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U.S. DEPARTMENT OF ENERGY (DOE) REVIEW OF U.S. NUCLEAR REGULATORY COMMISSION'S (NRC) THERMAL EFFECTS ON FLOW 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 Thermal Effects on Flow. The enclosed comments are directed primarily at the acceptance criteria for the subissues associated with Thermal Effects on Flow and related discussions of the technical bases supporting those criteria.

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 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 issue resolution status reports and provide comments for your consideration. The enclosure contains general, specific and editorial comments. We request that these comments be considered in the preparation of the next revision of the IRSR.

If you or you staff have any questions regarding our comments, please contact Deborah Barr at (702) 794-1749 or Carol Hanlon at (702) 794-1324.

Stephan Brocoum
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OL&RC:TCG-0928

Enclosure:
Comments on Issue Resolution Status Report,
Revision 2, Key Technical Issue: Thermal Effects
on Flow

DNMSS07
WM-11
Rec'd from
DNMSS 1/23/02

YMP-5

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COMMENTS ON ISSUE RESOLUTION STATUS REPORT: REVISION 2, KEY TECHNICAL ISSUE THERMAL EFFECTS ON FLOW

General Comments

1. Some of the acceptance criteria in the Issue Resolution Status Report (IRSR) do not appear to be consistent with the flexibility allowed in the NRC's proposed 10 CFR 63. For example, proposed 10 CFR 63 would require DOE to demonstrate that the geologic repository contains multiple barriers but does not prescribe which barriers are important to waste isolation or the methods required to describe their capability to isolate waste. DOE supports the evident intent of the proposed rule that it is inappropriate to overly prescribe the approach that must be used to implement and evaluate the performance of multiple barriers. However, text in the IRSR is seemingly worded to require the inclusion of specific barriers, design features, events, or processes in models (e.g., see specific comment #7 below). DOE should also be allowed the opportunity to present the technical basis for either inclusion or exclusion of specific features, events, and processes of the geologic setting in the performance assessment. As noted in some of the specific comments that follow, we suggest that some overly prescriptive guidance in the IRSR be deleted, and that the discussions in the IRSR contain no implicit or explicit requirements that are not incorporated in the criteria.

2. Some of the IRSR acceptance criteria and discussions call for conservatism. For example, Technical Acceptance Subcriterion 2.1 on page 74, states that "Parameter values (single values, ranges, probability distributions, or bounding values) are derived from site-specific data or an analysis is included to show how the assumed parameter values lead to a conservative effect on performance." As written, the only options allowed are the use of site-specific data and demonstrating that assumed values lead to a conservative effect. This does not consider the use of, for example, establishing probability distributions based on analog data or expert elicitations. Therefore this criterion appears to be inconsistent with the requirements of proposed 10 CFR 63.114(b), which would require DOE to "Account for uncertainties and variabilities in parameter values and provide the technical basis for parameter ranges, probability distributions, or bounding values used in the performance assessment."

   The Commission notes in Part VIII of the Supplementary Information in the proposed rule: "Intentional addition of conservatism, either by making the measure of performance unduly stringent or by using worst-case, bounding assumptions in the evaluation, was argued to be impractical from a regulatory point of view." DOE agrees with this view and will use conservatism where necessary and appropriate to demonstrate compliance with proposed 10 CFR 63. However, we suggest that conservatism not be prescribed in the IRSR.

Specific Comments

1. Section 3.3.7, page 31, paragraph below bullets states: "Initial results from the SHT [Single Heater Test] seem to indicate that the DKM [dual-permeability model] is most appropriate in governing heat transfer and fluid-flow processes and subsequent temperature field predictions (TRW Environmental Safety Systems, Inc., 1998 pg 3-162)."

When the Technical Basis Document was developed, the above quoted statement was believed to be valid based upon initial results from the SHT. The DKM is preferable to the effective continuum model in simulating water movement in the thermal tests, including the SHT. Based on more recent results documented in the Drift Scale Test Progress Report No. 1 (CRWMS M&O 1998) and the Single Heater Test Final Report (CRWMS M&O 1999) we still agree that DKM is a better if coupled thermohydrologic processes are considered. However, in terms of simulating temperature distributions in the local rock mass, thermal test results do not indicate that the DKM is superior to the equivalent continuum model (ECM) as previously suggested. DOE suggests that the text be revised to reflect this information.

