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MAR 22 2000

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U.S. DEPARTMENT OF ENERGY (DOE) REVIEW OF U.S. NUCLEAR REGULATORY COMMISSION'S (NRC) CONTAINER LIFE AND SOURCE TERM ISSUE RESOLUTION STATUS REPORT, REVISION 2

The DOE has reviewed Revision 2 of the Issue Resolution Status Report (IRSR) on the Key Technical Issue of Container Life and Source Term. The enclosed comments are directed primarily at the acceptance criteria for the subissues associated with container life and source term and related discussions of the technical bases supporting those criteria.

In general, the DOE agrees with the risk-informed, performance-based approach that the NRC staff has adopted in its development of the proposed 10 CFR Part 63. However, we are concerned that some of the discussions in the subject IRSR contain implicit or explicit requirements beyond those in the acceptance criteria. A number of these requirements and some of the acceptance criteria themselves appear to be more prescriptive than is the intent of the performance-based proposed 10 CFR Part 63. They appear to remove the flexibility contained in the proposed regulations and are not clearly linked to repository performance. These concerns are noted in our comments.

DOE appreciates the opportunity to review the IRSRs and provide comments for your consideration. The enclosure contains both general and specific comments. We request that these comments be considered in the preparation of the next revision of the IRSR.

If you or your staff have any questions regarding our comments, please contact Paige Russell at (702) 794-1315 or Carol Hanlon at (702) 794-1324.

Stephan Brocum
 Assistant Manager, Office of
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OL&RC:TCG-0840

Enclosure:
 Comments on Issue Resolution Status
 Report, Revision 2, September 1999
 Key Technical Issue: Container Life
 and Source Term

*NMSSOM
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**COMMENTS ON ISSUE RESOLUTION STATUS REPORT
REVISION 2, KEY TECHNICAL ISSUE:
CONTAINER LIFE AND SOURCE TEAM**

General Comment

A number of acceptance criteria in the issue resolution status report (IRSR) are related to materials for waste packages and supporting hardware that are not part of the current repository design concept. For example, on Section 3.4, page 15, paragraph 3, the discussion of carbon steel and concrete drift liner is no longer applicable. On Section 4.2.2, page 23, the discussion of thermal embrittlement in carbon steel materials is no longer applicable to the waste package.

DOE recommends that references to materials in the IRSR, that are not part of DOE designs currently under consideration, be revised to recognize the lack of applicability to current designs. Also, DOE recommends that all criteria related to specific design measures be caveated as appropriate to acknowledge the criterion is inapplicable if the design measure discussed is not used in DOE's design.

Specific Comments

1. Section 3.1, page 7, item viii states that the "release rate of actinides will be controlled by solubility limits rather than by colloidal stability."

This is not an accurate statement based on the Site Recommendation (SR) Performance Assessment (PA) models currently under development. Am, Pu, and probably Th and Ac, will be transported as irreversibly and/or reversibly bound to colloids in the models. The IRSR statement seems to be based on DOE's earlier position. DOE recommends changing the text to say the "release rate of some actinides..."

2. Section 3.2.2, page 8, next to last sentence states that "Thermal stability of corrosion-resistant Ni-based Alloy 22, used as inner overpack materials in the VA design and proposed as outer overpack in EDA-II, can also be compromised by prolonged exposure to elevated temperatures." The maximum temperature projected for the implementation of designs currently under consideration is less than 350° C for all projected cases. Therefore, it is generally believed that embrittlement of Alloy 22 is not a likely result.

DOE recommends that the IRSR discussion be revised to recognize DOE's intention to keep waste package temperatures low enough to prevent thermal instability of the waste package materials.

3. Acceptance Criterion (3) for all six subissues states that "Sufficient data (field, laboratory, and natural analog) are available to adequately define relevant parameters for the models used to evaluate performance aspects of the subissues."

DOE plans to address this criterion by determining whether the relevant parameter is an important factor in the calculation of the dose to the average member of the critical group, whether additional data would be useful in reducing the uncertainty, and whether additional data could be collected for a reasonable expenditure of resources and in a reasonable period of

time. Once there is little perceived benefit in attempting to further define the parameter as determined by these considerations, remaining uncertainties in the parameter will be addressed appropriately in conjunction with the Total System Performance Assessment (TSPA).

DOE recommends that the criterion be revised to state: "DOE has obtained data (field, laboratory, and natural analog) to define relevant parameters for the models used to evaluate performance aspects of the subissues and has appropriately characterized uncertainties remaining in the parameters."

