPA states that it intends to adopt, in large part, as "the bases for selecting models . . . the same as those given by the ICRP in their Publication ICRP 30." Id. at 33,054/1. EPA also indicates that it "has revised its risk assessment numbers to correspond to . . .

its RADRISK model," id. at 33,056/2, which incorporates values "taken mostly from the tabulations in ICRP Publication 30." Id. at 33078/2.

In addition, EPA expressly utilizes ICRP-30 dosimetry methods in other Agency regulations. See, e.g., EPA's CERCLA reportable quantities rulemaking, codified at 40 CFR Part 302 ("the Agency relied heavily on the health data and human intake limits published by the . . . [ICRP], particularly as reflected in its Publication 30 . . ." 54 Fed. Reg. 22524, 22530/3 (May 24, 1989)); and its radionuclide NESHAP, 40 CFR Part 61 (in adopting the effective dose equivalent (EDE) dosimetry methods, originally used in ICRP-26 and thereafter incorporated into ICRP-30, for "use[] in all the dose standards promulgated by EPA in this notice," EPA acknowledged that the "specific organ doses and the 'whole body dose'" methodology "is no longer consistent with current practices of radiation protection." 54 Fed. Reg. 51654, 51662/2 (Dec. 15, 1989)).

Other agencies also utilize ICRP-30 dosimetry methods in their regulations. For example, NRC uses ICRP-30 in its radiation protection standards at 10 CFR Part 20, see 56 Fed. Reg. 23360, 23370 (May 21, 1991) ("The amendments to part 20 in this final rule employ the ICRP-30 dose parameters." (footnote omitted)), and its emergency preparedness rule at 10 CFR Part 30, see 54 Fed. Reg. 14051, 14052 (April 7, 1989). Likewise, DOE uses it in its radiation protection regulations (e.g., 10 CFR Part 835, Appendix A, n. 2; and Appendix C) and departmental orders (e.g., Order 5400.5).

EPA also has incorporated ICRP-30 dosimetry into the Agency's radiation protection guidance to other Federal agencies. For example, on January 20, 1987, the President approved EPA's recommendations for a new "Radiation Protection Guidance to Federal Agencies for Occupational Exposure," which EPA published as Federal Guidance Report No. 11, 52 Fed. Reg. 2822 (Jan. 27, 1987). EPA intended that the guidance would

> be implemented by the various Federal agencies having regulatory responsibilities for workers . . . Federal agencies are encouraged to reference the tables in this and future editions of this Federal Guidance Report in their regulations so as to assure a uniform and continuing application of the 1987 Federal guidance.

Federal Guidance Report No. 11, Preface. In that Report, EPA stated that it was

> present[ing] values for derived guides that make use of contemporary metabolic modeling and dosimetric methods . . . The Annual Limits on Intake (ALIs) and Derived Air Concentrations (DACs) tabulated herein are numerically identical, in most cases, to those recommended by the ICRP in their Publication 30. Exceptions include values for plutonium and related elements, which are based upon information presented in ICRP Publication 48, and a few radionuclides not considered in Publication 30, for which nuclear decay data were presented in ICRP Publication 38.

Id. EPA has continued its use of ICRP-30 dosimetry methods in its Federal Guidance Report No. 12 (1993). See Federal Guidance Report No. 12, Preface, p. iii.

Indeed, EPA mandates use of Federal Guidance Report Nos. 11 and 12, and therefore ICRP-30 dosimetry methods, in parts of the proposed Part 197 other than the groundwater

standard, *i.e.* the individual protection standard and the subpart A (preclosure) requirements. Likewise, EPA mandates the use of Federal Guidance Report Nos. 11 and 12, and therefore ICRP-30 dosimetry methods, in other Agency regulations including for example the generic IPS in 40 CFR Part 191 (see, e.g., Background Information Document For Amendments to 40 CFR Part 191, EPA 402-R-93-073, pp. 5-7 (Nov. 1993)). DOE also references Federal Guidance Report Nos. 11 in its radiation protection regulations at 10 CFR Part 835 (see, e.g., 10 CFR §835.2(a) (definitions of "Annual Limit on Intake" and "Derived Air Concentration")).

In addition, NAS has recognized the need for the Yucca Mountain standard to reflect "advances in scientific knowledge" regarding "apparent dose-response relationships" and "dosimetry." (NAS, pp. 4, 64-65, and 118).

Despite this overwhelming body of recognition of the application of ICRP-30, and despite EPA's acknowledgment that ICRP-2 dosimetry is outdated, EPA continues to adhere to ICRP-2. Specifically, section 197.35, Table 1, would establish a combined beta and photon emitting radionuclide limit of 4 mrem/yr "to the whole body or any organ," which is ICRP-2 terminology, as opposed to an "effective dose equivalent" (EDE) limit based on ICRP-30).

EPA's apparent rationale for adhering to ICRP-2 is apparently based on a policy concern that the Agency mandates use of ICRP-2 dosimetry in contexts where the MCLs apply (i.e., public drinking water systems) or where EPA has imposed the numerical equivalent of the MCLs (e.g., some CERCLA site cleanups). However, a number of countervailing policy considerations exist.

For example the MCLs were created in 1976 in response to the Safe Drinking Water Act. In the 1996 SDWA amendments, Congress encouraged EPA to use new science when revising the MCLs under §1412(b)(9):

> [T]he level necessary to maintain public health protection may change as new or additional information becomes available. Where the Agency makes a determination regarding human health effects that are inconsistent with determinations on which the Administrator has relied in establishing . . . [an MCL], the Administrator is encouraged to revise the standard to reflect the more recent information.

H.R. Rep. No. 104-632, p. 31.

Further, use of the updated (and EPA-utilized) science of ICRP-30 would not conflict with the SDWA anti-backsliding provision, §1412(b)(9). That section provides that "[E]ach revision [to an MCL] shall maintain, or provide for greater, protection of the health of persons." As noted above, the SDWA, and therefore this provision, does not apply. Regardless, this site-specific standard would not constitute a revision to any MCL; the proposed limit of 4 mrem/yr effective dose equivalent would be comparable to the current MCL. Rather, only the underlying calculational methods (dosimetry) would be updated.

Nor does EPA's Groundwater Policy prohibit the use of updated science. In fact, it specifically contemplates site-specific considerations in decisions regarding protection of groundwater. See EPA Groundwater Policy at 5.

EPA's adherence to ICRP-2 is implausible in light of the use of ICRP-30 by EPA and other agencies in analogous situations. EPA has not articulated a reasonable explanation for its use of ICRP-2 in this rulemaking while it has proposed the revised methodology of ICRP-30 in other related contexts such as the proposal on revised MCLs. Failure to consider this important aspect of the groundwater standard would render any final rule "arbitrary and capricious" under current case law.

IX. Physical Dimensions and Orientation of the Representative Volume

EPA proposes DOE would have two options for determining the physical dimensions and orientation of the representative volume of groundwater for purposes of assessing compliance with the GPS. EPA solicits public comment on the reasonableness of these approaches, which it refers to as the "well-capture zone" and the "slice of the plume" approaches:

> ***Un-numbered Request for Comment, p. 47004/1:***
> *We request public comment upon these approaches. Comments also are requested upon whether it is desirable and appropriate for us to provide more quantitative requirements for the proposed representative volume in the final standards. If so, please provide specifics.*

DOE Comment:

If EPA establishes a GPS, DOE supports EPA's proposal to provide DOE with two alternatives for selection of the physical dimensions and orientation of the representative volume.

DOE Rationale:

Both approaches are reasonable and consistent with a groundwater protection demonstration during a 10,000 year compliance period, for the reasons stated by EPA in its Preamble. Further, allowing DOE the option to select the appropriate approach would provide necessary regulatory flexibility for DOE and NRC during the compliance demonstration phase.

TAB C

DOE Comments and Responses to EPA Questions
Regarding Proposed
Human Intrusion Standard ("HIS")

I. Consideration of the Consequences of Human Intrusion

EPA requests comment regarding several aspects of the consideration of human intrusion, as follows:

> ***EPA Specific Request for Comment # 10, p. 47010/3:***
> *Is the single-borehole scenario a reasonable approach to judge the resilience of the Yucca Mountain disposal system following human intrusion? Are there other reasonable scenarios which we should consider, for example, using the probability of drilling through a waste package based upon the area of the package versus the area of the repository footprint or drilling through an emplacement drift but not through a waste package? Why would your suggested scenario(s) be a better measure of the resilience of the Yucca Mountain disposal system than the proposed scenario?*
>
> ***Related request for comment, p. 46999/3:***
> *We request comment upon the reasonableness of the proposed human-intrusion scenario, and whether an approach similar to that used for WIPP is more appropriate.*
>
> ***Related request for comment, p. 47000/1:***
> *We request comment upon how much the human-intrusion analysis will add to protection of public health. Also, given current drilling practice in the vicinity of Yucca Mountain, we seek comment upon whether our proposed, stylized, human-intrusion scenario is reasonable.*
>
> ***Related request for comment, p. 47000/1:***
> *This approach has the advantage of encouraging DOE to use a robust engineered design. We request comment upon the appropriateness of using either of these alternatives.*

DOE Comment:

The results of the human intrusion analysis should be considered only as a qualitative indicator of resilience of the repository, rather than be compared to a finite limit. If Alternative 1 in the rule is not changed to eliminate any comparison to finite limit, DOE believes that Alternative 2 should be selected for the final rule.

DOE Rationale:

Recommended Approach:

The ability of the geologic repository to continue to isolate waste from the environment over the long term as a result of limited human intrusion into the engineered barrier system should be analyzed, and the results and bases of this analysis should be included in the license application. While no quantitative regulatory limit would apply to the results, the Nuclear Regulatory Commission would consider the results of this analysis as a qualitative indicator of the ability of the geologic repository to continue to perform acceptably following human intrusion.

The purpose of the human intrusion analysis should be to assess the resilience of the repository system in terms of its ability, after intrusion, to recover and continue to isolate waste from the accessible environment over the long term. The DOE's position on this issue is consistent with the stated purpose of the human intrusion recommendation in the 1995 National Academy of Sciences Report (NAS), which is "to evaluate the resilience of the repository to intrusion" (NAS, p. 109) and to "inform a qualitative judgment" (NAS, p. 111). These qualitative considerations would reflect "the key performance issue [of] whether the repository … performance would be substantially degraded" (NAS, p. 111), *i.e.*, the extent to which the repository system would heal itself.

The repository's post-intrusion performance should be satisfactory if the dose rate returns, over a reasonable period of time, to a value close to the dose rate absent human intrusion. Questions to be considered qualitatively should be: (1) Will the overall repository system be significantly compromised as a result of a single hole penetrating the system (e.g., would the drifts flood, or would the borehole become a long-term preferential pathway through the unsaturated zone to the saturated zone?), and (2) Will the repository system "heal itself" to the extent that a single borehole does not allow a significant degradation of the barriers that comprise the repository system?

Although the NAS recommended comparing the results of the intrusion to a quantitative limit, we are instead recommending the results be used as a qualitative indicator of resilience of the repository. Our position is that the assumed intrusion scenario is highly unlikely, as discussed below, and that using a highly unlikely scenario to potentially disqualify a site is inappropriate. In addition, to meet a quantitative human intrusion standard, a new design requirement would be needed in the design basis, and the design could be forced into one that is suboptimal from the standpoint of total system performance. That is, instead of providing additional protection to public health and safety, protection could be reduced.

Deviating from the NAS recommendation for a quantitative standard for policy considerations is reasonable, and the NAS recognized that policy considerations could lead to changes in how their recommendation would be implemented (NAS, p. 113). Furthermore, the NAS noted that "the value of analyses of consequences of human intrusion at Yucca Mountain is limited", because "such analyses are more meaningful in selecting among alternative sites … than in assessing the performance of a particular site and design" (NAS, p. 109).

EPA Alternatives:

EPA proposes a separate human intrusion requirement, which in Alternative 1 and potentially in Alternative 2 has the same stringent finite limits as the individual protection standard, but which would require the DOE to demonstrate compliance using a stylized scenario based on a highly improbable and inherently inconsistent set of assumptions. The highly unlikely nature of the proposed scenario limits its usefulness and makes quantitative comparisons inappropriate as a basis for an important national decision. The proposed scenario is unlikely for the following reasons.