2. Section 5.3.5, page 75: Technical Acceptance Subcriterion 3.1 states: "Specifically, it is necessary to either demonstrate that liquid water will not reflux into the underground facility or incorporate refluxing water into the TSPA and bound the potential adverse effects..." But in the same Section, the discussion for Technical Acceptance Subcriterion 3.3 seemingly precludes the first of these options by stating "The effects of refluxed water need to be incorporated into the TSPA." The discussion for Subcriterion 3.1 states that the subcriterion is considered open in part because conceptual and mathematical models do not include mechanisms that could lead to water refluxing into the drift. The TSPA models for Site Recommendation are incorporating the effects of reflux on seepage into drifts by coupling the seepage model to the thermally driven percolation fluxes. DOE is continuing to evaluate the potential for water refluxing into the underground facility and will either include it in the TSPA models, or demonstrate technical bases for excluding it. DOE requests clarification via revision to the wording in the discussion of Subcriterion 3.3 to be consistent with the flexibility contained in Subcriterion 3.1 and with the intent of proposed 10 CFR 63.

3. Section 3.4.1, page 36: The IRSR states: "MULTIFLO Version 1.0 process-level model runs were not successful due to numerical difficulties when the complete TPA base case property set was used" and "Identification of which property values from the TPA base case cause the modeling difficulties has not been completed." Page 63 of the IRSR indicates that MULTIFLO is still being used in Revision 2 of this IRSR and that current NRC/CNWRA analyses are based upon it.

   Because of the indicated difficulties with the MULTIFLO Version 1.0 model, clear interpretation of the results is difficult. DOE would benefit from an updated discussion that specifically clarifies the uncertainties in the values in Tables 1 through 6, that are based on MULTIFLO.

4. Section 3.4.3, page 41, Table 6: DOE provided a comment on Revision 1 of this IRSR that values in Table 6 appear anomalous. The comment stated:

   > "Section 3.4.3 Page 22: The text refers to Table 6, which shows very early failures under three infiltration rates, but does not indicate the temperatures or relative humidities assumed or explain what caused the early failures. In addition, the number of failures are anomalously identical for each case."

   This comment was not addressed in IRSR Revision 2, but DOE believes the comment could be revisited and addressed as part of the clarification of the status of MULTIFLO and the resulting analyses.

5. Section 4.2.1, page 45 and Section 5.2.3, page 67: Subcriterion 2.2 states "Models include, at a minimum, the processes of evaporation and condensation and the effects of discrete geologic features." In this subcriterion, the phrase "discrete geologic features" is not defined. A discrete geologic feature can range from a grain or crystal in a rock to a lithophysal cavity to a stratum to a volcano to a tectonic plate, etc. This requirement to include specific processes seemingly precludes DOE from using the options, in the future, of demonstrating that such features, events, or processes can be excluded based on site evidence or lack of impact. DOE suggests that this subcriterion be revised to allow DOE the flexibility to include or exclude specific features, events, and processes of the geologic setting consistent with proposed 10 CFR 63.114(e). Additionally, we recommend that a clarification of what specifically is meant by discrete geologic features be provided.

6. Section 5.2.4, page 67: Subcriterion 2.3 states "Models include, at a minimum, an evaluation of important thermohydrological phenomena, such as (i) multidrift dry-out zone coalescence, (ii) lateral movement of condensate, (iii) cold-trap effect, (iv) repository edge effects, and (v) condensate drainage through fractures." The discussion of this criterion indicates that DOE models' prediction of cold trap formation should include the effects of ventilation and heat transfer. It also states that effects of discrete geologic features on rapid and episodic moisture redistribution need to be incorporated, directly or indirectly, into the conceptual models used by DOE.

