

REVIEW OF:

TECHNICAL POSITION ON REPOSITORY DESIGN-THERMAL LOADS,  
NRC PUBLIC COMMENT DRAFT: AUGUST, 1990

Prepared For The Nuclear Regulatory Commission  
Contract No. NRC-02-88-005  
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CNWRA COMMENTS ON THE NRC PUBLIC COMMENT DRAFT OF THE TECHNICAL POSITION ON REPOSITORY DESIGN-THERMAL LOADS: AUGUST, 1990, RATIONALE FOR EACH COMMENT, AND SUGGESTED RESOLUTION OF EACH COMMENT

COMMENT 1

*close quotes?*

Page 2, para. 1, Sections 3.0, 3.2, 4.1.3, and 4.2

The staff takes the position that it "expects development/refinement [of models] to continue...during the period of repository construction and performance confirmation testing. It is conceded that this is a laudable goal for DOE to pursue and that it is likely to occur to at least some degree. However, NRC should give further thought to the potential ramifications of taking such a position.

**Rationale For Comment**

First, the position may be interpreted to imply that NRC could make a decision regarding Construction Authorization based on modeling which is inadequate from a regulatory perspective. This is contrary to the requirement (correctly noted in Section 4.2) that the license application and the information upon which it is based must be complete and adequate to support a licensing decision with "reasonable assurance". The regulatory requirement in 10 CFR 60.31 clearly establishes that such "reasonable assurance" is to be obtained at the time of Construction Authorization.

Second, the position builds into the licensing process an implicit escalation in licensing requirements as the repository progresses through the various stages of licensing under 10 CFR Part 60, Subpart B. This escalation is particularly evident in (a) Section 3.0 which notes that the method "is ultimately [i.e. at some time in the licensing process] based on a fully integrated formulation" but concedes starting out with one-way coupling and (b) Section 4.1.3 which states that the staff "expects DOE to develop a fully interactive model". It may be desirable from a scientific perspective for DOE to continue to improve its understanding regarding detailed prediction of repository performance. However, there would seem to be little regulatory basis or necessity for requiring DOE to continue to pursue development of increasingly more complex models when they would already have satisfactorily demonstrated compliance with Part 60 with "reasonable assurance" at the time of construction authorization. It is not clear what grounds the NRC would have for requiring further more sophisticated modeling provided that reasonable assurance had already been demonstrated, albeit with simplified models and conservative assumptions. This would appear to be a fundamental policy matter on how NRC intends to deal with DOE as a License Applicant.

## Suggested Resolution

The staff takes the position that "at the Construction Authorization stage of the repository licensing process, the DOE should demonstrate through evidence of its mechanistic understanding of thermally induced phenomena as well as coupled effects between the processes that there is reasonable assurance that there will not be an unreasonable risk to the health and safety of the public. However, this should not preclude DOE from further refinement of model if additional knowledge is gained during the period of repository construction that may be needed to reduce uncertainties and to meet the performance objectives of 10 CFR Part 60."

The following paragraphs and sections of the technical position need to be revised to incorporate the suggested resolution: page 1, para. 3; page 2, para. 1; page 2, para. 3; page 9, last para.; and Sections 3.0, 3.1, 3.2, 3.3, 4.0, 4.1.3, and 4.2.

## COMMENT 2

Page 2, para. 4; Sections 3.0, 3.1.5, and 4.1.5.

The concept "that a performance assessment (PA) model will exist, which accepts the predicted T-M-H-C responses...for evaluation of total system performance" conveys the notion that all of the detailed analysis codes must necessarily be constructed in such a manner that their outputs (i.e. calculated responses) 'feed' directly into the PA system code. In the context of the current approach to PA, this may or may not be so.

## Rationale For Comment

The current approach to "total system performance assessment" modeling recognizes (a) the likely inability to model all the details of the processes and events germane to the repository in a single 'total system' computer code and (b) the (contrasting) need to understand certain complex phenomena through the use of auxiliary analyses of such detailed processes and events. The thermal analysis will most likely be such an auxiliary detailed analysis for demonstrating compliance with 10 CFR 60.131(i) whose outputs will not feed directly into the "total system performance assessment" code.

## Suggested Resolution

The text should be revised so that the DOE is not unduly constrained in the development of its compliance demonstration and, likewise, that the NRC is not unduly constrained in the development of its compliance determination methods for 10 CFR 60.133(i). Such revisions should incorporate the important concept that detailed auxiliary analysis will likely be required to evaluate certain complex (probably near-field) phenomena which may be treated in the total system PA models in a simplified or generalized manner.

The following paragraph and sections of the technical position need to be revised to incorporate the suggested resolution: page 2, para. 4; and sections 3.0, 3.1, 3.2, 4.0, and 4.1.5.

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COMMENT 3

Section 3.1 and Figure 1

This technical position commences with detailed lower-level calculations and involves top-level performance assessment only very late in the process (Step 7 in Figure 1). In the context of the top-down approach to "total system performance assessment" (particularly the concept of iterative performance assessment) that is currently envisioned by the NRC and CNWRA staffs, this approach is inconsistent.

