October 4, 1995

Mr. Ronald A. Milner, Director
Program Management and Integration
Office of Civilian Radiactive
Waste Management
U.S. Department of Energy
1000 Independence Ave. SW
Washington, DC 20585

SUBJECT: U.S. DEPARTMENT OF ENERGY (DOE) ANNOTATED OUTLINE FOR TOPICAL REPORT, "DISPOSAL CRITICALITY ANALYSIS"

Dear Mr. Milner:
Pursuant to the U.S. Department of Energy (DOE) request in its letter to me of August 18, 1995, the U.S. Nuclear Regulatory Commission staff has performed a scoping review of the subject annotated outline (AO), in accordance with NRC's high-level waste topical report (TR) review plan. Our review focused primarily on the planned purpose, scope, and content of the proposed TR. NRC staff agrees that a methodology for criticality control analyses for a geologic repository is an appropriate subject to be addressed by a TR. However, the staff believes that some changes should be made to the AO to properly characterize the purpose, scope, and content, and any corresponding limitations of the proposed TR.

Generally, the staff believes that the focus of the TR should be narrowed. For example, we would recommend that the methodology be specific to the Yucca Mountain site, to the extent practicable, and that the scope of the report be limited to the post-closure period, as there are significantly more issues and uncertainties related to post-closure criticality control. This is consistent with our interest in focusing our resources during this period of prelicensing consultation on the most difficult and significant technical issues. Enclosed are specific comments, and our bases for making them, that were generated by the scoping review. We would like to discuss these comments at the upcoming technical exchange on October 10, 1995. NRC intends to track the DOE's response to the scoping review, but will not track the comments individually.

If you have questions, or would like to discuss these issues further, please contact NRC project manager, Robert Johnson, on (301) 415-7282.

Sincerely,

Joseph J. Holonich, Chief
High-Level Waste and Uranium
Recovery Projects Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

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RETURN TO REGULATORY CENTRAL FILES

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Office of Civilian Radiactive
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U.S. Department of Energy
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Washington, DC 20585

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If you have questions, or would like to discuss these issues further, please contact me on (301) 415-6643.

Sincerely,

Joseph J. Holonich, Chief
High-Level Waste and Uranium
Recovery Projects Branch
Division of Waste Management
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CC List for Milner letter dated October 4, 1995

cc: R. Loux, State of Nevada
J. Meder, Nevada Legislative Counsel Bureau
W. Barnes, YMPO
C. Einberg, DOE/Wash, DC
M. Murphy, Nye County, NV
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S. Brocoum, Las Vegas, NV

Scoping Review

U.S. Department of Energy Annotated Outline for Topical Report, "Disposal Criticality Analysis"

Prepared By: Division of Waste Management
U.S. Nuclear Regulatory Commission

Background:

The U.S. Nuclear Regulatory Commission has traditionally accepted topical reports (TRs) for review of specific technical issues which could be performed independent of a particular licensing action. After review, and if approved by the staff, a TR can be incorporated by reference in a license application (LA). Provided that the TR is appropriately applied in the application, further technical review by staff during licensing is minimized. The primary benefits of TR's are the reduction of duplicative effort, standardization, and the associated increased efficiency in review for multiple licensing actions.

Although the high-level waste (HLW) program expects to receive only a license application for the Yucca Mountain site, NRC has recognized a benefit from the use of the U.S. Department of Energy's (DOE's) License Application Annotated Outline supplemented by a few TRs for those topics agreed to by NRC and DOE. These TRs are expected to eventually be used, in part, to demonstrate compliance with 10 CFR Part 60. NRC has developed a TR review plan[1] which details NRC's HLW TR review procedures. This review represents a scoping review performed pursuant to that plan.

Below, NRC has listed comments resulting from our scoping review of the document, "Annotated Outline for Topical Report, 'Disposal Criticality Analysis,'" submitted to NRC under cover letter (S. Brocoum, DOE, to J. Holonich, NRC) dated August 18, 1995.