Drilling for water, although an important resource in the region, is not likely to occur above the repository, as opposed to nearby dry washes, where the depth to groundwater is

significantly less. Also, a borehole would be unlikely to intersect a waste package, because the waste packages cover only a small proportion of the repository footprint. Further, if a waste package were intersected, the drill bit would likely be deflected off of the hard metallic engineered barrier system consisting of a drip shield and a two-layer waste package. If the drill bit were not deflected, numerous drill bits would have to be replaced to penetrate first the drip shield and then the waste package.

Should the drillers continue into the waste package, the radioactive tailings would be brought to the surface. Continued drilling would only increase the drillers' exposure to radioactive tailings, which would likely debilitate or kill them. Should replacement drillers continue the process, they would have to continue replacing drill bits to exit the waste package. Completing a drillhole from the surface through a waste package to the water table instead of abandoning the hole appears incredible during the 10,000 year regulatory period.

DOE's position is that current drilling techniques would likely not lead to waste package penetration without recognition by the drillers for at least 10,000 years, because DOE's waste packages are not likely to degrade significantly during this time. Once the drillers recognize the hazard, any further drilling into or beyond the repository becomes advertent, and the NAS recommended considering only inadvertent intrusion.

Alternative 2 effectively allows the human intrusion analysis to be used as a qualitative indicator of repository resilience if DOE demonstrates that wastes packages are not likely to degrade significantly for at least 10,000 years. If Alternative 1 in the rule is not changed to eliminate the comparison to a 15 mrem/yr limit in any case, DOE believes that Alternative 2 should be selected for the final rule.

WIPP Approach:

Using an approach similar to that used at WIPP in 40 CFR Part 194 might have one potential advantage - that the probabilities of intersecting the repository and a waste package could be based on historical drilling frequency, rather than unrealistically assumed to be probabilities of one. However, this approach has many disadvantages. For example, the WIPP criteria were based on the fact that the area surrounding WIPP had a considerable history of drilling for a proven resource, potash. In contrast, there is no evidence of the presence of mine shafts or exploratory drilling at the potential repository site. The Yucca Mountain area has a low potential for resource drilling. Further, as EPA noted in the preamble, the WIPP approach is inconsistent with the findings and recommendations of the NAS. Therefore, DOE does not believe this approach makes sense at the Yucca Mountain site.

TAB D

DOE Comments and Responses to EPA Questions Regarding Miscellaneous Issues Concerning The Proposed Yucca Mountain Standards

I. Consideration of Negligible Incremental Risk ("NIR") And Collective Dose

NAS recommended against a collective dose standard and against considering extremely low, incremental levels of dose. Consistent with NAS, EPA appropriately concludes that a collective dose standard is unnecessary. However, EPA does not propose exclusion of NIR from consideration. EPA requests comment regarding its proposed approach and any alternative approaches:

> ***EPA Specific Request for Comment # 7, p. 47010/3:***
> *The NAS suggested using an NIR level to dismiss from consideration extremely low, incremental levels of dose to individuals when considering protection of the general public. For somewhat different reasons, we are proposing to rely upon the individual-protection standard to address protection of the general population. Is this approach reasonable in the case of Yucca Mountain? If not, what is an alternative, implementable method to address collective dose and the protection of the general population?*
>
> ***Un-numbered Request for Comment, p. 46992/2:***
> *We request comment upon this approach [to protection of the general population]. Commenters who disagree with this approach should specifically address why it is inappropriate for the Yucca Mountain disposal system and make suggestions about how we might reasonably address this issue.*

DOE Comment:

DOE agrees that the individual protection standard protects the general population and renders any population/collective dose standard (and any release/containment limits) unnecessary. In view of EPA's proposal not to establish a population/collective dose standard (or a release/containment limit), DOE does not comment on EPA's proposal not to exclude NIR from consideration.

DOE Rationale:

In EnPA § 801(a)(2)(A), Congress asked NAS whether an individual-protection standard (IPS) for the Yucca Mountain site could protect the general population. In response, the NAS concluded that an IPS could protect public health and safety, given the particular characteristics of this site, provided that the public and policymakers accept the concept that an extremely small potential individual dose spread out over a large population poses a potential risk that is negligible. (NAS, pp. 7, 57). As NAS notes, individual protection standards (*e.g.*, 40 CFR Part 191) universally accept this concept. NAS refers to such a risk concept as "negligible incremental risk [or dose]." (NAS Report p. 59).

NAS considered the possible scenarios of exposure for the global population and concluded that the least unlikely scenario was the potential release of gaseous radionuclides (carbon dioxide gas containing ^{14}C) from the Yucca Mountain disposal system. (NAS, p. 7.) NAS estimated that the average dose to members of the global population under this scenario to

be extremely small -- 0.003 μSv/year (0.0003 mrem/yr) -- and equated that to an annual risk of fatal cancer (assuming the linear no-threshold hypothesis) of 1.5 in 10 billion (1.5×10^{-10}). (NAS, p. 61.) NAS concluded that such incremental doses are negligibly small, and it cited as support NCRP No. 116, entitled "Limitation of Exposure to Ionizing Radiation."

NAS also considered whether a population or collective dose/risk standard might be useful in protecting local persons in some populations outside the critical group. (NAS, pp. 61-62.) NAS concluded that, while it might theoretically be possible to calculate a dose/risk to such persons, doing so would require assumptions too arbitrary to be useful in deciding whether to accept or reject the repository site. (NAS, p. 61.)

NAS further explained that there are great uncertainties in trying to estimate or understand the radiation effects upon large populations, especially when these effects are calculated by summing extremely small individual doses among large populations. (NAS, pp. 59, 61-63.) Such uncertainties would, of course, be greater for the very long (10,000 year) compliance period being proposed by EPA and for hypothetical populations whose size, makeup, and location during those 10,000 years are currently unknown. Ultimately, NAS concluded (NAS, p. 63) that

> The resulting data for a risk assessment would become so arbitrary that no adequate decision basis would result. We therefore conclude that there is no technical basis for establishing a population-risk standard that would limit the risk to the nearby population for a Yucca Mountain repository.

NAS also considered whether a release limit (also known as a containment limit) or a population standard offered advantages over an IPS. NAS found that "a release limit for a site-specific standard does not reduce scientific complexity or uncertainty was similar. Without calculations of dose or risk [which the IPS provides], a release standard appears arbitrary." (NAS, p. 64.) NAS therefore recommended against a release or containment limit.

EPA acknowledges that the extremely low levels of individual risk and dose cited by NAS as being associated with the release of ^{14}C from Yucca Mountain are many orders of magnitude below the levels at which EPA has regulated in other circumstances. Preamble at 46991/2. Also consistent with NAS, EPA reached the conclusion, although for somewhat different reasons, that a population/collective dose limit (or a release/containment standard based on a population or collective dose) is unnecessary. In explaining its view why a population/collective dose limit (or a release limit / containment limit) is not necessary for the Yucca Mountain site, EPA notes the different considerations in developing its generic standard in 40 CFR part 191 as compared to a site-specific standard for Yucca Mountain. (Preamble, p. 46992/1.)

DOE agrees in principle with most of EPA's reasons for not proposing a collective or population dose/risk limits or a release limit or containment standard based on such a dose/risk, specifically that: (1) the NAS projection of extremely small doses to individuals resulting from air releases from Yucca Mountain; (2) estimating the number of health effects resulting from a 0.0003 mrem/yr dose rate, in addition to the dose rate from background radiation, in the general

population is uncertain and controversial; and (3) the all-pathways "individual protection standard is sufficient to protect public health based upon the unique characteristics of the area around the Yucca Mountain site" (*i.e.* the justification for a population-protection or release limit requirement, as modeled in the supporting analyses for the generic standards at 40 CFR part 191, does not apply at Yucca Mountain). (Preamble at 46991-46992.)[1]

[1] In addition, EPA proposes additional ground water protection standards that would establish specific limits that EPA represents would protect groundwater as a resource and would indirectly protect hypothetical users of groundwater. DOE addresses the unnecessary redundancy of a separate, single pathway groundwater standard elsewhere in these comments.

II. Compliance Periods

EPA proposes a 10,000 year compliance period for each standard and requests comment, as follows:

EPA Specific Request for Comment # 8, p. 47010/3:
Is our rationale for the period of compliance reasonable in light of the NAS recommendations?

EPA Specific Request for Comment # 14, pp. 47010/3 - 47011/1:
Is the 10,000-year compliance period for protecting the RMEI and ground water reasonable or should we extend the period to the time of peak dose? If we extend it, how could NRC reasonably implement the standards while recognizing the nature of the uncertainties involved in projecting the performance of the disposal system over potentially extremely long periods?

EPA Specific Request for Comment # 16, p. 47011/1:
We are proposing to require, in the individual-protection standard, that DOE must project the disposal system's performance after 10,000 years and we have specified how NRC must use those projections. Are the specified uses of the projections appropriate and adequate?

Un-numbered Request for Comment, p. 47007/3:
We request comment upon our proposal to impose the ground water protection standards during the first 10,000 years following disposal and whether we should, instead, adopt a compliance period of time-to-peak concentration (see the How Far into the Future should Compliance be projected? earlier in this notice for a discussion of time-to-peak-dose compliance period which is the basis of this concept). Commenters recommending the time-to-peak-concentration approach should address our concerns, particularly those related to implementability, as expressed above.

Un-numbered Request for Comment, p. 46993/2:
We request public comment upon two alternatives for the compliance period for the individual-protection standard. One alternative is to adopt a compliance period that is the time to peak dose within the period of geologic stability. The second alternative is to adopt a time period during which the repository must meet the disposal standards. For the reasons described below, we believe that the second alternative is preferable. Therefore, we are proposing that the peak dose within 10,000 years after disposal must comply with the individual-protection standard.

Un-numbered Request for Comment, p. 46995/1-2:
As noted earlier, NAS concluded that "there is no scientific basis for limiting the time period of the individual-risk standard to 10,000 years or any other value." Nevertheless, there is still considerable uncertainty as to whether current modeling capability allows development and validation of computer models that will provide sufficiently meaningful projections over a time frame up to tens-of-thousands to hundreds-of-thousands of years. . . . In light of the cumulative uncertainty for calculations over an extremely long time, it may be more appropriate to consider, in a regulatory decisionmaking, assessments of disposal system performance over such time in a qualitative manner. We request comments upon the reasonableness of adopting the NAS-recommended compliance period or some other approach in lieu of the 10,000-year compliance period which we favor and describe below. We also seek comment upon whether the NAS-recommended compliance period can be implemented in a reasonable manner and how that could be done.

Un-numbered Request for Comment, p. 46996/2:
Thus, we request comment upon our proposal of a 10,000-year compliance period to judge compliance with proposed § 197.20 and our proposal to require consideration of the peak dose, using performance assessments, if it occurs after 10,000 years. Again, after 10,000 years, we would not require the calculated level to comply with a specific numerical standard but we would

require its consideration as an indicator of longer-term performance and be included in the EIS for Yucca Mountain.
We also request comment upon the appropriateness of a 10,000-year compliance period for the individual-protection standard. Commenters should address the issues that we should consider in determining the appropriate compliance period. We also specifically request comments upon whether the NAS's recommendation of the time to peak dose within the period of geologic stability can be implemented reasonably and, if so, how that could be done.

DOE Comment:

DOE agrees that the regulatory periods of compliance should be 10,000 years. Further, DOE agrees the Final Environmental Impact Statement (FEIS) should present calculations on post-10,000 year performance based on the best information available to DOE at the time the FEIS is being prepared, including the current understanding of a repository design and the current versions of performance assessment models.

DOE Rationale:

While NAS recommended a peak dose compliance period, NAS acknowledged that its recommendation was based solely on technical considerations and did not reflect regulatory or policy concerns that may mitigate against such an extended period. (NAS, p. 56). EPA has the discretion to promulgate a standard using a different period, such as 10,000 years, based on technical considerations and considerations of legal authority, policy, and administrative implementability.

As discussed in EPA's preamble, there is significant uncertainty whether quantitative performance assessment can produce meaningful projections over periods of tens of thousands to hundreds of thousands of years. Arbitrary assumptions about long-term climate change, particularly extensive glaciation, reduce the value of the projections for compliance purposes. Also, using biosphere assumptions based on today's conditions make projections far beyond 10,000 years questionable, because significant biosphere changes, even human evolutionary changes, are likely. Further, there is no policy basis for the acceptable level of confidence necessary to determine compliance using such long-term projections. Using a period of compliance of 10,000 years is also consistent with policy established in the generic radiological protection standards for geologic repositories, 40 CFR Part 191, and with NRC's proposed approach for its technical criteria at 10 CFR Part 63. Further, a similar 10,000 compliance period has been judicially upheld as being "rational, technologically based and within the Agency's discretion." *NRDC v. EPA*, 824 F.2d 1258, 1292-1293 (1st Cir., 1987).