   DOE is assessing the need to include the effects of ventilation and heat transfer in evaluations of cold trap effects and the need to include the effects of discrete geologic features on rapid and episodic moisture redistribution. DOE will either include these effects in the conceptual models, or demonstrate technical bases for excluding them. However, the discussion seems to include requirements more prescriptive than those in the criterion. These requirements to include specific effects seemingly precludes DOE from using the options, in the future, of demonstrating that such features, events, or processes can be excluded based on site evidence or lack of impact. DOE requests clarification via revision to the wording in the discussion of Subcriterion 2.3 to indicate that either the specific processes could be included in the DOE models, or that DOE could demonstrate appropriate technical bases for excluding them.

7. Section 5.2.4, page 68: Subcriterion 2.4 states "Models include all significant repository design features." The discussion of subcriterion 2.4 states "Although the final design of the repository has not been determined, proposed modifications to the TSPA-VA repository design include use of drip shields, backfill and ventilation. The effects of such design features have been shown to have a significant effect on moisture redistribution. Therefore these design features need to be incorporated into the models..." DOE plans to evaluate all major design features important to waste isolation to comply with proposed 10 CFR 63.114. We suggest that the criterion be revised to state "Models include all major design features important to waste isolation." This would avoid the use of the term "significant," which is not well defined. DOE also requests clarification via revision to the wording in the discussion to delete the requirement that the specified design features (i.e., drip shields, backfill and ventilation) need to be incorporated into the model, as these may or may not be included in the final design.

8. Section 5.2.4, page 68: Subcriterion 2.6 states: "Conceptual model uncertainties have been defined and documented and effects on conclusions regarding performance assessed." The discussion that accompanies the acceptance criterion requires that the models be "...unambiguously consistent with physical observations of the DST or some other appropriate heater test or analog site. That is, test cases or analog sites that do not provide adequate information to discriminate between conceptual models cannot be used to reduce conceptual model uncertainty." DOE will continue to define and document conceptual model uncertainties and assess the effects on conclusions regarding performance. However, the discussion seemingly imposes additional, poorly defined requirements that exceed the scope called for by the subcriterion and which do not appear justified. DOE requests clarification via revision to the wording in the discussion to delete the seemingly overly prescriptive guidance, or the regulatory and technical bases for their inclusion be provided.

9. Section 5.2.4, page 68: Subcriterion 2.7 and Subcriterion 3.4 (page 76), both state "Mathematical models are consistent with conceptual models, based on consideration of site characteristics." In both cases, the discussions state that "mass balance of models needs to be confirmed to ensure the mathematical and conceptual models are consistent, based on consideration of site characteristics." DOE will continue to evaluate the mathematical models to ensure that they are consistent with the conceptual models. However, the requirements in the discussions do not appear to be consistent with the flexibility allowed in proposed 10 CFR 63 and the subcriteria, which do not specify that the mass balance needs to be confirmed. DOE requests clarification via revision to the wording in the discussions that the mass balance requirement be deleted, or the regulatory and technical bases for their inclusion be provided.

10. Section 5.2.4, page 69: The discussion of subcriterion 2.8 states "Alternative process-level models are not provided for critical heat and mass transfer mechanisms. For example, refluxing into the drift during the heating process can have profound effects on TSP. However, an alternative model of these processes has not been formulated to provide confidence in the original conceptual and mathematical models. In addition, results from an alternative model for seepage into a drift which indicates significantly higher level of seepage are not used in subsequent models and analyses."

    The subcriterion appropriately indicates that the alternative models and modeling approach must be consistent with available data and current scientific understanding. However, the IRSR does not provide a detailed basis that demonstrates that the alternatives suggested in the discussion are consistent with available data and current scientific understanding. Based on available information, it has not been demonstrated that mechanisms such as dripping, dripping from refluxing during heating periods, or seepage and dripping into emplacement drifts under isothermal conditions are consistent with available data and current scientific understanding. Based on available information, it has not been demonstrated that the magnitude and time of the resulting expected annual dose would be significantly changed by the omission of these mechanisms. DOE recognizes the importance of these processes and continues to investigate the potential for dripping, dripping from refluxing during heating periods, or seepage and dripping into emplacement drifts under isothermal conditions. Seepage has also been incorporated into current models. However, we believe that requiring the inclusion of such mechanisms is not consistent with the flexibility allowed under proposed 10 CFR 63.114(c) and (e) as this precludes DOE from using the options, in the future, of demonstrating that such features, events, or processes can be excluded based on site evidence or lack of impact. To

comply with proposed 10 CFR 63.114(c), we plan to consider alternative conceptual models of features and processes that are consistent with available data and current scientific understanding, and we plan to evaluate the effects that alternative conceptual models have on the performance of the geologic repository. We request clarification via revision to the wording in the discussion to not specify alternatives to be used in models and analyses in keeping with the flexibility of performance-based proposed 10 CFR 63.

