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NUCLEAR REGULATORY COMMISSION
WASHINGTON, D.C. 20555

OFFICE OF THE
EXECUTIVE DIRECTOR
FOR OPERATIONS


July 14, 1992

TO: D. Rathbun, OCM/IS
L. Van Cise, OCM/KR
J. Gray, OCM/JC
R. Boyle, OCM/FR
K. Whitfield, OCM/GdeP

FROM: James L. Blaha, AO/OEDO

SUBJECT: PRELIMINARY NRC STAFF COMMENTS
ON DOE WORK RELATED TO EPA HLW
STANDARDS

The enclosed is provided for your
information regarding staff comments on
DOE work related to EPA HLW standards.


James L. Blaha, AO/OEDO

Enclosure:
As stated

cc: J. Taylor, EDO
H. Thompson, DEDS
R. Bernero, NMSS
SECY

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PDR COMMS NRCC
CORRESPONDENCE PDR



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JUL 10 1992

MEMORANDUM FOR: James L. Blaha
Assistant for Operations
Office of the Executive Director
for Operations

FROM: Robert M. Bernero, Director
Office of Nuclear Material Safety
and Safeguards

SUBJECT: PRELIMINARY NRC STAFF COMMENTS ON DOE WORK RELATED
TO EPA HLW STANDARDS

Enclosed are preliminary Nuclear Regulatory Commission staff comments recently transmitted to the U.S. Environmental Protection Agency (EPA) giving the NRC staff's views on several items of technical work being performed by the U.S. Department of Energy (DOE) to support EPA's high-level waste (HLW) standards. These preliminary comments are consistent with previous NRC staff comments on Working Drafts 2 and 3 of EPA's standards. Because the Commissioners have frequently voiced interest in our interactions with EPA, they may wish to receive copies of these preliminary comments. Please distribute as appropriate. Copies of DOE's "working paper" reports are not included, but can be obtained from Dan Fehringer, 504-1426.

EPA's schedule for reissuing its standards continues to slip. EPA now expects to have the technical support for its standards available for NRC staff review in late July, and to submit its standards for Office of Management and Budget approval in October. The NRC staff still plans to review EPA's technical support documents within about 30 days of receipt. The staff will then inform the Commission of its views regarding the adequacy of EPA's standards and the supporting documentation.

Robert M. Bernero, Director
Office of Nuclear Material Safety
and Safeguards

Enclosure:
Preliminary Comments

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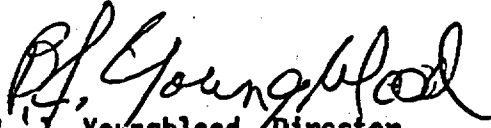
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J. William Gunter, Director
Criteria and Standards Division, ANR-460
Office of Radiation Programs
U.S. Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Gunter:

Thank you for the opportunity to review early draft reports of several technical analyses performed for you by the U.S. Department of Energy (DOE) as support for your high-level waste standards. Because of the preliminary nature of these analyses and DOE's obvious intent to continue working on them, we are providing only an informal review at this time as you requested. Enclosed are preliminary NRC staff comments on these early draft reports.

Sincerely,


B. J. Youngblood, Director
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure:
As stated

cc: John Roberts, DOE

~~9268264180~~

Preliminary NRC Staff Comments on
Draft DOE Technical Analyses

Human Intrusion The NRC staff has no objection to the general concept proposed by DOE -- i.e., qualitative evaluation of the potential for, and the consequences of, intrusion (and, presumably, other types of human-initiated releases). In our view, the analyses of natural resources required by our own regulation would be quite similar. We note, however, that DOE's proposed text for 40 CFR Part 191 would not constitute an environmental standard since it would not contain "limits on radiation exposures or levels, or concentrations or quantities of radioactive material, in the general environment . . ." Accordingly, if EPA chooses to adopt DOE's recommendation, DOE's text should be incorporated as a non-binding assurance requirement, rather than as part of the containment requirements.

If EPA chooses to adopt DOE's recommendation, EPA might also wish to consider whether adjustments would be needed in the table of release limits of the standards. EPA's release limits were originally intended to apply to all releases from both natural and human-initiated disruptions. If human-initiated releases are to receive a separate, qualitative evaluation, some degree of reduction in the release limits might be appropriate.