DOE agrees that the analysis of peak dose beyond 10,000 years should be a part of the public record. Including this analysis in the environmental impact statement is an appropriate method to present the analysis and allow the public to comment on it. DOE agrees that this analysis should not be used to determine compliance with the standard. The results should serve only as an indicator of long-term performance of the repository, and decisionmakers could use the results as one source of information, taking into account the limited basis of the analysis.

The analysis of peak dose beyond 10,000 years is to be used only as an indicator of long-term performance and not as a quantitative measure of compliance. In addition, the FEIS must be prepared well before the license application (LA) in order to be available for consideration in making a decision whether to recommend the site for development as a repository. Therefore, it is neither necessary nor reasonable to expect the FEIS to evaluate the exact design or use the performance assessment model version that will exist at the time the LA is submitted. It also would be unnecessary to update the FEIS calculations at the time of LA submittal unless significant differences from the estimated impacts presented in the FEIS were anticipated.

To clarify the rule with respect to the 10,000 year period, DOE recommends in the section on what other projections must be made by DOE (§197.30), and the human intrusion standard (Alternative 2, 197.25(b)), add the following sentence: "The environmental impact statement calculations will be based on DOE's understanding of a repository design and the versions of performance assessment models available at the time the Final Environmental Impact Statement is being prepared.

III. Need For A New Subpart A

EPA proposes that the Yucca Mountain standard for storage apply to a combination of storage aboveground and in the repository, and that subpart A of 40 CFR Part 191 continue to apply to storage aboveground. Because the EnPA of 1992 calls for EPA to develop a standard for radioactive material "stored or disposed of in the repository" and does not specify aboveground storage, EPA requests comments on Subpart A applying to aboveground storage.

> ***Un-numbered Request for Comment, p. 46984/1:***
> *We request comment upon our proposed interpretation that section 801 of the EnPA directs us to develop new standards that apply only to radioactive materials stored in the repository. We also request public comment upon whether we should instead construe section 801 of the EnPA as providing for the establishment of new storage standards, rather than applying the existing storage standards in 40 CFR part 191 to storage, or handling, of radioactive materials at the Yucca Mountain site prior to their movement into the repository. If we decide, based upon the alternative interpretation of section 801, to promulgate new storage standards for the site, we anticipate that we would adopt standards essentially the same as those in 40 CFR 191.03(a). Thus, we request public comment upon whether we should develop and adopt in this rulemaking, under section 801 of the EnPA, new standards for management and storage activities at the site, and request comments upon the adoption of such standards based upon those in 40 CFR 191.03(a).*

DOE Comment:

DOE agrees that EPA should develop and adopt in this rulemaking, under section 801 of the EnPA, new standards for management and storage activities at Yucca Mountain. DOE supports an interpretation of the EnPA that Subpart A, 40 CFR Part 197, should apply to storage at the repository, whether aboveground or in the repository, and that 40 CFR §191.03(a) would not apply to storage at the repository. DOE, believes, however that the dose from storage aboveground should be limited to 25 mrem/year, consistent with NRC's 10 CFR Part 72 and proposed 10 CFR Part 63.

DOE Rationale:

A revision to Subpart A of Part 197 to make it the only standard applicable to storage aboveground and in the repository is appropriate because the EnPA directs EPA to develop Yucca Mountain site-specific standards. Consistent with the EnPA, 40 CFR Part 197 should be the only radiation protection standard that applies to Yucca Mountain. Consistent with 40 CFR Part 197 being the only standard that applies to Yucca Mountain, 40 CFR §191.03(a) should not apply as the standard for storage. EPA's rulemaking for Yucca Mountain standards is an efficient way to avoid using two different rules at the same site in determining compliance.

As proposed, Subpart A would adequately protect public health and safety as it would combine the doses from storage aboveground and in the repository into one standard. This combination of doses, limited to 15 mrem/year CEDE, effectively limits the dose from storage aboveground to less than 15 mrem/year, making Subpart A of 40 CFR 191 (40 CFR §191.03(a)) unnecessary. DOE, believes, however that the dose from storage aboveground should be limited

to 25 mrem/year, consistent with NRC's 10 CFR Part 72 and proposed 10 CFR Part 63.Also, revising Subpart A of Part 197 to be the only applicable standard would avoid the need to utilize the older dose methodology of 40 CFR §191.03(a).

IV. Use of Bounding Analyses

EPA proposes that geologic, hydrologic, and climatic conditions vary within reasonable bounds and requests comments, as follows:

> ***Un-numbered Request for Comment, p. 46993:***
> *In concert with the NAS Report, we also propose not to allow the assumption that conditions in the future will be the same as present conditions for geologic, hydrologic, and climatic conditions. We are proposing this because we believe the parameter values in the performance assessment which relate to these conditions can be reasonably bounded. We propose to require that these conditions be varied within reasonable bounds over the compliance period and request comment upon this proposed approach.*

DOE Comment:

DOE agrees that geologic, hydrologic, and climatic conditions should vary within reasonable bounds for the performance assessment and that the biosphere assumptions should be fixed through rulemaking.

DOE Rationale:

Allowing the geologic, hydrologic, and climatic conditions to vary within reasonable bounds, based on the record of the recent geologic past, is a sound approach that is conservative and protective of public health and safety. This assumption is also consistent with the recommendations of the NAS.

Fixing the characteristics of the biosphere through rulemaking is desirable because projecting biosphere conditions necessitates making assumptions that are very uncertain, may not be boundable, and do not have a scientific basis. Fixing the assumptions is also consistent with the recommendations of the NAS.

V. Unlikely Natural Events

EPA proposes to base the probability of natural events and processes on the geologic record and to exclude unlikely or very unlikely events and processes from certain performance assessment. EPA requests comments, as follows:

> ***Un-numbered Request for Comment, p. 46997/1:***
> *A related issue upon which we request comment is if there is a period of the geologic record which we should require DOE and NRC to use to calculate the probability of processes and events occurring. The probability of a geologic event, such as an earthquake, occurring in the future typically comes from evidence of previous events which is preserved in, and can be dated by using, the geologic record. We believe that the geologic record is best preserved in the relatively recent past . . .*
> *We are proposing to allow the exclusion of unlikely natural events from both the ground water and human-intrusion assessments. The approach for the ground water protection requirements is consistent with subpart C of 40 CFR part 191 . . . while the approach for the human-intrusion assessment is consistent with the NAS recommendation . . . We request public comment upon whether this approach is appropriate for Yucca Mountain.*

DOE Comment:

DOE agrees on the appropriateness of using the record of the recent geologic past and requests clarification on the exclusion of unlikely or very unlikely events and processes.

DOE Rationale:

Use of the geologic record:

DOE agrees with EPA's conclusion that the geologic record is best preserved in the relatively recent past. DOE believes that probabilities of processes and events for the 10,000 year period of compliance should be calculated based on this record because this record is likely to be representative of processes and events for the next 10,000 years.

Unlikely vs. very unlikely events and processes:

EPA's proposal distinguishes between unlikely events and processes and very unlikely events and processes, but the purpose and use of this distinction is unclear. EPA proposes to exclude very unlikely events and processes (i.e., those with a likelihood of occurrence of less than 10^{-4} in 10,000 years) from performance assessments for the individual protection, groundwater protection, and human intrusion standards (Preamble, p. 46996). In addition, EPA proposes to exclude unlikely natural events and processes from the groundwater and human intrusion standards (Preamble, p. 46997), but not from the individual protection standard (Preamble, p. 46999).

However, the proposed rule uses "undisturbed performance" to mean exclusion of unlikely events and processes (as opposed to only very unlikely events and processes) and applies the modifier "undisturbed" to both individual and groundwater protection standards.

Thus is it is unclear:

(1) Whether performance assessments for groundwater protection (and human intrusion) exclude additional natural events and processes compared to that for the individual protection standard, and

(2) What the extent of the additional exclusion is.

DOE recommends that EPA clarify the exclusion of unlikely or very unlikely events and processes. DOE further recommends that the same exclusion of unlikely events and processes and very unlikely events and processes be used for all three standards and that the rule be clarified in this respect.

VI. Expert Elicitation

EPA requests comments on whether it should specify expert elicitation guidelines, as follows:

> ***Un-numbered Request for Comment, p. 46997/3:***
> *We request comment upon whether it is appropriate for us to set guidelines for the use of expert opinion in this standard and, if so, what those guidelines should be.*

DOE Comment:

EPA should not include specific requirements for expert elicitation.

DOE Rationale:

Expert judgment is information provided by a technical expert in his or her subject matter area of expertise, based on opinion or on a belief based on available technical data, theory and reasoning. Typically obtained informally from one expert, expert judgment is accepted, for review, by decision makers in a myriad of formal proceedings. In some instances, the expert judgment of a group of experts is elicited through a formal, highly structured, and well-documented process known as expert elicitation. However, most expert judgments are not formally elicited.

Whether expert elicitation, instead of expert judgment, is warranted depends on the issue under consideration. A well-defined area of expertise does not require a formal expert elicitation to resolve differing expert opinions. One expert is competent to testify. However, where adequate field or experimental data are not reasonably available or where it is not practical to perform additional theoretical analyses, it may be appropriate to obtain the expert opinion of multiple experts.

DOE should have the flexibility to determine whether the costs and benefits of performing an expert elicitation are advantageous compared with the costs and benefits of gathering more data and/or performing additional theoretical analyses. NRC would then review that DOE determination as part of the NRC compliance determination.

DOE believes that if specific guidelines are established for expert elicitations, those guidelines should be determined by the implementing regulator. NRC, the implementing regulator at Yucca Mountain, has a tradition of reviewing expert judgment in licensing proceedings. Indeed, for the high-level radioactive waste program, the NRC Staff already has developed guidance for those instances where DOE formally elicits expert judgment. See *Branch Technical Position on the Use of Expert Elicitation in the High-Level Radioactive Waste Program, NUREG-1563 (November 1996).* This guidance builds upon two earlier NRC documents: *Elicitation and Use of Expert Judgment in Performance Assessment for High-Level Radioactive Waste Repositories*, *NUREG/CR-5411* (May 1990); and *Qualification of Existing*

Data for High-Level Nuclear Waste Repositories, Generic Technical Position, NUREG-1298 (February 1988).

VII. Assurance Requirements

EPA considered setting assurance requirements but did not propose any. EPA solicits comments on this approach, as follows:

> ***Un-numbered Request for Comment, p. 46998/2:***
> *We request comment upon whether it is appropriate for us to establish assurance requirements in 40 CFR part 197, and if so, what those requirements should be.*

DOE Comment:

DOE agrees that EPA should not establish assurance requirements in 40 CFR Part 197.

DOE Rationale:

As EPA notes (Preamble at 46998/2-3), the Agency previously exempted NRC-regulated facilities from the assurance requirements in 40 CFR Part 191 because NRC had similar provisions in its 10 CFR Part 60 standards. The scope of NRC's risk-informed performance-based regulation in proposed 10 CFR 63 addresses topics similar to those that would be potential subjects for assurance requirements. These include multiple barriers, active and passive institutional controls, performance confirmation and post closure monitoring, retrieval, and site characteristics (including human interference) that could adversely affect performance. Proposed 40 CFR 197 and 10 CFR 63, together, provide adequate "confidence" that the licensed repository at Yucca Mountain will function as required without the imposition of redundant assurance requirements.

Also, the assurance requirements should not be included in 40 CFR Part 197 because they are matters of implementation. The assurance requirements in 40 CFR Part 191 expressly did not apply to facilities regulated by the Commission, and likewise are not needed in Part 197.

Further, the purposes for the assurance requirements in 40 CFR Part 191 do not apply to the Yucca Mountain site. The Part 191 assurance requirements were included to provide confidence EPA believed were needed for long-term compliance with the containment requirements (40 CFR §191.13), not the individual protection requirements (40 CFR §191.15) nor the groundwater protection standards (40 CFR §191.24). Because EPA does not propose similar containment requirements in 40 CFR Part 197, similar assurance requirements are not needed here.