11. Section 5.2.4, page 69: Subcriterion 2.10 states "Models used to predict shedding around emplacement drifts are shown to contain an adequate level of heterogeneity in media properties." In the discussion of the subcriterion, the IRSR additionally indicates that "DOE models used to predict moisture redistribution near emplacement drifts do not have the capability to predict penetration of the boiling isotherm by water flowing down a fracture. Seepage models have not been demonstrated to predict the amount of water entering an emplacement drift with an acceptable level of uncertainty. DOE models need to adequately represent these heat and mass transfer mechanisms in heterogeneous media to adequately predict shedding around emplacement drifts."

    Both the criterion and discussion seemingly require that specific features, processes, and events be included in the models and apparently are not consistent with the flexibility allowed in 10 CFR 63. Based on available evidence it has not been demonstrated that mechanisms such as penetration of the boiling isotherm by water flowing down a fracture are consistent with available data and current scientific understanding. Based on available evidence it has been demonstrated that the magnitude and time of the resulting expected annual dose would be significantly changed by the omission of such mechanisms. DOE continues to investigate the potential for seepage and continues to characterize heterogeneity. Seepage and heterogeneity are also being incorporated into current models. However, DOE requests clarification via revision to the wording in the text to remove requirements that specific features, events, and processes be represented in models as this precludes DOE from using the options, in the future, of demonstrating that such features, events, or processes can be excluded based on site evidence or lack of impact.

12. Section 5.2.4, page 70, first paragraph, last sentence: The discussion of subcriterion 2.11 states "Once the design heat load has been finalized, DOE will have to demonstrate that heater test results <u>of</u> analog site observations, used to support TH models, are consistent with predicted temperature regimes." DOE believes that "of" should be "or". Using "of" changes the meaning of the sentence completely and needs to be corrected.

13. Section 5.2.4, page 70: Subcriterion 2.13 states "Models include the effects of ventilation particularly if ventilation could result in deposition or condensation of moisture on a WP surface." This criterion prescribes a process that must be included in models and is not consistent with the flexibility allowed in proposed 10 CFR 63.114. DOE suggests that the IRSR be revised to state "Models include the effects of ventilation, or the technical basis for exclusion should be provided."

14. Section 5.2.4, page 70: Subcriterion 2.14 states "The media properties of a model contain an adequate level of heterogeneity so that mechanisms such as dripping are not misrepresented." and the discussion indicates that the "DOE models have not been demonstrated to contain an adequate level of heterogeneity so that mechanisms such as dripping from refluxing during

heating periods or from seepage under isothermal conditions are adequately and appropriately represented, provided the appropriate heat and mass transfer mechanisms are included in the conceptual and mathematical models."

The criterion is vague (i.e., it does not provide a clear definition of what constitutes an adequate level of heterogeneity) and the discussion contains mandates additional to the criterion. Based on available evidence, it has not been demonstrated that mechanisms such as dripping, dripping from refluxing during heating periods, or seepage and dripping into emplacement drifts under isothermal conditions are consistent with available data and current scientific understanding. Based on available evidence it has been demonstrated that the magnitude and time of the resulting expected annual dose would be significantly changed by the omission of these mechanisms. DOE believes that requiring the inclusion of such mechanisms is not consistent with the flexibility allowed under proposed 10 CFR 63.114(c) and (e) and precludes DOE from using the options, in the future, of demonstrating that such features, events, or processes can be excluded based on site evidence or lack of impact. DOE suggests that the subcriterion be revised to state "The media properties of a model contain a level of heterogeneity so that mechanisms consistent with available data and current scientific understanding and whose omission would significantly change the magnitude and time of the resulting expected annual dose are represented." DOE requests clarification via revision to the wording in the discussion to not contain additional requirements that are not incorporated in the criterion.