Three-Bucket Approach Evaluating the safety of an HLW repository involves projecting its waste isolation capability within an environment that will evolve in an uncertain manner. Because we cannot predict with certainty what the future environmental conditions will be, we must postulate several future conditions that are representative of the full range of conceivable environmental conditions. It is neither possible nor necessary to foresee and evaluate all possible futures. Rather, the "reasonable assurance" (or "reasonable expectation") test of repository licensing requires only that a set of potential future conditions be identified that is reasonably representative of the full range of possible futures.

A convenient way to evaluate possible future environmental conditions for a repository is through use of a scenario analysis in which each "scenario" represents one possible set of future environmental conditions. For example, one scenario might include no disruptive environmental conditions, a second might consist of human intrusion into a repository, fault movement might constitute a third scenario, and the combination of fault movement and human intrusion might be a fourth scenario. As illustrated in the December 3, 1991, letter from Robert M. Bernero to Margo Oge, it is possible to define mutually exclusive scenarios using a technique similar to the event tree method used in probabilistic risk analysis. Defining scenarios to be mutually exclusive is a key concept in understanding the NRC staff's proposed alternative wording for EPA's containment requirements.

EPA's 1985 containment requirements contained two relevant criteria: (1) there must be less than one chance in ten that the cumulative release of radioactive material will exceed EPA's table of release limits, and (2) there must be less than one chance in one thousand that the cumulative release will exceed ten times EPA's table. In addition, EPA's "Guidance for Implementation" suggested that "categories of events or processes" with less than one chance in ten thousand need not be considered when evaluating compliance with the containment requirements. EPA's guidance also suggested that an assessment of repository

One effect of EPA's 1985 standards was to limit the size of the permissible release from any credible release scenario to ten times EPA's table. This limit applied to all scenarios, regardless of likelihood, provided the scenario has a probability greater than about 10^{-3} to 10^{-4} . (The exact threshold would depend on the number of scenarios with probabilities in this range.) Importantly, if an applicant could demonstrate that all credible, mutually exclusive scenarios have releases less than ten times EPA's table of release limits, that alone would suffice to demonstrate compliance with the second part of EPA's containment requirements (less than one chance in one thousand that the cumulative release will exceed ten times EPA's table). However, the wording of EPA's 1985 standards also required estimation of the probabilities of unlikely scenarios as well as estimation of the sizes of the releases. Since probabilities on the order of 10^{-3} over 10,000 years will be highly uncertain and contentious, and since they are not needed to ensure that any credible release will be less than ten times EPA's table of release limits, the NRC staff developed alternative language for EPA's standards that would eliminate the need for such probability estimates.

The NRC staff's proposed alternative mimicked EPA's 1985 language, making only the minimal changes needed to substitute a deterministic release limit applicable to all scenarios for EPA's probabilistic limit for unlikely releases. In retrospect, it appears that many misunderstandings of the NRC staff's proposal would have been avoided if substantially different language had been suggested. The following regulatory text might better describe the NRC staff's concept.

* * *

"Scenario" means a hypothetical future set of repository environmental conditions including any sequence of potentially disruptive processes and events that is sufficiently credible to warrant consideration.

Disposal systems for radioactive waste shall be designed to provide a reasonable expectation that, for 10,000 years after disposal, the release of radionuclides caused by any scenario will not exceed ten times the quantity calculated according to Table 1 (Appendix A).

Disposal systems for radioactive waste shall be designed to provide a reasonable expectation that, for 10,000 years after disposal, there will be at least a 90 percent likelihood that the cumulative release of

radionuclides to the accessible environment will not exceed the quantity calculated according to Table 1 (Appendix A).

DOE identifies a number of questions which DOE asserts must be answered before DOE can evaluate the merit of the three-bucket approach. The NRC staff's views on each of these questions is presented below.