VIII. ALARA

NAS concluded that "that there is no scientific basis for incorporating the ALARA [as low as reasonably achievable] principle into the EPA standard or USNRC [U.S. Nuclear Regulatory Commission] regulations for the repository." (NAS, p. 13.) Consistent with that recommendation, EPA does not propose to incorporate any ALARA requirements into its Yucca Mountain standards.

DOE Comment:

DOE agrees with NAS' finding and recommendation, and EPA's proposal, that ALARA not be included in the EPA standard.

DOE Rationale:

NAS found that ALARA's "applicability to geologic disposal of high-level waste is limited at best" and that "the difficulties of demonstrating technical or legal compliance with any such requirement for the post-closure phase could well prove insuperable even if it were restricted to engineering and design issues." On that basis, NAS concluded that "that there is no scientific basis for incorporating the ALARA [as low as reasonably achievable] principle into the EPA standard or USNRC [U.S. Nuclear Regulatory Commission] regulations for the repository." (NAS, p. 13.) DOE agrees with NAS's findings and recommendations regarding ALARA, and supports EPA proposal not to incorporate ALARA into its standards.

IX. Intergenerational Equity

EPA proposes that the risks to future generations should be no greater than the risks considered acceptable at the present and requests comments, as follows:

> ***EPA Specific Request for Comment # 11, p. 47010/3:***
> *Is it reasonable to expect that the risks to future generations be no greater than the risks judged acceptable today?*

DOE Comment:

DOE agrees that current generations have a responsibility to future generations and that the issue of intergenerational equity is a matter for EPA to consider in the context of this rulemaking.

DOE Rationale:

The issue of how much risk should be imposed on future generations is a question of fairness, resource allocation and equity. In considering this issue, NAS stated that "whether and how best to be fair to future generations is an important societal question --- In drafting standards, EPA should as a matter of policy address whether future generations should have less, greater, or equivalent protection." (NAS, pg.56.) DOE agrees that current generations have a responsibility to future generations and that the issue of intergenerational equity is a matter to be considered in the context of this rulemaking.

Many factors needing consideration to determine the equity of risk limits to future generations were addressed in a report by a panel of the National Academy of Public Administration entitled "Deciding for the Future: Balancing Risks, Costs, and Benefits Fairly Across Generations." (June 1997.)

DOE agrees that current generations have a responsibility to future generations and that the issue of intergenerational equity is a matter for EPA to consider in the context of this rulemaking. For reasons discussed elsewhere in these comments, DOE believes that the proposed all-pathways individual protection standard is sufficiently conservative and would protect the public health and safety of future generations.

X. Level of confidence (§ 194.14)

EPA proposes that the level of confidence needed to assess compliance for postclosure performance be based on the concept of reasonable expectation, which is said to be less stringent than NRC's concept of reasonable assurance.

DOE Comment:

The level of confidence adopted in the final standards must take into account the inherent uncertainties in assessing compliance for a long-term repository.

DOE Rationale:

DOE agrees with EPA that the appropriate level of confidence needed for compliance is less than absolute proof because absolute proof is impossible to attain due to the uncertainty of projecting long-term performance. DOE also agrees that compliance should take into account the inherent uncertainties in making long-term projections.

In the proposed 10 CFR §63.101 for Yucca Mountain, NRC has also stated it is not expected that complete assurance can be presented. DOE agrees with NRC that proof for postclosure performance is not to be had in the ordinary sense of the word because of the uncertainties inherent in the understanding of the evolution of the geologic setting, biosphere, and engineered barrier system. NRC stated that allowance would be made for the uncertainties involved.

Whether the standard for level of confidence is reasonable assurance or reasonable expectation, that standard and its implementation should reflect the inherent uncertainties in the assessment of long-term repository performance and compliance.

XI. Use of Backfill

EPA uses language in the proposed rule and the preamble that inappropriately requires DOE to use backfill when closing the repository.

DOE Comment:

DOE recommends that reference to the use of backfill be eliminated in the final rule.

DOE Rationale:

The determination of whether backfill would be used should depend on factors involving performance and implementation. The decision will depend on how the design evolves and would appropriately be made during later stages of the design evolution. DOE believes that the radiological protection standards for a repository should not require backfill, because the benefit of backfill in protecting public health and safety has not yet been determined. DOE recommends that reference to the use of backfill be eliminated for the final rule.

DOE recommends that reference to the use of backfill be eliminated in the definition of "disposal" in §197.12, by eliminating the words "backfilled and" from the following:

> Disposal … begins when all the ramps and other openings into the Yucca Mountain repository are closed and ~~*backfilled and*~~ sealed.

XII. Groundwater Flow

EPA uses language in the preamble of the proposed rule with regard to the direction of groundwater flow that is not internally consistent and appears to differ from the direction as documented by the DOE.

DOE Comment:

EPA should clarify what is meant by regional ground water flow and the direction of ground water flow from the potential repository to the location of the CG or RMEI.

DOE Rationale:

On p. 46980/1, the preamble states, "Regional ground water in the vicinity of Yucca Mountain is believed to flow generally in a south-southwesterly direction." While this may be accurate on the scale of the Death Valley Region (CRWMS M&O 1998, Figure 5.2-3), the ground water flow from Yucca Mountain to the community of Amargosa Valley (Lathrop Wells) appears to be east, then southeast (CRWMS M&O 1998, Figures 5.3-228 through 5.3-232). EPA should clarify this discussion so that the direction of groundwater flow to the location of the CG or RMEI is described in a way that is consistent with the available data. This comment also applies to language on p. 46989/3, 47008/3 and 47009/1. A discussion on p. 47008/3 also refers to ground water flow in "an easterly direction."

XIII. Definition of Storage

EPA's proposed storage standard addresses operations at the Yucca Mountain site without distinguishing between operations for anticipated, normal events and unanticipated, unlikely events.

DOE Comment:

The DOE recommends the addition of the word "normal" to the description of operations (40 CFR 197.3): "DOE must demonstrate to NRC that normal operations on the Yucca Mountain site will occur in compliance with this subpart".

DOE Rationale:

The Subpart A storage standard (15mrem CEDE) when implemented by the NRC in 10 CFR 63 should address only normal operations and Category I Design Basis Events (that is, anticipated events) but not to Category II Design Bases Events (that is, unlikely events). Category II events were addressed separately by NRC in a 1996 revision to 10 CFR 60, which has been incorporated into the proposed 10 CFR 63. The DOE-proposed change will ensure that the misapplication of the 15mrem limit (for normal operations) to Category II design basis events does not occur.

TAB E

DOE Comments on the Background Information Document for 40 CFR 197

DOE Comments on

Background Information Document (BID) for 40 CFR 197

The comments that follow are in two groups according to DOE's perception of their importance. Within each group, the comments are ordered in the same manner as the referenced text is ordered in the Environmental Protection Agency (EPA) Background Information Document.

Group 1: Technical errors or omissions that, in DOE's judgment, could impact the technical underpinning or justification for EPA's conclusions or position, or are inconsistent with DOE's current understanding of the science or DOE's current approach to performance assessment.

Comment 1. DOE recommends that the discussion on page 3-2, second & third paragraphs, be replaced with the following text, or similar:

> **"The geohydrologic features of the Yucca Mountain site, and the fact that most of the spent fuel has not been reprocessed and is hot, allow the use of a thermal loading strategy in which heat emissions can deter water from contacting waste packages for an extended period of time. The combination makes Yucca Mountain unique in comparison with the options available in other parts of the world.**
>
> **Other countries are generally contemplating colder repositories for reprocessed spent fuel in strata that are saturated with moisture, and thus must contemplate longer-term corrosive contact between water and waste packages.**
>
> **All countries, including the United States have evolved toward using more robust engineered barrier systems to compensate for the uncertainties in predicting the performance of natural barriers."**

Rationale: Both the unique features of Yucca Mountain and the high heat-generation rate of the waste contribute to keeping the area around the waste packages dry. Many other countries have employed reprocessing to remove the fission products from the transuranics, and the resulting waste has a much lower heat rate per unit volume. Also, the existing text inappropriately implies that other countries are placing a greater emphasis on engineered barrier systems than is the United States. DOE's engineered barrier systems will play a key role in waste isolation at Yucca Mountain.

Comment 2. DOE recommends that the 1st sentence in the 4th paragraph in section 4.3.2 be deleted.

Rationale: The sentence is unclear and potentially misleading relative to the resolution status of the U.S. Nuclear Regulatory Commission (NRC) igneous activity and structural deformation key technical issues (KTI). The status of the KTI/Issue Resolution Status Reports program is complex when subissues are considered. The fact that DOE and the NRC are working towards the resolution of the KTIs is adequately addressed in the remainder of the discussion.

Comment 3. DOE recommends that the abbreviation "MTIHM" be revised throughout chapter 5 (and elsewhere in the BID as applicable) to "MTHM." Assuming the updated data from the DOE Draft Environmental Impact Statement (DEIS) are used in the chapter as recommended in a subsequent DOE comment, use of MTIHM as described in the first sentence in section 5.2.1 and the accompanying footnote is unnecessary.

Rationale: "MTIHM" should not be used as it is the initial before-burnup value, whereas the numbers appropriate for chapter 5 are after-burnup values. These "after-burnup" values better represent the material being sent to the repository.

Comment 4. DOE recommends that the 3rd sentence in the 1st paragraph of section 5.1 be revised to read "The waste inventories cited are from sources of Federal Government…" DOE also recommends that Chapter 5 of the BID be reviewed in detail, and revised as necessary to reflect the most recent data. Specifically, DOE recommends that the following references be utilized throughout Chapter 5 instead of the outdated references in the existing text:

- **DOE 1999. *Draft Environmental Impact Statement for a Geologic Repository for the Disposal of Spent Nuclear Fuel and High-Level Radioactive Waste at Yucca Mountain, Nye County, Nevada,* DOE/EIS-0250D, July 1999. Appendix A. (DEIS). ACC: MOL.19990816.0240.**

- **DOE 1996. *Integrated Data Base for 1996: U.S. Spent Nuclear Fuel and Radioactive Waste Inventories, Projections and Characteristics*. DOE/RW-0006, Rev. 13, 1997.**

Rationale: The most current references do not appear to have been used for the development of Chapter 5. They are not the "most recent and reliable sources," as stated in section 5.1. Use of these sources has resulted in some discrepancies in cited characteristics of the waste inventory. Revision 13 of DOE/RW-0006 was used as a primary reference for the Repository DEIS, but Revision 12 was used for Chapter 5 of the BID.

Comment 5. DOE recommends that the 3rd sentence under "Hanford Site" in section 5.2.2 be revised by adding the phrase "by heavy metal mass" after "…1 percent…"

Rationale: If "1 percent" is used, it should be specified as "by heavy metal mass." Sometimes these percentages are stated by volume instead of MTHM, and there is a big difference in the result.

Comment 6. DOE recommends that the 2nd sentence in the 1st paragraph of section 5.4 be revised to read: "About 4667 MTHM of vitrified high-level waste and 2333 MTHM of DOE spent nuclear fuel represent the balance of the total repository inventory."

Rationale: Comment reflects actual DOE SNF and HLW repository allocation.

Comment 7. DOE recommends that chapter 6 or other appropriate chapter of the BID include additional information that was used or relied upon to support the difference in numerical values between the 25-mrem dose standard contained in 40 CFR 191 (1985) and the 15-mrem dose standard proposed in 40 CFR Part 197.

Rationale: Page 10-3, last paragraph, states that the 25 mrem/yr (whole body) [or 75 mrem/yr (thyroid)] limits, established in 40 CFR Part 191, are "roughly equivalent" to a 10 mrem/yr limit under the current effective dose equivalent (EDE) protection concept. A review of the BID,

including Chapter 6, revealed no information that explains how EPA arrived at the conclusion that 25 mrem is roughly equivalent to 10 mrem EDE.

In its Proposed Action, EPA states its conclusion slightly differently: "We estimate that the 25-mrem/yr, whole-body dose limit established in 1985 is essentially equivalent to the risk associated with today's proposed limit of 150 microSv (15 mrem) CEDE/yr."

Dose and risk can be correlated through use of a risk coefficient. Therefore, if the risk associated with the 25-mrem, whole body standard (40 CFR Part 191, promulgated in 1985) is the same as the risk posed by the 15-mrem CEDE standard, the basis for the numerical difference in the dose numbers must lie in the difference in risk coefficient factor used previously (1985) as opposed to that used currently. However, EPA provides no discussion or information regarding the possible differences in the risk coefficients. Chapter 6 touches on radiation effects issues, but it has omitted specific information that directly relates to the possible changes in relevant risk coefficients.