15. Section 5.2.4, page 70, subcriterion 2.15: In the discussion, the IRSR cites "recent analyses (Hughson and Dodge, 1999)" to support the assertion that non-uniformity in drift walls can lead to dripping. However, a review of this abstract in *Eos* does not provide details sufficient to evaluate the analyses, as the abstract only provides a summary discussion of preliminary results. DOE will continue to evaluate the effects of drift wall irregularities and will include them in models, if determined necessary. DOE believes that some additional discussion of the technical details would provide an enhanced basis to understand how this work could be utilized.

16. Section 4.2.1, Page 46 and Section 5.2.4, page 71: Subcriterion 2.16 states "Physical mechanisms such as penetration of the boiling isotherm by flow down a fracture are not omitted due to over-simplification of the physical medium or the conceptual model." In the discussion, the IRSR also indicates that "DOE conceptual models have not been demonstrated to contain all necessary mechanisms to ensure that all processes that could lead to water introduction into the drift and onto WPs are included. Mechanisms that provide for the penetration of the boiling isotherm are not included in the DOE conceptual model. Seepage and dripping into emplacement drifts under isothermal conditions have not been demonstrated to be adequately included in the DOE conceptual models."

    For the same reasons as stated in previous comments, we believe that requiring the inclusion of specific mechanisms is not appropriate or consistent with the flexibility allowed under proposed 10 CFR 63.114(c) and (e). DOE suggests that the subcriterion be revised to state "Physical mechanisms consistent with available data and current scientific understanding and whose omission would significantly change the magnitude and time of the resulting expected annual dose are not omitted due to over-simplification of the physical medium or the conceptual model." DOE requests clarification via revision to the wording in the discussion in Section 5.2.4 to remove additional requirements that are not incorporated in the subcriterion.

17. Section 3.3.7, page 33, first paragraph: The IRSR states "This expectation is not consistent with results from laboratory-scale heater experiments that experienced deposition of corrosive precipitates in the drift during the heating phase of the experiments (Green and Prikyl, 1998, 1999). Phenomenological results from these tests are relevant even though the chemical environment of the tests differs from YM." This laboratory scale model is also referred to on page 32, the second full paragraph.

    At the Appendix 7 meeting in April 1999, there appeared to be agreement that this model is not a good Yucca Mountain analog. A concrete liner is no longer planned for Yucca Mountain emplacement drifts, and the caustic chemistry in the model was due to a concrete liner. If this is the case, it is unclear how these tests are considered relevant. DOE suggests that the text be clarified and a more detailed basis statement be provided. Additionally, DOE requests that the IRSR clarify whether the paper by Green and Prikyl (1999) has been published. The bibliography indicates the paper was submitted to a symposium but does not indicate acceptance or publication.

18. Section 4.2.1, Page 46 and Section 5.2.7, page 72: Technical Acceptance Criterion 5 states "Equivalent continuum models are acceptable for the rock matrix and small discrete features if it can be demonstrated that water in these features is in hydraulic equilibrium with matrix water. Significant discrete features, such as fault zones, should be represented separately unless it can be shown that inclusion in the equivalent continuum model produces a conservative effect on calculated overall performance."

    This criterion is not in agreement with proposed 10 CFR 63.114(e), which states "Provide the technical basis for either inclusion or exclusion of specific features, events, and processes of the geologic setting in the performance assessment. Specific features, events, and processes of the geologic setting must be evaluated in detail if the magnitude and time of the resulting expected annual dose would be significantly changed by their omission." Additionally, as noted in General Comment #2 above, proposed 10 CFR 63 does not require or encourage conservatism. DOE suggests that the text be revised or clarified to be consistent with the intent of proposed 10 CFR 63.

19. Section 4.3.1, page 48 and Section 5.3.3, page 73: Technical Acceptance Criterion 1 states "Abstractions of process-level models may be used if predictions from the abstracted model are shown to conservatively bound process-level predictions. In particular, DOE may use an abstracted model to predict water influx into an emplacement drift if the abstracted model is shown to bound process-level model predictions of the influx of water as liquid or vapor into an emplacement drift."

