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ISSUE RESOLUTION STATUS REPORT

KEY TECHNICAL ISSUE: REPOSITORY DESIGN AND THERMAL-MECHANICAL EFFECTS

Division of Waste Management
Office of Nuclear Material Safety and Safeguards
U.S. Nuclear Regulatory Commission

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This Issue Resolution Status Report (IRSR) was prepared by Dr. Mysore Nataraja, Senior Geotechnical Engineer, Division of Waste Management, Engineering and Geosciences Branch. The author acknowledges the supervision provided by Richard Weller (Section Leader) and N. King Stablein (Acting Branch Chief) and the guidance provided by the High-Level Waste (HLW) Review Board. Ms. Edith Barbely provided her usual enthusiastic secretarial support. A number of key technical issue leads have provided inputs at various stages of completion of this IRSR. The Performance Assessment and Integration Section of the Performance Assessment and HLW Integration Branch reviewed the drafts and assisted the author in making this IRSR uniform with the other current IRSRs. Lastly, C. William Reamer, in the Office of the General Counsel, reviewed the draft for any legal objections.

1.0 INTRODUCTION

One of the primary objectives of the U.S. Nuclear Regulatory Commission's refocussed prelicensing program is to direct its activities toward resolving the 10 key technical issues (KTIs) it considers to be most important to repository performance. This approach is summarized in Chapter 1 of the staff's "NRC Annual Progress Report for FY 96 NUREG/CR-6513, No. 1," (Ref. 1). Other chapters address each of the 10 KTIs by describing the scope of the issue and subissues, path to resolution, and progress achieved during fiscal year (FY) 1996.

Consistent with 10 CFR Part 60 requirements and a 1992 agreement with the U.S. Department of Energy (DOE), staff-level issue resolution can be achieved during the prelicensing consultation period; however, such resolution at the staff level would not preclude the issue being raised and considered during the licensing proceedings. Issue resolution at the staff level during prelicensing is achieved when the staff has no further questions or comments (i.e., open items) at a point in time, regarding how the DOE program is addressing an issue. There may be some cases where resolution at the staff level may be limited to documenting a common understanding regarding differences in the NRC and the DOE points of view. Furthermore, pertinent additional information could raise new questions or comments regarding a previously resolved issue.

An important step in the staff's approach to issue resolution is to provide DOE with feedback regarding issue resolution, before the viability assessment. Issue Resolution Status Reports (IRSRs) are the primary mechanism that the staff will use to provide feedback to DOE regarding progress toward resolving the subissues comprising the KTIs. IRSRs include: (i) acceptance criteria and review methods for use in issue resolution and regulatory review; (ii) technical bases for the acceptance criteria and review methods; and (iii) the status of resolution including where the staff currently has no comments or questions, as well as where it does. Additional information is also contained in the staff's Annual Progress Report, which summarizes the significant technical work toward resolution of all KTIs during the preceding FY. Finally, open meetings and technical exchanges with DOE provide opportunities to discuss issue resolution, identify areas of agreement and disagreement, and develop plans to resolve such disagreements.

In addition to providing feedback, the IRSRs will serve as guidance for the staff's review of information in DOE's viability assessment. The staff also plans to use the IRSRs in the future to develop the Standard Review Plan (SRP) for the repository license application.

Each IRSR contains six sections, including this Introduction in Section 1.0. Section 2.0 defines the KTI, all the related subissues, and the scope of the particular subissue or subissues addressed in the IRSR. Section 3.0 discusses the importance of the subissue to repository performance, including: (i) qualitative descriptions; (ii) reference to a total system performance (TSP) flowdown diagram; (iii) results of available sensitivity analyses; and (iv) relationship to DOE's waste containment and isolation strategy (WCIS) (i.e., the DOE approach to its safety case). Section 4.0 provides the staff's review methods and acceptance criteria, which indicate the basis for resolution of the subissue and which will be used by the staff in subsequent reviews of DOE submittals. These acceptance criteria are guidance for the staff and, indirectly, for DOE as well. The staff's technical basis for its acceptance criteria are also included to further

document the rationale for the staff decisions. Section 5.0 concludes the report with the status of resolution indicating those items resolved at the staff level and those items remaining open. These open items will be tracked by the staff, and resolution will be documented in future revisions of the IRSR. Finally, Section 6.0 includes a list of pertinent references.