4. Acceptance Criterion (8) for all six subissues states that "Model outputs were validated through comparisons with outputs of detailed process models, empirical observations, or both."

Validation suggests that the model outputs would be compared with observed results over the full range of operating conditions, including time over the regulatory period of 10,000 years. Repository models cannot be validated, as such. Strict 'validation' over 10,000 years cannot be obtained, and is not required. Sufficient confidence in the models must be shown that they are acceptable for the purpose to which they are applied. Activities to demonstrate confidence include comparison of calculated behavior with measurements in laboratory and field, comparison with alternate conceptual models and calculations approached, comparison with natural and man-made analogs, conservative and bounding of problematic model features and parameters, expert elicitation, etc.

DOE recommends that the criterion be changed to read: 'Although strict 'validation' over 10,000 years cannot be obtained, and is not required, sufficient confidence in the models must be shown that they are acceptable for the purpose to which they are applied.'

5. Acceptance Criterion (6), Subissue 1, page 20 states: "DOE has conducted a consistent, sufficient, and suitable corrosion testing program at the time of the LA submittal. In addition, DOE has identified specific plans for further testing to reduce any significant area(s) of uncertainty as part of the performance confirmation program."

For reasons noted in comment #3 above, DOE suggests that the criterion be reworded to allow DOE the flexibility to determine when enough information has been obtained, as long as remaining uncertainties are adequately characterized.

Similar wording is also found in Acceptance Criterion (7) to Subissue 2 on page 22, Acceptance Criterion (8) to Subissue 3 on page 25, Acceptance Criterion (8) to Subissue 4 on page 27, and Acceptance Criterion (8) to Subissue 6 on page 31. DOE recommends that these criteria be revised consistent with the above discussion.

6. Acceptance Criterion (7), Subissue 1, page 21 states: "DOE has established a defensible program of corrosion monitoring and testing of the engineered subsystems components during the performance confirmation period to assure they are functioning as intended and anticipated."

The container and the overall engineered barrier system are designed to be so robust that one would not expect to see evidence of failure on the order of the short time period of the performance confirmation program. Thus, the results obtained during the performance confirmation period should confirm the expected robust behavior of the overall engineered barrier system. DOE suggests revising “assure” to “enhance confidence” or similar.

Similar wording is found in Acceptance Criterion (8) to Subissue 2 on page 23, Acceptance Criterion (9) to Subissue 3 on page 25, and Acceptance Criterion (9) to Subissue 4 on page 27. DOE recommends that the criteria be revised as stated above.

7. Subissue 5, Acceptance Criterion (2) states: “DOE has identified all the features, events, and processes that may increase the reactivity of the system inside the WP. The acceptance criteria provided for the Scenario Analysis subissue in the Total System Performance Assessment and Integration (TSPAI) IRSR must also be considered.”

DOE believes that use of the term “all” is too prescriptive and could lead to confusion about what is really required. We recommend that “all the features, events, and processes” be changed to “all *credible* features, events, and processes.” For credibility, we could recommend (for postclosure) the numerical FEP criterion in 63.102(j); (for precloure) 63.2 Design basis 2. Also, we recommend adding the word “significantly” after “may” to remove implication that DOE must consider events with a non-zero but negligible effect on reactivity. The same change should be made to the first sentence in the third paragraph in section 4.5.2.

8. Subissue 5, Acceptance Criterion (4) states: “DOE has developed a technically defensible, transparent, and traceable method in assigning probability values to each of the scenario classes, scenarios, configuration classes, and configurations.”

DOE recommends that the existing wording after “method” be replaced with “...for evaluating probabilities of distinct configurations for which criticality is credible.”

9. Section 4.5.2, paragraph 2 implies that minimizing the potential for and consequences of criticality is the appropriate regulatory objective. Such an open-ended objective could allow DOE to be challenged as to why it did not pursue design measures for the purpose of minimizing criticality, although the repository performance objectives are met and the changes do not result in any discernible impact on repository performance. DOE’s criticality analysis methodology includes steps for reducing the probability and consequences of criticality if necessary to meet criteria established in the methodology, but it does not include the open-ended “minimize” term.

DOE suggests modifying the sentence to state: “DOE should develop a set of design criteria to provide reasonable assurance that the design of the waste package and engineered barrier systems are adequate to meet repository performance objectives. Such criteria may include measures to reduce the probability and/or consequences of postclosure criticality.”