    The criterion requires conservatism rather than allowing the flexibility of proposed 10 CFR 63 (See General Comment 2) and is seemingly more prescriptive than the requirements of proposed 10 CFR 63.114(g) which states: "Provide the technical basis for models used in the performance assessment such as comparisons made with outputs of detailed process-level models and/or empirical observations (e.g., laboratory testing, field investigations, and natural analogs)." DOE plans to provide the technical basis for the models used in performance assessment. DOE suggests that the text be revised to read "The technical basis for models used in performance assessment should be provided."

20. Section 5.3.4, page 74: Subcriterion 2.1 states "Uncertainties and variabilities in parameter values are accounted for using defensible methods. The technical bases for parameter ranges, probability distributions, or bounding values used are provided. Parameter values (single values, ranges, probability distributions, or bounding values) are derived from site-specific data or an analysis is included to show the assumed parameter values lead to a conservative effect on performance."

    DOE plans to account for uncertainties and variabilities in parameter values and to provide the technical basis for parameter ranges, probability distributions, or bounding values used in the performance assessment. However, proposed 10 CFR 63 does not require that an analysis be included to show the assumed parameter values lead to a conservative effect on performance. Additionally, as written, the only options allowed by this criterion are the use of site-specific data and demonstrating that assumed values lead to a conservative effect. This does not consider the use of establishing probability distributions based on analog data or expert elicitations. DOE suggests that the subcriterion be revised to state "Uncertainties and variabilities in parameter values are accounted for using defensible methods. Parameter values (single values, ranges, probability distributions, or bounding values) are derived from site-specific data or other sources, and the technical bases for parameter ranges, probability distributions, or bounding values used are provided."

21. Section 5.3.4, page 74: Subcriterion 2.2 states "Analyses are consistent with site characteristics in establishing initial conditions, boundary conditions, and computational domains for conceptual models." The criterion is considered closed by the IRSR. Nonetheless, the discussion states that "However, there remains uncertainty in values considered appropriate for infiltration at the atmospheric boundary. Additional site characterization and sensitivity analyses will be required to resolve the uncertainty to an acceptable level."

    DOE plans to account for uncertainties and variabilities in parameter values and to provide the technical basis for parameter ranges, probability distributions, or bounding values used in the performance assessment. However, we do not believe that uncertainty in values necessarily requires additional site characterization or sensitivity analyses as stated in the discussion. The "acceptable level" of uncertainty will depend on a number of factors. DOE requests clarification via revision to the wording in the discussion to remove the requirements for additional work and to recognize that uncertainties should be addressed as part of the TSPA process.

22. Section 5.3.5, page 75, Subcriterion 3.1: The discussion states: "Analyses or models predicated on the results of the seepage models should use the results of the "high-seepage" alternative models to be conservative." The discussion indicates that an assumption in TSPA-VA Technical Basis Document (based on detailed drift-scale thermal hydrologic calculations) that there is no seepage into the drift is not conservative. The discussion further indicates that "The TSPA-VA assumption of no dripping into the drift during the first 5000 years of heating is not conservative." This stress on conservatism does not appear to be consistent with proposed 10 CFR 63 (as discussed in General Comment #2). DOE plans to use conservatism as necessary and appropriate and continues to investigate seepage and currently includes seepage in models. However, we believe that conservatism should neither be stressed in this IRSR nor used as a basis for mandating inclusion of features, events, or processes. DOE requests clarification via revision to the wording in the text to not require the use of conservative

assumptions or models. DOE will continue to evaluate the use of seepage in models and will include it in final models, if determined necessary.

23. Section 5.3.5, page 76: Subcriterion 3.3 states "Conceptual model uncertainties have been defined and documented, and their effects on conclusions regarding TSP have been assessed." The last sentence of the discussion states that "The effects of refluxed water need to be incorporated into the TSPA." Subcriterion 3.3 does not specifically require inclusion of refluxed water into the TSPA. The requirement in the discussion to include specific effects seemingly precludes DOE from using the options, in the future, of demonstrating that such features, events, or processes can be excluded based on site evidence or lack of impact. DOE will continue to evaluate the need for refluxed water to be included in models . and will include it, if determined necessary. DOE requests clarification via revision to the wording in the discussion to remove the requirement that any particular feature, event, or process be included in the TSPA.