Comment 8. In the 2nd paragraph, last sentence on page 7-10, DOE recommends that the phrase "basaltic eruptive centers formed in the basins adjacent to Yucca Mountain perhaps as recently as 4,000 years ago" be changed to "relatively few basaltic eruptive centers formed in the basins adjacent to Yucca Mountain as recently as 4,000 years ago and subsequent basaltic eruptive centers formed in the basins adjacent to Yucca Mountain over 75,000 years ago."

Rationale: The existing text puts the age of local volcanism somewhat out of context. Most of the basaltic eruptive centers are older than 75,000 years. The 4,000-year figure refers only to the youngest deposits of the single Lathrop Wells volcanic center, and these deposits are very minor in their distribution. Most of the Lathrop Wells volcanic center is 75,000 years old or older.

Comment 9. DOE recommends that the phrase "from 500 million to less than 400,000 years." be changed to "from over 500 million years old to 10,000 years old" in the 1st sentence of the 4th paragraph on page 7-10.

Rationale: The Precambrian started 570 million years ago, and the Holocene extends to the present time.

Comment 10. DOE recommends that the 3rd paragraph on page 7-50 be deleted and replaced with a statement giving the results of the Total System Performance Assessment – Viability Assessment (TSPA-VA) igneous activity analyses.

Rationale: The TSPA-VA igneous activity analyses have now been completed, and the results summarizing the probabilities of igneous events should be presented here.

Comment 11. DOE recommends that the phrase "Beneath Yucca Mountain, the water table is within or just above the Calico Hills interval…" in the 2nd sentence of the 3rd paragraph on page 7-89 be changed to " Beneath Yucca Mountain, the water table is primarily below the Calico Hills interval…"

Rationale: Directly beneath Yucca Mountain, the water table occurs either within the Calico Hills unit or in the underlying Crater Flat Tuff unit (as shown in Figure 7-19, and page 7-82, 3rd paragraph, 2nd sentence). The water table does not occur above the Calico Hills unit beneath Yucca Mountain itself. Incorrect placement of the water table above the Calico Hills could have a significant effect on estimated unsaturated and saturated zone radionuclide transport times.

Comment 12. DOE recommends that the 5th sentence in the 2nd full paragraph on page 7-159 be revised to state: "Uncertainty in the corrosion rate of Alloy 22 (corrosion resistant barrier for the waste package) was also modeled. Uncertainty in waste package manufacturing defects was also addressed, and as a result, the model used for this TSPA assumed for the base case that a single juvenile waste package failure occurs 1000 years after disposal."

Rationale: Existing text states that uncertainty in the Alloy 22 corrosion rate was the cause of the single juvenile failure in the waste package, which is not correct. Uncertainty in waste package manufacturing defects, particularly weld defects, was the basis of the 1 in 1000-year juvenile failure rate for TSPA-VA. The corrosion rate of Alloy 22 is not a factor impacting waste package juvenile failures (Viability Assessment, Volume 3, Section 3.4.1.4, page 3-81).

Comment 13. In the 3rd full paragraph on page 7-180, DOE recommends inserting the word "past" before "near-field coupling" in the first sentence and adding the following sentences at the end of the paragraph. "In the Viability Assessment, the drift seepage model was based on ambient conditions and was not coupled to the thermal model. DOE assumed that the first waste package fails 1000 years after emplacement and is under a drip."

Rationale: The existing text leaves an incorrect impression of DOE's past approach to modeling seepage.

Comment 14. DOE recommends that Table I-3 in Appendix I on page I-9 that shows threatened and endangered species in Southern Nevada be replaced with the following table.

Table I-3. Threatened and Endangered Species in Southern Nye County

Common Name	Scientific Name
ENDANGERED	
Southwestern Willow Flycatcher	***Empidonax traillii extimus***
Devils Hole pupfish	***Cyprinodon diabolis***
Ash Meadows Amargosa pupfish	**Cyprinodon nevadensis mionectes**
Warm Springs pupfish	***Cyprinodon nevadensis pectoralis***
Ash Meadows speckled dace	***Rhinichthys osculus nevadensis***
Amargosa niterwort	***Nitrophila mohavensis***
THREATENED	
Bald Eagle	***Haliaeetus leucocephalus***
Desert tortoise	***Gopherus agassizii***
Ash Meadows naucorid	***Ambrysus amargosus***
Ash Meadows milkvetch	***Astragalus phoenix***
Spring-loving centaury	***Centaurium namophilum***
Ash Meadows sunray	***Enceliopsis nudicaulis var. corrugata***
Ash Meadows gumplant	***Grindelia fraxino-pratensis***
Ash Meadows ivesia	***Ivesia eremica***
Ash Meadows blazing star	***Mentzelia leucophylla***

Rationale: DOE believes the list provided in Appendix I is incorrect for the following reasons: (1) It does not include six threatened and one endangered plant species found at Ash Meadows or the endangered southwestern willow flycatcher; (2) It includes fish species found in extreme northwestern Nevada (Cui-ui and desert dace); (3) It is not a complete list of the species found in "southern Nevada" because it does not include many of the listed species found in the Colorado River (Clark County) and is an incomplete list of the fishes found in Pahranagat Valley (Lincoln County); (4) The Pahrump poolfish has been extirpated from its natural habitat in Nye County and is now found only in ponds in and near the Las Vegas Valley in Clark County; and (5) The peregrine falcon is no longer listed as endangered.

DOE recommends that the list be limited to southern Nye County south of Tonopah. This will eliminate fish species (e.g., White River spinedace, Lahontan cutthroat trout, Railroad Valley

springfish) found greater than 75 miles from Yucca Mountain in northern Nye County and species found in Pahranagat Valley, the Muddy River, and the Colorado River in Lincoln and Clark counties. The recommended list was obtained from the U.S. Fish and Wildlife Service by the Yucca Mountain Project Office in January 1999 (letter from R.D. Williams, Field Supervisor, Fish and Wildife Service Nevada Fish and Wildlife Office, to W.R. Dixon, Manager, Department of Energy Environmental Affairs, dated January 21, 1999. "Species List for the Proposed Yucca Mountain Repository for the Disposal of Spent Nuclear Fuel and High-level Radioactive Waste," ACC:MOL.19990216.0017) and updated based on listing decisions that occurred in 1999 (64 FR 46542).

Comment 15. DOE recommends that "the greater the likelihood of significant lateral flow" be changed to "the lesser the likelihood of significant lateral flow" on page VI-2, paragraph 4, lines 4 and 5.

Rationale: Statement as written is technically incorrect, as cited in numerous literature sources.

Comment 16. DOE recommends that the following paragraph be added after the 3rd paragraph on page VI-7 (which begins "The densely fractured…"):

> **"Although the conceptual model of Montazer and Wilson (1984) hypothesized that perched water may occur at the contact between the Tiva Canyon welded (TCw) unit and the Paintbrush nonwelded (PTn) unit, no such occurrences have been observed in either surface-based boreholes (Rousseau et al. 1999, p. 170-174; Bodvarsson et al. 1997, Chap. 13) or in the Exploratory Studies Facility (ESF). Based on field observations in boreholes and in the ESF, the existence of perched water above the repository horizon is believed to be unlikely (DOE 1998, p. 2-48). In addition, three-dimensional simulation of flow in the unsaturated zone beneath Yucca Mountain resulted in no formation of perched water at this contact or within any lithostratigraphic interval above the repository horizon (Bodvarsson et al. 1997, Chap. 13). Although contrasting matrix properties at the TCw/PTn contact result in high matrix saturations (Flint 1998, Table 7), the permeability of the PTn is sufficiently high to allow downward drainage of water without perching. Furthermore, three-dimensional simulation of flow using the base-case parameter set and base-case infiltration indicates that little lateral movement occurs as water travels from the mountain surface to the repository horizon (Bodvarsson et al. 1997, Chap. 20)."**

Rationale: The first paragraph of page VI-7 indicates that refinements or revisions to the 1984 unsaturated zone conceptual model will be made by referencing the appropriate literature. The literature noted in the comment bears heavily on the important question of perched water and should therefore be addressed in the BID. This literature should lead the BID to conclude that available information indicates perched water does not occur at the TCw/PTn contact. The data collected and analyses performed by DOE make a strong case for the extremely low likelihood

of perched water at this contact. DOE has effectively ruled out the possibility of perched water occurring above the repository horizon and has formulated its repository safety case accordingly.

References:

Bodvarsson, G.S.; Bandurraga, T.M.; and Wu, Y.S. Eds. 1997. *The Site-Scale Unsaturated Zone Model of Yucca Mountain, Nevada, for the Viability Assessment.* LBNL-40376. Berkeley, California: Lawrence Berkeley National Laboratory. ACC:MOL.19971014.0232.

DOE 1998. *Viability Assessment of a Repository at Yucca Mountain,* DOE/RW-0508, Volume 1: Overview, Introduction, and Site Characteristics, Preliminary Draft B, September 10, 1998. North Las Vegas, Nevada: YMSCO. ACC:MOL.19990420.0160.

Flint, L.E. 1998. *Characterization of Hydrogeologic Units Using Matrix Properties, Yucca Mountain, Nevada*. Water-Resources Investigations Report USGS-WRIR-97-4243. Denver, Colorado: U.S. Geological Survey. ACC:MOL.19980429.0512. TIC: 236515.

Montazer, P. and Wilson, W.E. 1984. *Conceptual Hydrologic Model of Flow in the Unsaturated Zone, Yucca Mountain, Nevada*. Water-Resources Investigation Report 84-4345. Denver, Colorado: U.S. Geological Survey. ACC:NNA.19870519.0109. [Note: This is the same reference as USG84 in the BID, which omitted the authors' names.]

Rousseau, J.P.; Kwicklis, E.M.; and Gillies, D.C. (eds) 1999. *Hydrogeology of the Unsaturated Zone, North Ramp Area of the Exploratory Studies Facility, Yucca Mountain, Nevada*. Milestone Report 3GUP667M. Water-Resources Investigations Report 98-4050. Denver, Colorado: U.S. Geological Survey. ACC:MOL.19990419.0335. TIC: 243099.

Comment 17. DOE recommends that the following sentences be added to the end of the 4th paragraph on page VI-7 (first sentence starting with "The saturated hydraulic conductivity…") or substituted for a portion of the existing text in this paragraph.

"Although the conceptual model of Montazer and Wilson (1984) hypothesized that the ratio of horizontal to vertical hydraulic conductivity of the Paintbrush nonwelded (PTn) unit was 10 to 100, subsequent laboratory analysis of core samples and field-scale air-injection tests indicate that the PTn is not as strongly anisotropic as first envisioned. Comparison of air-injection permeability values (LeCain 1997) with laboratory core values (Flint 1998, Table 7) indicates that although greater, the air-permeability values for the PTn fall in the upper range of the core values or differ by no more than a factor of ten (CRWMS M&O, 1998, Section 5.3.3.1.2.3). This similarity between the field air-injection and laboratory core permeability values indicates that the permeability of the PTn is much more isotropic at the two scales than that of the welded units and that the PTn has some fracture permeability

(LeCain 1997, p. 29). Further, the similarity of air-permeability values for the PTn from both air-injection testing and pneumatic monitoring (CRWMS M&O, 1998, Section 5.3.3.1.2.4) indicates that the PTn is not strongly anisotropic. Taken together, these data, as well as other available data, indicate that the tendency for lateral flow in the PTn is not as strong as envisioned in the 1984 conceptual model (see Rousseau et al. 1999, p. 123-124). This conclusion is supported by three-dimensional simulation of flow using the base-case parameter set and base-case infiltration, which resulted in little lateral movement as water flows from the mountain surface to the repository horizon (Bodvarsson et al. 1997, Chap. 20). Therefore, steady-state vertical percolation into the Topopah Spring welded unit is essentially the same as vertical percolation into and through the PTn."

Rationale: DOE believes the existing text overemphasizes lateral flow in the PTn. The 1984 conceptual model of unsaturated zone flow hypothesized a strong tendency for lateral flow in the PTn. However, subsequent DOE data collection and analyses have shown that lateral flow in the PTn is only a minor component of total flow and that the dominant direction of flow in the PTn is vertically downward. This is because of relatively high matrix saturated hydraulic conductivity of the PTn, a component of fracture flow through the PTn that is pervasive at the site, and structural features that further enhance the bulk vertical permeability of the PTn. DOE believes the references cited are adequate to support this overall conclusion.