10. DOE suggests that “subcritical limit” be changed to “critical limit” in the second paragraph in section 4.5.2 (and everywhere else it appears in section 4.5). DOE’s postclosure criticality method does not include a subcritical limit, for reasons explained in DOE’s responses to the NRC’s August 1999 Request for Additional Information (RAI) on *DOE’s Disposal Criticality Analysis Methodology Topical Report* (DOE 1999).
11. Section 4.5.2, paragraph 3 states “For example, events such as igneous activity..., climatic change (change to pluvial conditions).”

The proposed 10 CFR 63.115(a)(2) states that only climate change from an arid to a semiarid climate need to be considered. “Biosphere pathways shall be consistent with arid or semiarid conditions” (64 FR 8677b). The Supplementary Information published with the proposed rule explains further, “Climate change studies for the Yucca Mountain region indicate that the Yucca Mountain climate could become cooler and wetter during the next ice age; however, analyses of the fossil records from the previous ice age indicate that the climate in the area south of Yucca Mountain is likely to change, at most, to conditions consistent with a semiarid climate classification” (64 FR 8646b). All related reports should use the same language as the rule. DOE recommends that “change to pluvial conditions” be replaced with “change from an arid to a semiarid climate.”

12. Section 4.5.2, paragraph 4 states that “...the acceptability of the model through validation and verification must be established.” Strict ‘validation’ over 10,000 years cannot be obtained, and is not required. Sufficient confidence in the models must be shown that they are acceptable for the purpose to which they are applied. Activities to demonstrate confidence include comparison of calculated behavior with measurements in laboratory and field, comparison with alternate conceptual models and calculational approaches, comparison with natural and man-made analogs, conservative and bounding of problematic model features and parameters, expert elicitation, etc.

DOE recommends that the criterion be changed to read: ‘Although strict ‘validation’ over 10,000 years cannot be obtained, and is not required, sufficient confidence in the models must be shown that they are acceptable for the purpose to which they are applied.’

13. DOE suggests that the word “could” be added after “that” in the first sentence of the fifth paragraph in section 4.5.2 to reflect the probabilistic nature of the assessment required. Also, we recommend changing “determined” to “evaluated” for the same reason.
14. Section 4.6 states that discussion of various engineered barriers is given because they may be in the LA design. DOE suggests that the text should also note that any particular acceptance criterion is only applicable if DOE has decided to incorporate it into the LA design and that otherwise DOE is not required to discuss the topic.

15. Subissue 6, Acceptance Criterion (6) states: "DOE has identified the chemical composition of the water in the environment surrounding the WPs and its evolution with time."

The language suggests that there can be certainty regarding the chemical composition of water around the waste packages. Because water will enter the environment surrounding the waste package some time in the future, the exact composition cannot be known. It can only be described in terms of probabilities. DOE recommends replacing "identified" with "investigated and described the variability in."

16. Section 4.6.2, page 32 describes the drip shield in terms that may assign functions to the drip shield that are not assigned by DOE. This is exemplified by the statement: "...part of the design of an effective drip shield is to physically separate the water that it sheds from water that condenses under it and flows through breached waste packages." The drip shield cannot prevent such waters from co-mingling in the invert.

Also, in the current baseline information controlling DOE's performance assessment, the drip shield has a shorter minimum lifetime than the waste package, which corresponds to the duration of the thermal period. Thus a primary function of the drip shield is to isolate the waste package from contact with potentially corrosive chemical conditions occurring outside the drip shield during the thermal period. DOE believes that, in the current design concept, drip shield performance is not required for the full 10,000-year performance period, although they will continue to perform even after partial degradation due to corrosion.

DOE recommends that the IRSR text be revised to reflect this comment.

17. Section 4.6, page 32, last sentence states that "... differences in electrochemical conditions ... need to be considered." The issue of an electrochemical cell set up between the steel rails and the waste packages has been examined in support of the Viability Assessment design. The issue is not being addressed for Site Recommendation. However, any reactions would lead to enhanced corrosion of the steel and not the waste package. DOE suggests the text be revised to acknowledge that the issue of electrochemical differences between waste packages and rails has been addressed.
18. Section 4.7, paragraph 1 indicates what documents will be reviewed in the process of pursuing issue resolution. (Similar text exists for all the subissues.)