24. Section 5.3.5, page 76, Subcriterion 3.5: The discussion states "Alternative process-level models are not provided for critical heat and mass transfer mechanisms. For example, refluxing into the drift during the heating process can have profound effects on TSP, however an alternative model for such a process has not been formulated to provide confidence in the original conceptual and mathematical models. In addition, results from an alternative model for seepage into a drift which indicates significantly higher level of seepage rates should be considered in the TSPA to ensure the TSPA is conservative."

    As discussed in previous comments, requirements to include specific effects seemingly preclude DOE from using the options, in the future, of demonstrating that such features, events, or processes can be excluded based on site evidence or lack of impact. DOE will continue to evaluate seepage and refluxing into drifts and will include seepage and refluxing into drifts, if determined necessary. However, DOE suggests that the text be revised to exclude conservatism that is not a requirement of proposed 10 CFR 63 and to not prescribe particular alternative models.

25. Section 5.3.8, page 77, Technical Acceptance Criterion 6 states: "Results of the TSPA related to TEF have been verified by demonstrating consistency with results of process level models." The IRSR states that the criterion is considered open. The discussion indicates that the process-level models do not incorporate seepage into the drift under isothermal conditions and refluxing into the drift during and after the heating period are not adequately incorporated into the process-level models. The IRSR states that in the absence of process-level models that represents these mechanisms, results from TSPA cannot be considered consistent with the process-level models.

    For reasons discussed in previous comments, DOE believes that requiring the inclusion of particular mechanisms is not consistent with the flexibility allowed under proposed 10 CFR 63.114. DOE will continue to evaluate seepage and refluxing into drifts and will include seepage and refluxing into drifts, if determined necessary. However, DOE requests clarification via revision to the wording in the discussion to delete the additional requirements that exceed the scope of the criterion and that are not consistent with the flexibility allowed under proposed 10 CFR 63.

26. Section 4.1.1, page 43 and Section 5.1.3, pages 60 to 64, Technical Acceptance Subcriterion 1.7 and discussion: Many of the references cited in Section 5.1.3 are dated between 1994 and 1997, which predate the planning and implementation of the drift-scale heater test (DST). Inferences or conclusions drawn from the dated references in subcriterion 1.7 do not reflect current thinking of the majority of the YMP thermal test team with regard to heat and mass losses in the DST. The DOE suggests that the IRSR be revised to include the most current YMP thinking regarding the tests as presented and discussed at Appendix 7 meetings.

The full text of the subcriterion (including the initial clause from page 42) states "Thermohydrologic tests are designed and conducted: to account for all mass and energy losses/gains in the thermal test system." DOE has some concerns with this subcriterion and the associated discussion.

- The discussion of the subcriterion focuses on the DST. The DST was neither designed nor conducted to account for all mass and energy losses/gains in the thermal test system. Thus, the staff has proposed a criterion that will not be possible for DOE to meet for the DST.

- The IRSR requires DOE to account for *all* mass and energy losses/gains in a thermohydrologic field test like the DST. Requiring this degree of accuracy and precision for a large-scale thermal test set in a natural system appears to not be possible to meet.

For reasons discussed below, DOE does not believe that it is necessary to account for all mass and energy losses/gains. While DOE believes that the subcriterion as written is not appropriate, we recognize the NRC's concern regarding the DST and suggest that further interactions may aid in reaching a mutual agreement. The following discussion is provided to begin that dialog.

In a number of places in the discussion, the IRSR indicates that the mass and energy losses through the bulkhead of the DST are not being monitored (page 60). Contrary to the implications in the statement on page 62 (7th paragraph, 1st sentence) that "The central concern with the DST is that **unmonitored** heat and mass loss...," heat and mass loss is accounted for in the numerical simulations. Currently, it appears total heat loss is between 20 and 30 kW and the mass/water loss is approximately 35 liters per hour.