-How to determine unambiguously the bucket into which each sequence of events and processes falls. In the NRC staff's view, there would be no need to assign scenarios to "buckets" based on the likelihoods of the scenarios. The NRC staff's proposed alternative would apply two separate criteria to projected repository performance. First, no credible sequence of processes and events (scenario) could cause a projected release greater than ten times EPA's table of release limits. This limit would apply to each scenario, regardless of probability, provided the scenario is "sufficiently credible to warrant consideration." The second criterion would require that there be at least a 90 percent likelihood that the cumulative release, from all credible scenarios, would be less than EPA's table of release limits. When evaluating compliance with this criterion, scenarios would need to be included only to the extent necessary to demonstrate compliance. If, for example, three scenarios have probabilities of 0.5, 0.39 and 0.01, and if the projected release for each scenario is less than EPA's table, compliance would have been demonstrated without need to evaluate any other scenarios, regardless of likelihood.

-The meanings of certain terms used in the statements of the approach (e.g., "sequences," "anticipated," "sufficiently credible to warrant consideration," "scenario"). "Sequence" would have its plain English meaning. If the order in which processes or events occur within a sequence is important for a performance assessment, two options would be available: define separate scenarios for each order, or use the worst (highest release) order as an approximation of all orders containing the same processes and events. As a practical matter, the latter option will need to be used in most cases if the number of scenarios is to be kept manageable.

"Anticipated" was used in the NRC staff's original proposal, but editing of the staff's comments caused the word to lose all meaning. As indicated in the revised wording above, the term is not necessary, and its use in the previous proposal should be ignored.

"Sufficiently credible to warrant consideration" would have the meaning intended by EPA in its 1985 standards, i.e., scenario probabilities on the order of 10^{-5} to 10^{-4} over 10,000 years. EPA's 1985 standards referred to the release probability (sum of scenario probabilities) in the containment requirements, but seemed to refer to scenario probabilities in EPA's implementation guidance. Therefore, it is impossible to make a direct numerical translation from EPA's 1985 standards to the NRC staff's proposed alternative. In any case, the NRC staff considers it more appropriate to state the concept qualitatively, and to provide numerical guidance in a format (e.g., a Regulatory Guide) that allows some

flexibility in application. The important point is that no change is intended in the scope of analyses that would have been required by EPA's 1985 standards.

"Scenario" would be defined as suggested above.

-The logical consistency of comparing incomplete CCDFs to limits originally established for a complete CCDF. When demonstrating compliance with regulatory requirements, a demonstration of compliance must be sufficiently complete to show compliance, but need not be complete in any absolute sense. Even with EPA's 1985 standards, there would have been no need to develop a "complete CCDF." EPA's 1985 standards required only "less than one chance in ten" of exceeding EPA's table, and "less than one chance in one thousand" of exceeding ten times the table. DOE could have demonstrated compliance without constructing a CCDF at all by merely showing that the projected release from each mutually exclusive scenario would be less than EPA's table. Even if that were not possible (if releases from some scenarios were greater than one), a "complete CCDF" would not be necessary. In fact, EPA's own guidance recognized this by acknowledging that scenarios with probabilities less than one in ten thousand could be ignored, and when EPA noted that "performance assessments need not evaluate in detail the releases from all events and processes."

-The uncertainty in knowing how much more restrictive the "three-bucket approach" is, when compared with the original standard. In the December 3, 1991 letter from Robert M. Bernero to Margo Oge, the NRC staff demonstrated the basis for its belief that its proposed alternative would be no more and no less stringent than EPA's 1985 standards.

-Whether the determinations of probabilities must be more accurate, or less accurate, than those required for showing compliance with the original standard. The NRC staff's alternative would require significantly less precision for probability estimates for most "unlikely" scenarios since those scenarios would not need to be included in a CCDF. If the consequence of an "unlikely" scenario were greater than 10X EPA's table, it would only be necessary to demonstrate that the scenario is not "sufficiently credible to warrant consideration." (If the consequence is less than 10X EPA's table, no probability estimate would be needed at all.) For "likely" scenarios, i.e., those that significantly influence the overall probability of exceeding 1X EPA's table, there would be no difference between the two concepts.

-Whether the probability limits for the buckets take parameter variabilities into account. As noted in the response to DOE's first "question," the NRC staff's alternative does not define "buckets" into which scenarios must be placed. The staff's alternative establishes a deterministic release limit (ten times EPA's table) which applies to all credible scenarios, regardless of scenario probability. An additional, probabilistic requirement would also be applied to the more likely scenarios -- i.e., at least a 90 percent likelihood that the projected release would be less than EPA's table. DOE's demonstration of compliance

with the latter requirement would need to include as many scenarios as necessary to demonstrate a likelihood of at least 90 percent.