Additional References to Those Cited in Previous Comment:

CRWMS M&O 1998. *Yucca Mountain Site Description*, Revision 00, September 1998 - (Document ID B00000000-01717-5700-00019) Book 2, Section 5 - Hydrologic System. ACC:MOL.19980729.0051.

LeCain, G.D. 1997. *Air-Injection Testing in Vertical Boreholes in Welded and Nonwelded Tuff, Yucca Mountain, Nevada*. Water-Resources Investigations Report 96-4262. Denver, Colorado: U.S. Geological Survey. ACC:MOL.19980310.0148. TIC: 233455.

Comment 18. DOE recommends that the third and fourth paragraphs on page VI-8 (starting with "Water flows from the matrix of the Paintbrush…" and "Flow enters the Calico Hills…") be replaced with the following paragraph.

"Although the 1984 conceptual model of Montazer and Wilson implied that slow, matrix flow would dominate in the Topopah Spring welded (TSw) unit, subsequent data collection and analysis have demonstrated this not to be the case. For example, in situ measurements of water potential and core measurements of water potential and saturation indicate a deep percolation environment that is generally conducive to sustaining deep fracture flow (Rousseau et al. 1999, p. 124). Water potentials throughout most of the PTn and TSw are very high [greater than −0.3 megapascals (MPa)] and are nearly depth-invariant. Thus, the imbibition capacity of the densely welded rocks, at least near fractures, is very small because of low matrix

permeabilities and low water-potential gradients across the fracture-matrix interface. In addition, pneumatic data indicate that fracture permeabilities of the densely welded rocks are very high, several orders of magnitude greater than those of the host matrix. The pneumatic data also indicate that the fracture network is globally interconnected throughout the TSw, thus providing a vertically interconnected system of openings to sustain downward liquid flow. Furthermore, three-dimensional simulation of flow in the unsaturated zone beneath Yucca Mountain using the base-case parameter set and base-case infiltration indicates that 80 percent of the percolation flux at the repository horizon occurs as fracture flow (Bodvarsson et al. 1997, Chap. 20)"

Rationale: DOE believes evidence indicates that fracture flow in dominant in the TSw and that most of the water that percolates to the repository horizon will have little or no interaction with water contained in the matrix of the TSw. This conclusion is supported not only by the physical and hydrologic data contained in the references cited above, but also in an extensive body of hydrochemical and isotopic data such as that cited in Yang et al., 1996 (YAN96) and Paces et al., 1996 (PAC96), both of which are already cited in the BID.

Comment 19. DOE recommends that the text near the bottom of page VI-103 be modified to remove the implication that greater flux means greater dilution.

Rationale: Greater flux does not necessarily yield greater dilution. The dilution in the aquifer itself is a function of dispersive characteristics and distance. It is possible to have nearly the same dilution with increased flux (although as modeled in the Viability Assessment there was a relationship between volumetric flow and dilution).

Comment 20. DOE recommends that the discussion on page VI-104 regarding 10,000-year travel times in the alluvium be better supported. DOE believes that such times are unlikely unless predicated on specific assumptions such as the amount of alluvium.

Rationale: Self-explanatory.

Group 2: Minor technical errors or omissions that probably would not impact the technical underpinning or justification for EPA's conclusions or position, and are not inconsistent with DOE's current understanding of the science or DOE's current approach to performance assessment.

Comment 21. DOE recommends that an entry be added to Table 1-1 as follows: "1999 DOE publishes a *Draft Environmental Impact Statement* (DEIS) for a geologic repository at Yucca Mountain." This accomplishment should also be the subject of an additional bullet on page 4-4.

Rationale: The DEIS reflects the most current information available on many of the programmatic activities discussed in the BID.

Comment 22. DOE recommends that the discussion of DOE program activities in the 1st full paragraph on page 4-2 be modified to recognize that high-level waste will also come from a former commercial reprocessing facility at West Valley, New York that is now managed by DOE.

Rationale: Self-explanatory.

Comment 23. DOE recommends that the first sentence in the 2nd full paragraph on page 4-2 be modified to state: "In addition to commercial and DOE spent nuclear fuel and high-level waste from DOE and commercial reprocessing operations, other radioactive wastes that have been considered for disposal in a repository at Yucca Mountain include fissile materials from…"

Rationale: The previous paragraph properly discusses DOE spent fuel as part of DOE's principal program activities. The sentence that is the subject of this comment, however, implies that such fuel has been considered for disposal. This statement is inaccurate and contradicts the previous paragraph.

Comment 24. DOE recommends that the last sentence in the second full paragraph on page 4-2 be ended after "commercial reactor fuel," and that the remainder of the sentence be contained in a new sentence that reads: "Defense high-level wastes, DOE spent nuclear fuel, and Navy spent nuclear fuel would contribute the equivalent of 7,000 metric tons heavy metal."

Rationale: As written the sentence is long and confusing, and it could be interpreted to mean that the repository would contain 63,000 metric tons of spent commercial reactor fuel and defense high-level wastes.

Comment 25. DOE recommends that the 2nd sentence on page 4-3 be replaced with the following: "The OCRWM charter includes responsibility for receipt of spent nuclear fuel from commercial reactors at the reactor sites and from storage facilities at DOE sites, interim storage of spent nuclear fuel as necessary prior to disposal, and transport of spent nuclear fuel to the site for interim storage and disposal. The Navy program, which

manages a small portion of DOE spent nuclear fuel, will transport their own spent nuclear fuel to the repository."

Rationale: Comment recognizes that some spent fuel will come from DOE sites, and that the Navy will transport their own spent nuclear fuel to the repository.

Comment 26. DOE recommends that the 2nd sentence in the paragraph on page 4-3 that follows the bulleted list be revised to state: "DOE has issued a Draft Environmental Impact Statement (EIS) and plans to issue a final EIS in late 2000. The Site Recommendation is planned to be submitted to the President in 2001 if the site is found suitable, and the License Application (LA) is planned to be submitted to the NRC in about 2002 (depending on program resources) if the site is approved for disposal."

Rationale: Comment reflects current program status.

Comment 27. DOE recommends that the 1st bullet after the paragraph that begins "The VA was published…" on page 4-3 be revised to replace "…the east-west Cross-Drift;…" with "…the Enhanced Characterization Repository Block (ECRB) Cross Drift;…"

Rationale: Comment reflects correct title of the Cross Drift.

Comment 28. DOE recommends that the word "approach" in the first bullet on page 4-4 be revised to "plan."

Rationale: The market-driven storage and transportation process is more accurately described as a plan, since the approach has not yet been developed.

Comment 29. DOE recommends that the number "2,700 metric tons" in the 2nd sentence of the 1st paragraph on page 4-5 be revised to "2,500 MTHM."

Rationale: As noted on page A-24 of the Repository DEIS, the number for projected DOE spent nuclear fuel is approximately 2,500 MTHM.

Comment 30. DOE recommends that the following sentence be inserted after the sentence in the 1st paragraph on page 4-5 that ends with "…throughout the United States." The sentence is: "The majority of this spent nuclear fuel and HLW is stored at three major sites in Idaho, South Carolina and Washington."

Rationale: This is a simple way to summarize where DOE material is located. See pages 4 and 5 of the Viability Assessment Overview.

Comment 31. DOE recommends that the discussion in the last two paragraphs and bullets on page 4-5 before section 4.3 be revised or deleted as they are not necessary to the discussion in the BID and are potentially misleading.

Rationale: The decisions referred to in the text are subject to change and not needed for the BID discussion. For example, one bullet states that aluminum-clad fuels will be sent to Savannah River. In fact, this is only an option that the EIS allows, and it will probably not be done unless the aluminum fuel is reprocessed at Savannah River.

Comment 32. DOE recommends that the words "spent nuclear fuel" be added before "storage facilities" in the last sentence before section 4.3.1 on page 4-6.

Rationale: Comment clarifies the purpose of the storage facilities noted in the sentence.

Comment 33. DOE recommends that the 1st sentence in the 4th paragraph in section 4.3.1 be deleted.

Rationale: Favorable and unfavorable conditions identified in 10 CFR 60.122 are similar to those in 10 CFR 960, and 10 CFR 60.113 provides specific performance objectives. The paragraph, as written, implies that DOE has specific criteria while the NRC does not. It would be correct to state that the proposed NRC regulations at 10 CFR 63 would not contain prescriptive criteria but would require DOE to demonstrate defense in depth.

Comment 34. DOE recommends that the word "ten" be changed to "nine" in the last sentence before section 4.6 and that "Pahrump County" be deleted.

Rationale: Pahrump is a town and not a county.

Comment 35. DOE recommends that the discussion beginning in the last paragraph on page 4-10 with the words "Extensive ethnographic…" be revised as follows:

> **"Extensive ethnographic research led to the identification of 15 tribes and one Native American Organization. In the mid-1990s, an additional tribe was also included. The following 17 tribal entities are currently involved in the Yucca Mountain Cultural Resources Program:**
> **1.**
> **2.**
> **.**
> **.**
> **10. Las Vegas Paiute Indian Tribe, Nevada**
> **.**

15. Paiute Indian Tribes of Utah
16.
17. Ely Shoshone Tribe, Nevada

All 17 groups requested…"

Rationale: Reference STO90, upon which this discussion was based, is not current due to the recent addition of the Ely Shoshone Tribe. The Las Vegas Indian Center is not a tribe but an organization.

Comment 36. DOE recommends that the 2nd sentence in the 1st paragraph of section 5.2 be revised as follows: Revise "pressure" to "pressurized," and revise item 2) to state: "2) government-sponsored research and demonstration programs, DOE test and research reactors, universities, and industry."

Rationale: Comment reflects standard terminology for PWR reactors. DOE test and research reactors contribute part of the total DOE spent nuclear fuel inventory.

Comment 37. DOE recommends that the three sentences that begin with "Spent nuclear fuels from one-of-a-kind…" and end with "…Savannah River Site (DOE95a)" in the 2nd paragraph of section 5.2 be rewritten to read:

> **"The majority of DOE spent nuclear fuel is stored at three major sites, which are the Hanford Site in Washington, the Idaho National Engineering and Environmental Laboratory (INEEL) in Idaho and the Savannah River Site in South Carolina. Some of the Fort St. Vrain spent nuclear fuel is being stored at the INEEL but the remainder is being stored in Colorado at the Fort St. Vrain facility."**

Rationale: The wording provided in the comment is clearer and corrects some inaccuracies. Not all of the Fort St. Vrain spent nuclear fuel is at the INEEL; N-reactor and Fast Flux Test Facility (FFTF) spent nuclear fuel is at Hanford and not the INEEL.

Comment 38. DOE recommends that the phrase "of commercial spent nuclear fuel" be added after "MTHM" in the last sentence of text in section 5.2.1.

Rationale: Comment makes context of the number 63,000 MTHM clear.

Comment 39. DOE recommends that the repository DEIS be cited as the basis for section 5.2.2 rather than the Spent Nuclear Fuel Environmental Impact Statement (FEIS).

Rationale: The repository DEIS contains the most recent and accurate data to support the section.

Comment 40. DOE recommends that "Idaho Chemical Processing Plant" be revised to "Idaho Nuclear Technology and Engineering Center" in the discussion on the Idaho National Engineering and Environmental Laboratory on page 5-5.

Rationale: Comment reflects current name of facility.

Comment 41. DOE recommends that, in the last sentence before the heading "Savannah River Site" on page 5-5, the phrase "metric tonnes" be replaced with "MTHM."

Rationale: MTHM is the correct unit of measurement.

Comment 42. DOE recommends that, on page 5-5, the last sentence in the 2nd paragraph under "Savannah River Site" be deleted, and that the 2nd sentence in the following paragraph be revised to state "These basins contain spent nuclear fuel and target material."

Rationale: The information in the text referenced is incorrect and is not needed for the discussion in the section.

Comment 43. DOE recommends that the 2nd sentence in the last paragraph on page 5-5 be revised to state: "About 50 percent of the fuels in the SRS basins consist of uranium clad in stainless steel or zircaloy."

Rationale: Comment provides correct percentage and name for the facility. Last part of sentence is deleted because DOE has no intention to reprocess this fuel.

Comment 44. DOE recommends that the last sentence in the 1st paragraph on page 5-6 be revised to remove "the Hanford site."

Basis: The Hanford site will not receive spent fuel from other generators.