An Interoffice Correspondence (IOC) (Wagner 1999) from R.A. Wagner to M.T. Peters was released October 21, 1999 entitled "Assessment of Heat Loss Through the Drift Scale Test Bulkhead". In summary, the original plan/design of the DST bulkhead is still considered satisfactory. The bulkhead was simply intended to provide a protective and primary thermal barrier to allow personnel, both visitors and workers, to observe the heated drift and to work in close proximity to the bulkhead/heated drift with minimal risk. After additional scrutiny, extensive and more accurate characterization of the heat loss through the bulkhead is considered difficult and unnecessary.

The need to measure heat loss through the bulkhead hinges ultimately on the accuracy of numerically simulating the thermal behavior in the DST. Analyses (discussed in Wagner 1999) indicate that an assumed convective boundary condition results in good comparative agreement between measured and simulated temperatures. Thus, the lack of accurate measurements of heat loss can be offset by proper numerical modeling. This approach is preferable to a direct measurement of heat loss for reasons of practicality.

Ideally, all aspects of the DST would be exactly represented/simulated numerically. However, in a large-scale, open system test like the DST, assumptions on many factors are unavoidable. Some of these factors are bulkhead boundary conditions as well as fracture spacings/lengths/apertures, fracture/matrix permeability, fracture saturation, and, to some degree, all material properties. Despite these shortcomings, calculated results, such as temperatures and rock saturations, can be compared to corresponding measurements to allow acceptable evaluation of conceptual models. DOE does not believe the approach to addressing heat and mass exchange through the bulkhead in the DST outlined in Wagner (1999) will significantly compromise the DST.

Despite prior difficulties, DOE expects to consider additional attempts to directly measure heat and mass loss. If an effective method is implemented, subsequent measurements will be incorporated into the numerical simulations of the DST.

DOE believes that this approach is consistent with the flexibility allowed in proposed 10 CFR 63.114(b) which requires accounting for uncertainties and variabilities in parameter values and providing the technical basis for parameter ranges, probability distributions, or bounding values used in the performance assessment. We suggest the criterion and discussion be revised to be consistent with this flexibility.

Editorial Comments

27. Section 1.0, page 1: The text notes that "Each IRSR contains five sections..." and then lists the six sections contained in this IRSR.

28. Section 2.0, page 3: The text states: "In this revision, DOE's thermohydrologic testing program is evaluated in the context of the acceptance criteria for Subissue 1. Evaluation of DOE's thermohydrologic modeling program in the context of the acceptance criteria of Subissues 2 and 3 will be provided in FY1999 (Revision 2 of this IRSR)." This discussion should not have been retained in Revision 2.

29. Section 5.1.3, page 58: the discussion of subcriterion 1.1 refers to the "Topopah Springs." The correct terminology is "Topopah Spring" without "s".

30. Recognizing the IRSR was issued in August 1999, some of the discussion is dated (e.g., page 59, 2nd to last paragraph; and page 60 discusses an upcoming Appendix 7 meeting to be held on 4/28/99).

31. Section 5.2.5, page 71: Technical Acceptance Criterion 3 discussion states "This criterion will be evaluated in Revision 2 of the TEF IRSR." It appears that this is a typographic error and that the appropriate revision is Revision 3.

32. Section 5.3.6, page 77: Technical Acceptance Criterion 4 discussion states "This criterion will be evaluated in Revision 2 of the TEF IRSR." It appears that this is a typographic error and that the appropriate revision is Revision 3.

REFERENCES:

CRWMS M&O 1998. *Drift Scale Test Progress Report No. 1.* BAB000000-01717-5700-00004 REV 01. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.19990209.0240.

CRWMS M&O 1999. *Single Heater Test Final Report.* BAB000000-01717-5700-00005 REV 00 ICN 1. Las Vegas, Nevada: CRWMS M&O. ACC: MOL.20000103.0634.

Wagner, R.A. 1999. Interoffice Correspondence (IOC) from R.A. Wagner to M.T. Peters dated October 21, 1999 entitled "*Assessment of Heat Loss Through the Drift Scale Test Bulkhead*" (LV.NEPO.TEST.RAW.10/99-373) ACC: MOL.19991111.0572