DOE's question may indicate a different concern -- i.e., treatment of uncertainties in release estimates when evaluating compliance with the deterministic release limit (ten times EPA's table). The NRC staff recognizes that any estimate of release will be uncertain, and that only a relative few of the sources of uncertainty can be quantified with any precision. The NRC's regulations accommodate such uncertainties, both those that can be quantified and those that cannot, by requiring a demonstration of "reasonable assurance" of compliance. EPA's standards use a similar term, "reasonable expectation," for the same purpose. In the NRC staff's view, the "reasonable assurance" concept will allow an appropriate regulatory evaluation of the uncertainties in DOE's demonstrations of compliance with EPA's standards, whether those standards adopt the staff's proposal or retain EPA's 1985 language.

In summary, DOE's analysis of the NRC staff's proposal indicates no reason to change the fundamental concepts originally proposed. The revised wording suggested above may prove easier to understand since it more clearly articulates the concepts of a scenario-based analysis of repository performance, and it more clearly imposes two separate regulatory criteria on repository performance. Also, formulating the containment requirement in CDF, rather than CCDF, language might help observers to better understand this alternative. In particular, "completeness" of an analysis is not required. It is only necessary to include a sufficient number of scenarios to demonstrate the required 90 percent likelihood that releases will be less than EPA's table. Once that level of likelihood has been demonstrated, incorporation of additional scenarios into a CDF would not be necessary.

Multimode Release Limits The NRC staff has no strong objection to the general concept of using different tables of release limits for evaluation of releases to different points in the environment. In fact, it may be an attractive compromise between the simplicity of the single table of EPA's 1985 standards and the desire for greater realism evident in DOE's suggestion for use of a limit on collective doses resulting from releases. The multiple table approach would eliminate some of the potential conservatism inherent in EPA's 1985 standards while avoiding the significant difficulties inherent in projections of collective doses over long time periods. The NRC staff notes, however, that additional explanation will be needed regarding application of multiple tables of release limits. Some releases may enter more than one environmental compartment, as when a release to the land surface is transported to a river through erosion, and then to the ocean. EPA will need to explain whether such pathways were considered when deriving the tables of release limits, or whether pathway modeling is to be done on a site-specific basis when implementing the standards.

The NRC staff anticipates substantial difficulty in implementing DOE's "point of compliance" concept for evaluating potential releases. The effect of this concept would be to treat portions of the environment as "barriers" to release of wastes. The NRC staff objects to this concept since it may be difficult for DOE to exercise effective, long-term control over any portion of the environment outside of the controlled area. Of greatest concern is DOE's suggestion that

releases to groundwater be ignored except to the extent that radionuclides are projected to be withdrawn through a well. Projecting the locations of wells and the amount of water withdrawn from them for 10,000 years after disposal may prove to be as difficult as projecting population sizes and locations for collective dose estimates. The NRC staff recommends that EPA reject DOE's "point of compliance" concept and, instead, retain the "accessible environment" definition used in the 1985 standards.

The NRC staff objects to DOE's proposed use of "site adjustment factors." DOE states that "[EPA] assumed, in deriving the release limits for the river and well releases . . . that the entire drainage system of all rivers . . . and all aquifers . . . are contaminated by the released radionuclides." The NRC staff questions both the accuracy of this statement and its relevance. In EPA's environmental transport model, EPA estimated collective impacts by determining the fraction of released radionuclides that would enter various pathways leading to humans. The concentrations of these radionuclides were not determined and were, in fact, irrelevant since individual impacts were not estimated. In EPA's model, potential releases would be transported by groundwater to a river. Then, withdrawals of water from the river for irrigation and for drinking water use would cause 10% of released radionuclides to enter food pathways and would cause 0.013% to be directly ingested with drinking water. In EPA's model, these fractions are not sensitive to the size of the river or to the location of discharge of contaminated groundwater. DOE's suggested use of "site adjustment factors" appears to be an attempt to estimate the likelihood that any individual person would be affected by a repository release. Since EPA's containment requirements are based on collective, rather than individual, risk, DOE's "site adjustment factors" seem to be inappropriate, and the NRC staff recommends that EPA not incorporate them into the standards.