**Rationale For Comment**

The thermal analysis will be a detailed analysis for thermally induced complex phenomena for demonstrating compliance with 10 CFR 60.133(i) which may be treated in the "total system performance assessment" model in a simplified or generalized manner. Thus indirectly it will be a sub-set of "total system performance assessment" model and it is essential that top-down approach be used in this technical position.

**Suggested Resolution**

- 3.1 The following methodology, see Figure 1, can be used to demonstrate compliance with 10 CFR 60.133(i):
  - 3.1.1 Determine aspects of the performance objectives that are sensitive to "thermal and thermomechanical response of the host rock and surrounding strata, and groundwater system" using currently available model for "total system performance assessment."
  - 3.1.2 Examine the thermally induced phenomena in the host rock and surrounding strata, and ground water system.
  - 3.1.3 Perform study or review to identify coupled processes.
  - 3.1.4 Develop performance based design criteria for the underground facility.
  - 3.1.5 Obtain or develop detailed predictive model for analysis.
  - 3.1.6 Design repository and perform analysis with predictive model and compare results to performance based design criteria.
  - 3.1.7 Use the predicted results in a "total system performance assessment" model to evaluate compliance with the aspects of performance objectives that are sensitive to thermal loads.
  - 3.1.8 Modify both the "total system performance assessment" model and "detailed predictive" model based on findings above and iterate.

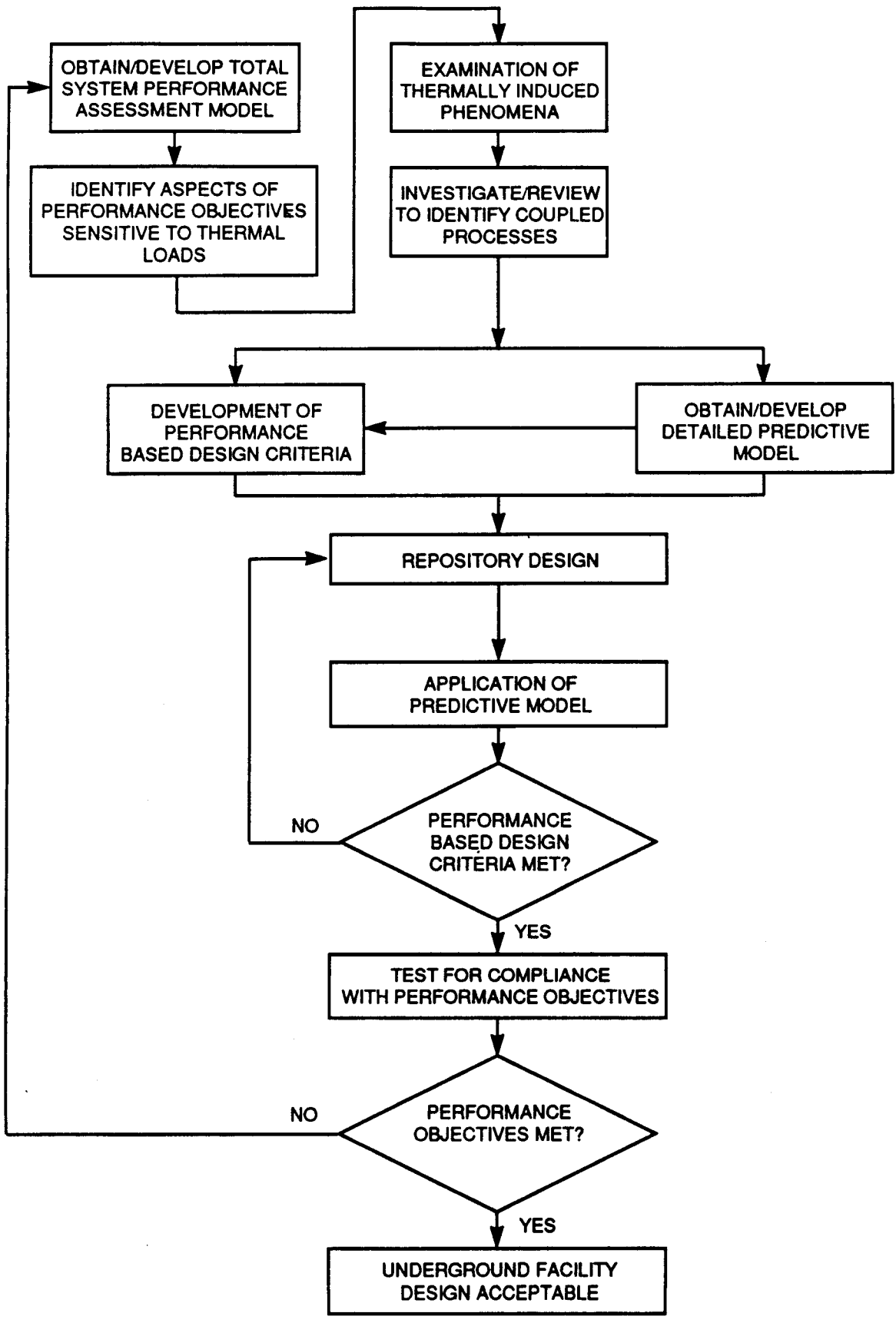


Figure 1. Suggested Methodology to Demonstrate Compliance with 10 CFR 60.133(i)

Sections 3.0, 3.1, 4.0, and 4.3, and Figure 1 need to be revised to incorporate the suggested resolution. In addition to these, sections 4.1.1 to 4.1.5 need to be expanded and renumbered to make consistent with suggested sections 3.1.1 to 3.1.8.