Comment 45. DOE recommends that, in the last sentence on page 5-6, "the Hanford site" be removed and "with the exception of Fort St. Vrain spent nuclear fuel, which will remain in Colorado" be added to the end of the sentence.

Rationale: Hanford will receive no spent nuclear fuel shipments, and the Ft. St. Vrain spent nuclear fuel will remain in Colorado under DOE management.

Comment 46. DOE recommends that the 1st paragraph on page 5-7 be changed as follows: Revise the 2nd sentence to read "Most DOE SNF will be stored dry to reduce identified vulnerabilities" and revise the 4th sentence to read: "One of these options is "melt-and-dilute" at the Savannah River site."

Rationale: Melt-and-dilute is the preferred treatment step being considered at Savannah River, and most DOE spent nuclear fuel will be stored dry in the future.

Comment 47. DOE recommends that the phrase "and DOE research/test" be added after "Naval propulsion" in the 3rd sentence of the 1st paragraph on page 5-8.

Rationale: Some DOE spent nuclear fuel was also reprocessed.

Comment 48. DOE recommends that the last sentence in the 4th paragraph on page 5-9, which starts with "Current DOE policy…" be deleted.

Rationale: The earlier policy was to delay acceptance of DOE high-level waste at the repository for five to six years, but this requirement has been eliminated as a result of the new EDA II design.

Comment 49. DOE recommends that "of HLW" be added after "10,110 MTHM," and that "70,000 MTHM" be revised to "70,000 MTHM of spent nuclear fuel and HLW" in the last paragraph on page 5-9.

Rationale: Existing text is unclear because it places both HLW and combined spent fuel/HLW quantities in the same sentence without specifying which is which.

Comment 50. DOE recommends that "The Hanford Waste Vitrification Plant" be revised to "A privatized high-level waste vitrification plant" in the last sentence before section 5.3.2.

Rationale: The Hanford Waste Vitrification Plant project was cancelled.

Comment 51. DOE recommends that the 1st sentence in section 5.3.2 be revised to state: "(…the remainder is high-level waste that contains sodium)."

Rationale: Comment clarifies terminology.

Comment 52. DOE recommends that the phrase "and these tanks are inside concrete vaults" be added after "stainless steel tanks" in the 3rd sentence in the 1st paragraph in section 5.3.2.

Rationale: Comment makes this discussion consistent with that in the following sentence and recognizes the additional barrier in the configuration for storage of acidic waste.

Comment 53. DOE recommends that, in the bulleted list on page 5-13, the 1st bullet be reworded as follows: "The salt solution will be removed from the tanks and will be treated in the salt processing facility." The remainder of the 1st bullet and the 2nd bullet should be deleted. The 3rd bullet should be reworded as follows: "At the Defense Waste Processing Facility, which began operation in 1996, the sludge is combined with glass frit and vitrified. The process removes mercury from the sludge. The vitrified waste is contained in stainless steel canisters."

Rationale: Comment reflects the current status of the processes.

Comment 54. DOE recommends that the phrase "resulted in large north-northeast fractures with…" be changed to "resulted in northerly trending faults with…" in the 2nd sentence of the 1st paragraph on page 7-10.

Rationale: These features are not "fractures" but rather are "faults" along which displacements have occurred. These faults not only trend north-northeast, but also trend north and northwest.

Comment 55. DOE recommends that the phrase "consist of ash-fall and ash-fall tuffs…" be changed to " consist of <u>ash-flow</u> and ash-fall tuffs…" in the 2nd sentence of the 1st paragraph on page 7-22.

Rationale: This appears to be a typographical error. Both types of tuff are present in the stratigraphic section.

Comment 56. The state abbreviations CA and NV in figure 7-16 are reversed.

Rationale: Self-explanatory.

Comment 57. The text on page 7-129, last paragraph before section 7.2.2.2 refers to figure 7-33 as a design concept for the emplacement transfer dock. However, figure 7-33 actually shows a waste package.

Rationale: Self-explanatory.

Comment 58. DOE recommends that usage of the terms "paleo-data" and "paleo-record" in the 2nd and 3rd paragraphs on page 7-116, respectively, be changed to "paleoclimate data" and "paleoclimate record."

Rationale: There are many different type of "paleo" data and records (i.e. Paleontologic, paleobotanic, paleomagnetic, etc.). The types that are of relevance at Yucca Mountain are specifically the paleoclimatic data and records.

Comment 59. DOE recommends that the last sentence in the 1st paragraph on page 7-134 be revised from "…emplace the packages so that they touch each other end-to-end…" to "emplace the packages very close to each other…"

Rationale: DOE is not considering emplacing waste packages so that they touch each other.

Comment 60. DOE recommends changing "U.S. Department of Agriculture (USDA) and the U.S. Geological Survey (USGS)." to "U.S. Geological Survey (USGS) and the Natural Resource Conservation Service (NRCS)" in line 2 of the 1st paragraph on page 8-42.

Rationale: Comment changes the source cite to accurately reflect the source of the soils data. (See following comment.)

Comment 61. DOE recommends deleting sentences 4 through 10 in the 1st full paragraph on page 8-42, and the paragraph that follows, and replacing them with the following or similar text:

> **"However, the soils encountered downgradient of Yucca Mountain, southwest of the Nevada Test Site (NTS) and in the vicinity of the junction of U.S. Route 95 and Nevada Route 373, have slopes well within the limits that are suitable for agriculture. Soils near the junction of U.S. Route 95 and Nevada Route 373 and farther south in the Amargosa Farming area were evaluated for agricultural production using data from the NRCS and site-specific data collected from soil pits that were excavated in the area (CRWMS M&O 1999). The dominant soil map units in the area between Yucca Mountain and the Amargosa Farming area include: Corbilt Gravelly Fine Sandy Loam, Warm, 2-4% slopes (2030), Yermo, hot-Arizo Association (2054); Shamock Gravelly Fine Sandy Loam, 2-4% slopes (2070); and Sanwell-Sanwell, warm-Yermo Association (2451) (Appendix III). Based on the Map Unit Interpretation (MUIR) database (NRCS 1998), all of these soils have characteristics that are potentially unsuitable for residential/sustainable farming (U.S. Department of Agriculture 1993). Descriptions of individual soil series documenting these characteristics may be found in Appendices B & C of CRWMS-M&O (1999). Potentially unsuitable characteristics include shallow indurated soil**

horizons or maximum values of pH, electrical conductivity, or sodium adsorption ratio that meet or exceed the limits that influence plant growth.

However, within the Amargosa Farming area, these same soil map units have supported commercial and residential agriculture for several years [e.g., Sanwell-Sanwell, warm-Yermo Association (2451), Shamock Gravelly Fine Sandy Loam, 2-4% slopes, and Yermo, hot-Arizo Association (2054); see Appendix III]. CRWMS-M&O (1999) put forth several possible reasons for this apparent contradiction, such as conservative soil quality guidelines, adapted crop species, and management practices that overcome soil deficiencies. These reasons along with past history suggest that many of the soils between the Amargosa Farming area and Yucca Mountain may also be used for agricultural production, given the availability of sufficient irrigation water.

In summary, agricultural activity would be limited around Yucca Mountain, given the steep slopes, rocky terrain, and shallow soils. However, southwest of the NTS and in the vicinity of the junction of U.S. Route 95 and Nevada Route 373, the topography is more conducive to agricultural production. All of the soils in this area have some characteristics that are considered potentially unsuitable for agricultural production, yet farther south in the Amargosa Farming area these same soils have been under production for several years. Thus, it appears that soils in the Lathrop Wells area could be farmed in the future, given adequate amounts of irrigation water."

References:

CRWMS-M&O 1999. *Evaluation of Soils in the Northern Amargosa Valley.* B00000000-01717-5705-00084 REV 00. Las Vegas, Nevada: CRWMS-M&O. ACC:MOL.19990224.0268.

NRCS (Natural Resource Conservation Service) 1998. *National Soil Data Access Facility: Official Soil Series Descriptions* (Soil Attribute Database). Available: http://www.statlab.iastate.edu/soils/nsdaf. TIC: 241713.

U.S. Department of Agriculture (Soil Survey Staff, Natural Resource Conservation Service) 1993. Soil Survey Manual, Handbook No. 18 Chapter 4. Washington D.C.: U.S. Government Printing Office. TIC: 240569.

These comments rely on incorporation of DOE comment that the soils map in Appendix III be replaced. The names of the soil associations and soil series were taken directly from the map proposed to replace the existing Appendix III soils map.

Rationale: Statements regarding percentages of dominant soil textures within an area do not provide sufficient background information to support summary statements regarding soil suitability for agriculture. Additional factors such as pH, salt content, soil depth, and erosion potential should also be considered. The text should note that soils in this area have inherent

characteristics that make them potentially unsuitable for agriculture. Also, the text is not supported by the referenced appendix. Appendix III does not include any of the area encompassed by the Busted Butte quadrangle map referred to in the text. Finally, the existing summary does not clearly summarize Section 8.2.3.3. Soil textures are given for the area around Yucca Mountain, but the summary only documents soil textures downgradient of Yucca Mountain. The summary should note that the soils in the area have characteristics that could be perceived as an obstacle to agriculture, and it should include statements on the topography of Yucca Mountain as limiting to agriculture.

Comment 62. DOE recommends that the phrase "This estimate represents a conservative upper bound estimate in that..." in the 1st paragraph on page 9-10 be replaced with "This estimate represents a conservative upper bound estimate for gaseous phase releases in that ..."

Rationale: Comment clarifies sentence. The implied assertion that the assumption is conservative with respect to total dose is reasonable and likely, but it is not supported by the argument. The dissolved fraction of the gaseous release may undergo less dispersion and dilution than the atmospheric fraction during transport to the receptor.

Comment 63. DOE recommends replacing "DOE concluded in the TSPA-VA that there are no risks from volcanism..." in the last paragraph on page 9-22 with "DOE concluded in the TSPA-VA that risks from volcanism are negligible..."

Rationale: EPA is paraphrasing the NRC review of the VA in this sentence, and in that regard the statement is true as written -- this is what the NRC said. However, it misrepresents the position DOE presented in the VA. The difference between "no risk" and "negligible risk" is small but worth noting.

Comment 64. References cited in Appendices I and V are not accompanied by corresponding complete citations in a reference list [e.g., NVE93a (pg. I-7), SPA83 (Table I-2), and FRE67 (pg. V-5)].

Rationale: Self-explanatory.

Comment 65. DOE recommends that the last sentence of the first paragraph on page I-1 be modified to: "The predominant <u>non-government</u> land use surrounding Yucca Mountain ..."

Rationale: Much of the land surrounding Yucca Mountain is government-owned, and much of that land is restricted from agricultural, mining, or recreational use.

Comment 66. DOE recommends that the following be added to end of the 1st sentence in the last paragraph of page I-4: "although approximately 80 percent of the employees reside in Clark County (CRWMS M&O 1994)."

Rationale: This comment clarifies that, although employment at the site is in Nye County (place of work), the important demographic characteristic of place of residence is predominantly in Clark County. Source:

CRWMS M&O 1994. *Yucca Mountain Site Characterization Project: Socioeconomic Monitoring Program 1994 U.S. Department of Energy/Nevada Employee Survey Data Report: Executive Summary.* Table 2-7. Las Vegas, Nevada. ACC:MOL.19950518.0082.

Comment 67. DOE recommends that the 2nd sentence in the lasts paragraph on page I-4 be replaced with: "During the week, an average of approximately 140 persons reside in NTS group quarters at Mercury."

Rationale: This clarification reflects the reduction in the numbers of persons residing temporarily in group quarters at the Nevada Test Site (NTS). This reduction is due to a change in missions at NTS and the reduction in contractor subsidies of the group quarters and ancillary facilities. The approximation of 140 is an unofficial number provided by Bechtel-NV, Housing.

Comment 68. DOE recommends that the 4th sentence in the last paragraph on page I-4 be changed as follows: "…employment at Yucca Mountain increased substantially, from 281 workers (65.8 FTEs) in January of 1988 (CRWMS M&O 1990) to 540 (371.9 FTEs) in December 1994 (CRWMS M&O 1995)."

Rationale: The increase is substantial, but only double from 1988 to 1994, not the 12-fold increase. The Socioeconomic Monitoring Program data shows the suggested data in the following two reports cited above:

CRWMS M&O 1990. *Yucca Mountain Project Socioeconomic Monitoring Program Data Report – June 1986 Through September 1989.* Tables 3-1 and 3-2. Las Vegas, Nevada. ACC:NNA.900327.0189.