The NRC staff would not consider it advisable to use duplicate tables of release limits for traditional and SI units of radioactivity. A single table, perhaps with a footnote indicating the conversion factor for the alternate system of units, should be sufficient.

Collective Dose The NRC staff has no objection to a collective dose formulation for EPA's standards, provided that such a formulation is accompanied by specification of a "standard biosphere," much like that suggested by DOE. As noted above, however, multiple tables of release limits may prove to be a more workable way to remove some of the potential conservatism inherent in EPA's 1985 standards while avoiding the problems inherent in projecting collective doses over long periods of time.

The NRC staff does not recommend that EPA allow the option of selecting from a suite of alternative standards (release limits or collective dose). The complexity of such standards, as well as the appearance of allowing the applicant to select the least stringent standards for a particular repository, would both be serious drawbacks to the alternative standards concept proposed by DOE. Instead, EPA should select a single, preferred formulation of its standards, and require compliance with those standards for all repositories.

TRU Waste Equivalency Unit The NRC staff has previously stated its view that the technical achievability basis underlying EPA's standards should be supplemented

by comparisons with other radiation protection standards and other accepted risks. Using technical achievability alone, it is not clear that EPA can develop any defensible basis for a TRU waste equivalency unit, since EPA has not evaluated the waste isolation capabilities of conceptual TRU waste disposal facilities.

Assuming that EPA adopts our previous recommendation for supporting the standards, the NRC staff wishes to voice its support for the general concept presented, at different times, by Neil Numark (EPA contractor), Jim Channell (New Mexico EEG), and Bill Russo (EPA staff). Using this approach, equivalent units of waste would be derived by considering both the half-lives of the radionuclides present in different types of wastes and the "environmental dose conversion factors" for those radionuclides. In effect, this approach would consider two units of waste to be equivalent if release to the environment of the average activity present during 10,000 years would cause an equivalent number of health effects.

Uncertainty Propagation The NRC staff has previously expressed its reservations about any requirement to project repository impacts longer than 10,000 years. We continue to believe that such projections would be highly uncertain, and would not likely provide a firm basis for judging the acceptability of a repository.

DOE argues that the time period for application of the individual and groundwater protection standards should be maintained at 1,000 years, rather than extending it to 10,000 years. In our view, DOE has not provided convincing justification for its recommendation. We see no reason why projections of individual doses or of groundwater contamination levels should be significantly more difficult than projections of cumulative releases. If cumulative releases can be projected for 10,000 years, it seems that the other measures of impact could be projected for that period of time also.

Carbon-14 DOE's presentation of the "carbon-14 issue" appears to the NRC staff to be one-sided and misleading. DOE correctly notes that potential gaseous releases from an unsaturated zone repository would be rapidly diluted to concentrations so low that individual impacts would be only a very small percentage of natural background radiation levels. However, DOE fails to mention that collective impacts from such releases could be substantial. Suppose, for example, that the 10,000-year release of carbon-14 would be 8,000 curies, as estimated in DOE's presentation. It is well known that the projected global collective dose commitment is about 400-500 person-rem per curie. Thus, 3 to 4 million person-rem would result from an 8,000 curie carbon-14 release. If these person-rem were valued at \$1,000 each, as suggested in the NRC's regulations for nuclear power plants, the U.S. should be willing to pay as much as 3 to 4 billion dollars to prevent such a release. Coincidentally, DOE's estimate of the cost to prevent release of carbon-14 falls within this range.

The collective dose estimate of the preceding paragraph raises a fundamental question which the NRC staff urges EPA to face head-on. That question is whether a collective dose estimate composed of tiny doses over thousands of years to billions of people is a meaningful basis for standard-setting. In the NRC staff's view, it is not. Uncertainties regarding the health risks of tiny doses

are so great as to make this type of collective dose estimate virtually meaningless. In addition, the long times over which doses would be incurred raises questions about a possible need to discount either the doses projected or the value of current expenditures for prevention of future doses. As EPA is well aware, discounting is a subject whose philosophical basis has uncertainties at least as large as the uncertainties about the health significance of the dose estimates. Thus, the NRC staff urges EPA to accept DOE's proposal, even though the staff does not completely agree with DOE's rationale.