Comments

1. The TR should be developed specifically to address Yucca Mountain and not generic repository criticality methodologies. This will narrow the scope of issues and provide consistency with the DOE LA and the NRC LA review plan, which will be site-specific documents. A methodology for dealing with classified and proprietary information should be established by the TR.

2. Methodologies for criticality control for the geologic repository operations area (GROA) should be based upon existing criticality control techniques which have been well established through operating experience, such as that at other DOE and NRC licensed facilities. Although NRC recognizes that pre-closure criticality control issues will have to be addressed during licensing, and are important considerations in the protection of workers and public health and safety, NRC does not expect that considerable uncertainty

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[1] The Topical Report Review Plan was transmitted to DOE under cover letter (J. Holonich, NRC, to D Shelor, DOE) dated February 28, 1994.

exists, nor that new or innovative procedures will have to be developed, for operations at the GROA as they relate to criticality control. With this in mind, and due to our limited staff availability and resource constraints, our view is that GROA criticality control is not a subject which must be handled through a TR, and recommend that it be removed from the TR. GROA criticality control would be treated separately from the disposal criticality TR, as part of the LA annotated outline (AO) or Site Characterization Plan progress reports.

In summary, staff believes that sufficient uncertainty exists for the post-closure control of criticality, and sufficient differences in the techniques to be applied, to warrant that this TR be limited to post-closure considerations. NRC generally supports the three-phase approach to criticality control suggested in the TR AO, but does not believe that the operational period (phase 1) warrants consideration in this TR.

Finally, to be consistent with the above, staff suggests that the title of the TR be changed to "Post-Closure Disposal Criticality Analyses Methodology Topical Report."

3. In the "Introduction," the list of items for which NRC approval is sought should be clarified and supplemented.

(a) The meaning of the second bullet, which states, "The deterministic criticality analysis methodology to be used to determine the upper safety limit for a given parameter as a function of the defined energy spectrum characterizing parameter," is unclear. Please clarify this phrase.

(b) Staff believes it would be beneficial if the specific processes and events considered, including anticipated processes and events (APEs) and unanticipated processes and events (UPEs), to which the methodology described in the TR will apply, are identified. The relationship of the APEs and UPEs to the terms used in the AO (i.e., "normal," "off-normal/accident," and "incredible") should be clarified. Due to potentially different strategies for dealing with widely varying types of events, NRC review and approval of methodologies on an event-specific basis seems appropriate. APEs and UPEs subsequently identified (e.g., through site characterization activities), and their relationship to the methodology presented in the TR, could then be incorporated through amendments to the TR.

(c) The design bases for criticality control should be provided in the TR. This would include repository layout and features, engineered features, and waste forms which were assumed in developing the scope of applicability of the methodology presented in the TR. The reference design geometric and materials properties of the packages, baskets, and overpacks should be included. Lastly the nominal design K_{eff}, and the conceptualizations and conditions under which it applies, should be identified. Future changes to design features, which impact the methodology for demonstrating criticality control, could be incorporated through amendments to the TR.

4. Regarding the "Regulatory Perspective," the interpretations and assumptions made concerning NRC, DOE, and the U.S. Environmental Protection Agency regulations and guidance should be specifically identified. The thought process and analyses relating these interpretations and assumptions to the design bases, methodology development, and problem conceptualization should be detailed. Examples include:

(a) How is the double contingency principle of 10 CFR 60.131 interpreted and applied for criticality control design during the isolation phase of the repository?

(b) How will experimental uncertainty and calculational bias be established and applied for post-closure, probabilistic analyses? How will uncertainties, from probabilistic calculations of credible conditions, be propagated through deterministic, static calculations for criticality? What about kinetic calculations?