CRWMS M&O 1995. *Yucca Mountain Site Characterization Project: Socioeconomic Monitoring Program Quarterly Employment Data Report – October 1994 through December 1994.* Tables 3-1 and 3-3. Las Vegas, Nevada. ACC:MOL.19950626.0522.

Comment 69. DOE recommends that the last sentence in the 1st paragraph on page I-6 be clarified to indicate that the "Recent openings of new dairies in Amargosa have generated additional demand for locally produced feed for dairy cows."

Rationale: As noted earlier in that paragraph, the milk produced at those dairies is shipped to southern California for processing and is not consumed locally. This change will clarify that the feed will be demanded locally, not the dairy products.

Comment 70. DOE recommends replacing the soils map in Appendix III with a different one, and that a reference cite be provided for the map ultimately used. A possible replacemtn would be a soil map entitled "Amargosa Valley Area Soil Types", Map no. YMP-97-146.0, compiled by the CRWMS M&O and included in the following report:

> **CRWMS M&O 1999. *Evaluation of Soils in the Northern Amargosa Valley.* B00000000-01717-5705-00084 REV00. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990224.0268.**

This map has the same soil classification coverage as the Appendix III map. The northern, western, and southern extents of this map are wider than the Appendix III map. However, it does not include the area encompassed by the Busted Butte quadrangle. It includes more of the Amargosa farm area and delineates the farming area boundary.

Rationale: The patterns on the Appendix III soils map and the legend labels are not discernable. Some soil associations appear to have the same pattern (e.g. Yermo-Arizo vs Corbilt-Skelon). Also, the Appendix III map does not delineate the location of the Amargosa farm area. This delineation may be helpful to compare the soils immediately south and west of the Nevada Test Site to the soils that are farmed in the Amargosa Valley. Finally, the Appendix III map does not support the discussion of soils in Chapter 8, section 8.2.3.3. The soils discussed in section 8.2.3.3 are located within the area encompassed by the Busted Butte quadrangle map. The map in Appendix III does not include this area.

Comment 71. DOE recommends changing the phrase "Because ostriches are assumed to be raised on commercial pelletized feed that is unaffected …" in the 1st sentence of the 3rd paragraph on page V-2 to "Because ostriches are assumed to be raised on <u>imported</u> commercial pelletized feed that is unaffected ... ."

Rationale: The phrase "commercial pelletized feed" is intended to suggest that all feed is produced from products that are grown outside of a potentially contaminated region. However, local companies that operate within the Amargosa Valley Farm area could potentially produce "commercial pelletized feed." The assumption is reasonable as clarified, given the small likelihood such food would be grown, processed, and consumed locally.

Comment 72. DOE recommends that the 3rd sentence in the last paragraph on page VI-60 be replaced with the following:

> **"In summary, saturated zone flow is affected by a) the presence of high- and low-permeability faults which offset hydrogeologic units sub-vertically, b) the**

heterogeneous permeability distribution within geologic units, c) the variation of dip and thickness of strata, d) the heterogeneous permeability distribution at the water table, e) the distribution of infiltration from the unsaturated zone, and f) the three-dimensional channelization, hydrologic mixing and dilution produced by the above mechanisms. In addition, saturated zone flow could be affected by upwelling or convection in faults, if faults are connected hydraulically to the Paleozoic units."

Rationale: The information in the Appendix VI was extracted mainly from 1997 milestone reports. More information has been incorporated into the saturated zone flow and transport model since 1997, allowing more rigorous analysis of the transport processes in the porous rocks, the alluvium, and the fractured rocks.

Comment 73. DOE recommends that the first sentence in paragraph 5 on page VI-63 be replaced with: "The model extends 10 km eastward and 15 km northward. However, it covers an area of 108 km^2 because it is not a rectangle."

Rationale: Area shown in existing text is incorrect.

Comment 74. DOE recommends that the second sentence on page VI-64, Paragraph 4, be replaced with: "Use of this surface assumes that the water level measurements in borehole G-2 and WT-6 represent a water table, although two- and three-dimensional simulations of flow geometry do not include the large gradient zone. By defining the top of the model by these water levels, the model can also be modified to simulate perched water in that area."

Rationale: DOE believes the modified text more accurately reflects current modeling.

Comment 75. DOE recommends that the 5^{th} sentence in paragraph 1 on page.VI-65, be replaced with: "Because not all geologic units are present beneath the water table, several thin layers are present at the top of the model everywhere and are assigned the properties of the unit at the water table at a particular location."

Rationale: DOE believes the modified text more accurately reflects current modeling.

Comment 76. DOE recommends that the 9^{th} sentence in paragraph 2 on page VI-65, be replaced with: "There are very little data to indicate that the intrablock faults are present beneath the water table."

Rationale: DOE believes the modified text more accurately reflects the current state of knowledge.

Comment 77. Page VI-70, first full paragraph, last sentence, states: "It is unclear where the authors (COH97) obtained their estimated pumping rates." References to where groundwater pumpage was obtained are listed on page 47 and 48 of the regional model (DAG97). DOE recommends the text be revised to reflect these references.

Rationale: Self-explanatory.

Comment 78. DOE recommends that page VI-74, paragraph 6, include as its first sentence: "Eleven (11) faults are modeled explicitly."

Rationale: Comment reflects the current model.

Comment 79. DOE recommends that the 5th and 6th sentences in the 2nd full paragraph on page VI-75 be replaced with: "Both displacement-only faults and faults zones with particular permeabilities were modeled."

Rationale: Comment reflects the current model.

Comment 80. DOE recommends that the 1st sentence in the last paragraph on page VI-84 be replaced with: "The area of the model corresponding to the small-gradient area was used as an investigative tool to explore and define saturated zone processes by way of hypothesis testing. By using this sub-area of the model only, biases that would be introduced by assuming the true cause of the large-gradient zone are avoided. The western boundary of this sub-grid was defined by the 731 m water table contour."

Rationale: Comment reflects the current model.

Comment 81. DOE recommends that the 5th sentence in the last paragraph on page VI-80 be revised to change "interactive" to "iterative."

Rationale: Comment reflects the current model.

Comment 82. On page VI-89, the first full paragraph, third sentence should be revised to read: "It is still unclear, however, how DOE will ultimately incorporate these processes (matrix diffusion) into the TSPA-LA since they are currently not considered in the TSPA-VA." DOE plans to incorporate matrix diffusion in the process model and TSPA through a transfer function approach, and we recommend the sentence be revised to reflect these plans.

Rationale: Self-explanatory.

Comment 83. Several sections of Appendix VI paraphrase or quote numerous references that are not cited, incorrectly cited, or not fully cited. DOE recommends that the correct references be provided. Examples noted include the following:

- **The text from page VI-68 to VI-70 appears to refer to the regional model D'Agnese 97, but it repeatedly references the model incorrectly. DOE recommends that the reference cite "COH97" be changed to "DAG97."**

- **The text from pages VI-71 to VI-73 discusses the site-scale flow model of Zyvoloski 97 but appears to incorrectly cite it as "COH97." DOE believes the correct reference is "ZYV97."**

- **The reference cited in Page VI-120, 3rd paragraph, first sentence starting with "The NRC has previously recommended…" is shown incorrectly in the reference list at the end of Appendix VI. Based on review of the text on Page V-120, the correct cite for "NRC97a, p. 8" is as follows:**

  NRC, 1997. *Issue Resolution Status Report on Methods to Evaluate Climate Change and Associated Effects at Yucca Mountain (Key Technical Issue: Unsaturated and Saturated Flow Under Isothermal Conditions),* June 1997. ACC:MOL.19971117.0697.

- **The references for DOE96 (Waste Containment and Isolation Strategy) and DOE98 (Repository Safety Strategy), both of which are cited on page VI-123, do not appear in the reference list. The complete citations for the subject documents are as follows:**

  DOE 1996. *Highlights of the U.S. Department of Energy's Updated Waste Containment and Isolation Strategy, Yucca Mountain Site, Nevada,* YMP/96-01, Revision 0, September 1996. Washington D.C.: OCRWM.

  DOE 1998. *Repository Safety Strategy: U.S. Department of Energy's Strategy to Protect Public Health and Safety After Closure of a Yucca Mountain Repository*. YMP/96-01, Revision 2. Washington D.C.: OCRWM. ACC:MOL.19980727.0001.

- **The reference citation for NRC97b on page VI-123 appears to be incorrectly shown in the reference list as a document pertaining to igneous activity. The correct citation for NRC's Issue Resolution Status Report that discusses present-day shallow infiltration is as follows:**

  NRC 1997. *Issue Resolution Status Report Key Technical Issue: Unsaturated and Saturated Flow Under Isothermal Conditions.* Revision 0, September 1997. Washington, D.C.: NRC. ACC:MOL.19980219.0572. (Section 4.3)

- **Pages VI-125 through VI-131, section titled "Deep Percolation (Present and Future)" appears to cite an incorrect reference. DOE believes that the appropriate citation for NRC's Issue Resolution Status Report on this particular subissue is as follows:**

  NRC 1998. *Issue Resolution Status Report Key Technical Issue: Unsaturated and Saturated Flow Under Isothermal Conditions; Revision 1, September 1998; Volume I & Volume II*. Washington, D.C.: NRC. ACC:MOL.19990105.0142 (Sections 4.4 and 5.4).

- **The text in pages VI-132 through VI-139, section titled "Saturated Zone Ambient Flow Conditions and Dilution Processes," refers to NRC work but does not cite the applicable NRC reference document. DOE recommends that the appropriate citation for NRC's Issue Resolution Status Report on this particular subissue be provided. The citation for the NRC report that discusses saturated zone ambient flow is as follows:**

  NRC 1998. *Issue Resolution Status Report Key Technical Issue: Unsaturated and Saturated Flow Under Isothermal Conditions; Revision 1, September 1998; Volume I & Volume II*. Washington, D.C.: NRC. ACC: MOL.19990105.0142 (Section 4.5 and 5.5)

- **DOE recommends that the eight NRC acceptance criteria for saturated-zone ambient flow conditions and dilution processes listed on pages VI-137 through VI-139, and the four acceptance criteria for matrix diffusion in saturated and unsaturated zones listed on pages VI-140 through VI-143, be numbered the same way as they are numbered in the associated NRC Issue Resolution Status Report. All the subject acceptance criteria are labeled as "(1)", which is apparently an unintended typographical error given the practice in the remainder of the Appendix.**

- **The text in pages VI-140 through VI-1143, section titled "Matrix Diffusion in Saturated and Unsaturated Zones," refers to NRC work but does not cite the applicable NRC reference document. DOE recommends that the appropriate citation for NRC's Issue Resolution Status Report on this particular subissue be provided. The citation for the NRC report that discusses matrix diffusion is as follows:**

  NRC 1998. *Issue Resolution Status Report Key Technical Issue: Unsaturated and Saturated Flow Under Isothermal Conditions; Revision 1, September 1998; Volume I & Volume II*. Washington, D.C.: NRC. ACC:MOL.19990105.0142. (Sections 4.6 and 5.6)

- **Pages VI-143 through VI-151, sections titled "Radionuclide Transport Through Porous Rock", "Radionuclide Transport Through Alluvium", "Radionuclide Transport Through Fractured Rock", and "Criticality in the Far Field" refer to NRC work but do not cite the applicable NRC reference documents. DOE recommends that the appropriate citations for NRC's Issue Resolution Status Reports on these particular subissues be provided.**

- **Text on pages VI-151 through VI-152, section titled "*NWTRB Identified Needs*," cites the 1999 report of the Nuclear Waste Technical Review Board (NWTRB), but the "References" section lists a 1998 NWTRB report. DOE recommends that the reference section be revised to show the current reference.**

- **Section on pages VI-152 through VI-157, titled "*Peer Review Panel Identified Needs,*" extensively quotes and paraphrases the TSPA Peer Review Panel report used by the EPA but does not provide a complete reference. The section also cites several other references that either are incorrectly listed in the "References" section or do not appear at all (i.e. CRW98, GEL98, WHI98, ARN98, STR96, STR97). DOE recommends the Reference section be revised to add the complete reference citations.**

- **DOE recommends that the EPA provide the complete citation for the report used by the EPA as the source of information for pages VI-157 through VI-162, section titled "*State of Nevada/T-Reg, Inc. Identified Needs*."**

Rationale: Self-explanatory.