It should be noted that the applicable Process Model Reports (PMRs) and Analysis and Model Reports (AMRs), as well as the features, events, and processes (FEPs) database will also be available for NRC review.

19. Section 4.7, paragraph 3 states that the NRC will evaluate DOE's demonstration that radionuclide releases will be sufficiently controlled. There is no regulatory requirement for "radionuclide release sufficiently controlled." The only regulatory requirements are for multiple barriers that make a contribution to waste isolation and that the overall performance of the repository meets the dose limit.

DOE recommends replacing “that the containers will be sufficiently long-lived and radionuclide releases sufficiently controlled and that the engineered barrier system contributes to overall repository system performance” with “that multiple barriers each make a definite contribution to meeting the overall repository system performance requirements in § 63.113 (b).”

20. Section 4.7, paragraph 5 discusses the attention that will be paid to monitoring and testing during the performance confirmation period, including container corrosion and aqueous radionuclide release.

Due to the relatively short time of the performance confirmation period and the robustness of the waste packages, it is unlikely that container corrosion or aqueous radionuclide release would be observed. Thus, the IRSR should state that results obtained in situ during the performance confirmation period should enhance confidence in the expected performance of the drip shield and container materials. In addition, laboratory drip shield, container, and waste form materials testing data should provide enhanced confidence in long-term predicted performance.

DOE suggests that the text be revised to reflect this comment.

21. Section 5.1.1, page 35, last paragraph makes a statement regarding the high temperature oxidation of Alloy 22. The statement implies that lower-temperature oxidation could be a problem. In fact, the maximum surface temperature is predicted to be less than 225°C in the repository. At this temperature and below, the oxidation of Alloy 22 is insignificant. Thus, this degradation mechanism should be eliminated from further consideration.

DOE suggests that the text be revised to reflect the above information.

22. Section 5.1.4, page 39, paragraph 1, the last sentence states that "DOE has not taken credit for the performance of stainless steel..."

This statement is not accurate. Some credit may be taken for the performance of the stainless steel. Such credit might include the reduction in the rate of radionuclide release from the degraded waste package. This subject is currently under analysis. DOE recommends changing the text to read “DOE is evaluating taking credit for the performance of stainless steel...”

23. Section 5.2.2, page 46, end of 2nd paragraph seems to be suggesting that the repository will be kept open for 300 years. The IRSR statement may have come from an earlier DOE statement regarding keeping the repository open for 300 years. However, the proposed repository safety strategy [Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) 2000] now has language that reflects the potential for keeping the repository open 50 to 125 years from initiation of waste emplacement. However, the design will not preclude keeping the repository open, with appropriate maintenance and monitoring, for 300 hundred years after initiation of waste emplacement. DOE recommends revising the text to be consistent with the current proposed repository safety strategy.

24. Section 5.3.4.1, page 54, line 15 states that the "chemistry inside a failed WP can be highly concentrated in chloride and metal chloride complexes." DOE recommends revising the text to recognize that this condition is limited to the initial thermal pulse because the potential for thermally concentrated waters is negligible after 10,000 years when the waste packages are expected to begin to fail. Thus, this condition might only occur for packages that fail early when the internals and cladding are at elevated temperatures. A DOE report currently in development (*Engineered Barrier System Physical and Chemical Environment Model*, ANL-EBS-MD-000033) will provide support for this assertion.
25. DOE does not agree with parts of the discussion in Section 5.5, which appear to reflect the NRC's request for additional information (RAI) to DOE's *Disposal Criticality Analysis Methodology Topical Report*. DOE submitted to the NRC a response to the RAI. We suggest that Section 5.5 be revised to incorporate the results of interactions and reviews related to the RAI and DOE's response to the RAI.

References

Civilian Radioactive Waste Management System Management and Operating Contractor (CRWMS M&O) 2000. *Repository Safety Strategy: Plan to Prepare the Postclosure Safety Case to Support Yucca Mountain Site Recommendation and Licensing Considerations*, Revision 3, TDR-WIS-RL-000001. ACC: MOL.20000119.0189.

U.S. Department of Energy (DOE) 1999. *Disposal Criticality Analysis Methodology Topical Report*, YMP/TR-004Q, January 1999. ACC: MOL.19990308.0035.

64 FR 8640. *Disposal of High-Level Radioactive Wastes in a Proposed Repository at Yucca Mountain, Nevada*. Proposed Rule 10 CFR 63. Washington, D.C.: National Archives and Records Administration. TIC: 242725.