(c) What time frame is being used for the methodology? How has this affected any design bases? (e.g., Were required boron-10 loads for container baskets determined based upon depletion and leaching calculations, which were subsequently cut off at a certain time?)

(d) What screening criteria are applied to establishing credible events and processes? (e.g., Is the performance assessment guidance of 40 CFR 191 Appendix C used?)

5. The methodology for providing designed criticality control should be identified and justified, for the combinations of containers and types of fuel expected for the repository. Differences in criticality control design bases should be explained. Where appropriate, alternate considerations given to special case fuel (e.g., advanced test reactor fuel, Ft. St. Vrain fuel, naval fuels) should be explained. A method for dealing with future reactor fuels (e.g., high enrichment, high burnup, or gadolinia-bearing fuels) should be identified to the extent practicable, including a methodology for validating burnups and isotopic compositions for these fuels. Waste disposal suitability criteria (i.e., Chapter 5 in the proposed AO) would factor into these explanations.

6. The general methodology for demonstrating criticality control, presented in the AO Chapter 3, seems logical. However, implementation of this approach should be described in greater detail in the AO. The comments in this area are:

(a) It is unclear to staff how validation of the models and establishment of the appropriate range of applicability will be accomplished through the experiments described in the AO. This is particularly true for scenarios resulting in altered packages or for phenomena external to the waste packages. NRC requests clarification on this issue. The methodology TR should provide guidance for techniques of code-to-code validation, which staff anticipates will be important for post-closure criticality control demonstrations. Due to the temperature fluctuations in the waste packages, DOE should also address temperature effects in K_{eff} calculations and benchmarking experiments.

(b) The relationship between the probabilistic models used to define input states and the deterministic criticality studies, and the propagation and treatment of uncertainties through both, should be established. A technique for assessing and addressing the sensitivity of the input parameters to the criticality potential should be established. The relationship between the sensitivity of a particular parameter towards inducing criticality, versus its sensitivity towards the overall performance of the facility should be developed. Will a final result be attained which indicates the "overall criticality frequency," similar to the "overall core damage frequency" of reactor probabilistic risk assessments? Or will some other parameter be used to characterize the criticality potential? How will the risks of criticality be related to the overall system performance?

(c) NRC believes that developing a methodology for modelling waste form and container degradation rates is a necessary part of the topical report on disposal criticality control. However, much of the information associated with waste form and container degradation will be incomplete at the time of submission of the disposal criticality methodology TR. Nevertheless, NRC recognizes that waste form and container degradation phenomena will have a major impact on the types and nature of criticality calculations. Accordingly, we recommend that DOE limit the disposal criticality methodology TR to conservative, well identified assumptions regarding waste form and container degradation. The analyses should include other waste package degradation modes in addition to corrosion, such as mechanical failure due to materials instability or external stresses. As knowledge is gained in this area, additional calculations, as appropriate, could be used to supplement or revise the disposal criticality methodology TR.

(d) It would be useful if guidance for event and fault tree development for post-closure criticality sequences were developed in the methodology TR.

(e) The AO states that events that may result in criticality both inside and outside the engineered barrier system (EBS) will be considered. The implications of the term "outside" the EBS are unclear. NRC agrees that these events should be considered by the topical, but staff considers that the AO should be expanded and clarified to adequately address this subject.

7. NRC considers, given the uncertainties associated with long-term predictions and in modelling dynamic events such as criticality excursions with limited and uncertain input data, that consequence studies of criticality events should be performed for those event sequences which contribute significantly to the overall criticality risk. Such analyses will place additional perspective on the system performance and the appropriateness of the selected design bases, and add general confidence to the approaches used and conclusions drawn about the adequacy of criticality control design features. NRC believes that a methodology for such analyses merits a separate chapter in the TR.

8. Lastly, the TR should briefly describe any on-going or planned research or performance confirmation activities that relate directly to the criticality control features of the waste package (e.g., long-term corrosion studies of neutron absorbing basket materials or structures).