COMMENT 4

Sections 3.2, 3.3, and Figure 2

In the context of Comment 1, Sections 3.2, 3.3, and Figure 2 need to be revised.

**Rationale for Comment**

Same as in Comment 1.

**Suggested Resolution**

The suggested Sections 3.2, 3.3, and Figure 2 are as follows:

- 3.2 It is expected....., and groundwater system. DOE should implement a program to develop these interactive models such that they are available at the Construction Authorization state of the repository licensing process. In the event a satisfactory understanding of the synergistic effects of various possible thermal-mechanical-hydrological-chemical couplings cannot be gained in step 3.1.3 above prior to Construction Authorization state, DOE should: (1) include as a minimum, the first-order coupling, i.e., thermo-mechanical, thermo-hydrological, and thermo-chemical be investigated separately, and (2) explain the current level of understanding of second-order couplings and justify why second-order coupling have not been included.
- 3.3 If predictive model cannot be developed through a mechanistic understanding of the second-order coupling of various possible thermal-mechanical-hydrological-chemical interactions, DOE should develop detailed predictive model of step 3.1.5 above taking into account first-order coupling. This detailed predictive model should be used to predict the response of the host rock, surrounding strata, and groundwater system as suggested by step 3.1.6 above.

Figure 2 Delete.

COMMENT 5

Section 4.1.3

Section 4.1.3 states unequivocally that the staff "expects DOE to develop a fully interactive model". This appears to be (a) inconsistent with other parts of this Technical Position (TP) and (b) not justifiable given the overall approach of the TP. Consequently, it will potentially cause confusion for both the license applicant and the license reviewer.

*? is this too "strong" a word?*

**Rationale for Comment**

First, the cited statement does not recognize the important role of the development of the performance-based design criteria in Section 4.1.2. These criteria can be used to screen out certain parameters and processes that are unimportant to the performance of the repository and, is not consistent with the model evaluation/modification process described in Figure 2 (which, interestingly, is discussed later in the same section that contains the unequivocal statement). The process described in Figure 2 should be expected to show that certain coupling are not needed and, hence, can be omitted from the model.

**Suggested Resolution**

This section needs to be renumbered as 4.1.5 and should be discussed in terms of the suggested resolution of comment 3 including suggested Figure 1.

**COMMENT 6**

Page 11, para. 3

The discussion in this paragraph regarding "performance measures" should be carefully reevaluated and revised.

**Rationale for Comment**

To be useful to the task of demonstrating or determining compliance with the regulatory requirements, any proposed performance measures must satisfy two criteria. First, they must be system parameters or system responses that directly related to the performance objectives. Second, they must be capable of being expressed in a manner which permits assignment or determination of levels of acceptability for those measures.

**Suggested Resolution**

The performance measure should be expressed in such a way so that the above two criteria are satisfied, for example, release of radionuclides, groundwater travel time, waste package life, and dissolution and release of waste from the engineered barriers.

**COMMENT 7**

Pages 11, 12, and 13.

The draft technical position assert that "The ultimate test of a model is that it must be empirically adequate." It is believed that empirical adequacy should be viewed as the minimum test, not the ultimate test.

Also, the draft TP presents the model validation concept of "empirical adequacy" (Van Fraasen, 1980) as well as that of the NUREG-0856 (NRC). Although these may not fundamentally disagree with each other, they are not fully compatible.

**Rationale for Comment**

When one engages in long-term predictions such as are required in the repository program, theoretical adequacy is also required because tests of empirical adequacy by their very nature do not permit the exploration of adequacy over the time-scale of regulatory interest.

Since the TP is guidance to the DOE, some additional discussion is appropriate to establish how the NRC staff intends to use "empirical adequacy" (Van Fraasen, 1980) and the NUREG-0856 in a complementary manner.

**COMMENT 8**

Page 3, para. 4.

The statement given here implies that if the DOE follows the method given in the subject TP, then the DOE will not be asked to provide data and related information sufficient for the staff to perform an independent analysis. Is this the intention?

**Rationale For Comment**

Irrespective of what method the DOE follows, it would always provide information sufficient for an independent check by NRC. It will be then up to NRC to decide whether it will conduct independent check or just review DOE's submittals.

**Suggested Resolution**

This paragraph needs to be revised to reflect the resolution of this comment.

**COMMENT 9**

Page 3, para. 3.

This paragraph states "Technical Positions are issued to describe and make available to the public criteria for methods acceptable to the NRC staff..... to the Department of Energy." However, no criteria for methods are given in this TP. Only methods are discussed.

**Rationale for Comment**

This statement is inconsistent with the contents of this technical position.

**Suggested Resolution**

This paragraph needs to be revised to make it consistent with the contents of the technical position.