2.0 KEY TECHNICAL ISSUE AND SUBISSUES

2.1 Primary Issue

The adequacy of DOE's repository design in the context of the performance objectives and design criteria of 10 CFR Part 60 is the primary focus of the Repository Design and Thermal-Mechanical Effects (RDTME) KTI. The primary issue may be stated simply as "design, construction, and operation of the geological repository operations area (GROA), including seals for the shafts and boreholes, to meet the preclosure and postclosure performance objectives, taking into consideration the long-term thermal-mechanical processes."

Consideration of the time-dependent thermal-mechanical (TM) coupled response of a jointed rock mass is central to repository design and performance assessment (PA). Consequently, it is the focus of both the preclosure and postclosure elements of this KTI. Design for adequate postclosure performance requires an understanding of the TM response of the jointed rock mass over a compliance period of hundreds to thousands of years. Long-term TM response is anticipated to influence evolution of the near-field environment, waste package (WP) degradation and associated release of radionuclides, performance of seals, flow into and beyond the emplacement drifts, and radionuclide transport mechanisms within the engineered barrier system (EBS) and surrounding rock mass. Design for the preclosure operation period of approximately 100-150 years requires an understanding of TM response of the jointed rock mass as it influences drift, shaft, and ramp stability, and waste retrievability.

2.2 Subissues

The RDTME KTI has been divided into subissues. It is expected that resolution of the subissues will lead to resolution of the issue. These subissues address topics that are of regulatory concern because they: (i) are, in general, at the limit of or beyond conventional engineering experience; and/or (ii) may jeopardize the safe preclosure operations or effective postclosure performance of the GROA. Although clearly interrelated, the subissues have been formulated to minimize redundancy. Alternatives, such as organizing the subissues by repository subsystem would require, for example, seismic effects to be considered separately for the drifts, the seals, and the WPs, thus introducing extensive duplication. The four main subissues are stated below, with important considerations within each subissue being noted parenthetically, as appropriate.

(1) Implementation of an Effective Design Control Process Within the Overall Quality Assurance (QA) Program

(2) Design of the GROA for the Effects of Seismic Events and Direct Fault Disruption (including implications for drift stability, key aspects of emplacement configuration, such as fault offset distance, retrievability, and WP damage)

(3) Consideration of TM Effects on Underground Facility Design and Performance (including implications for drift stability, key aspects of emplacement configuration that may influence thermal loads and associated thermomechanical effects, retrievability, and changes in hydrologic properties that may influence the near-field environment)

(4) Design and Long-Term Contribution of Repository Seals in Meeting the Postclosure Performance Objectives (including implications for inflow of water and release of radionuclides to the environment)

This initial IRSR documents the status of resolution of one component of the first subissue and one component of the second subissue. The remaining components of the first and second subissues and the other subissues will be addressed in subsequent revisions of this IRSR. Assuming resumption of adequate funding for the RDTME KTI in FY 1998, the NRC staff intends to: (i) complete postclosure aspects of this KTI prior to DOE's submittal of the Viability Assessment; and (ii) complete both preclosure and postclosure aspects prior to DOE's submittal of the License Application.

Each of the four main subissues may, in turn, be addressed in terms of its principal components. For example, although implementation of an effective design control process permeates the entire DOE high-level waste (HLW) repository program, it may be addressed in two segments. These are: (i) the design control process employed during the design, construction, and operation of the exploratory shaft facility (ESF); and (ii) the design control process used for the design, construction, and operation of the GROA. Each component must be consistent with the overall DOE QA program. Furthermore, to the extent that the ESF is incorporated into the repository, its design must fulfill the requirements for preclosure safety and postclosure performance.

Similarly, the following three components have been identified for the second subissue: (i) the DOE methodology to assess seismic and fault displacement hazard; (ii) the DOE seismic design methodology; and (iii) seismic and fault displacement inputs to design and PAs. Note that DOE has elected to consider preclosure aspects of seismic design separate from those for postclosure, although the repository design must eventually be shown to meet both sets of requirements. While this IRSR deals with the second component (i.e., design methodology) and parts of the third component (i.e., design inputs), a companion IRSR within the Structural Deformation and Seismicity KTI addresses the remaining components.

The third subissue, namely the consideration of TM effects in design and PAs, has two important components: (i) stability of the underground excavations with regard to safety during the preclosure period, waste retrievability, and potential adverse effects on emplaced wastes; and (ii) changes of hydrological properties of fractures due to TM perturbation of the rock mass that may adversely affect the near-field environment. The first component has broad design and performance implications that will be the subject of future work under the RDTME KTI. Certain aspects of the second component are being addressed in a companion IRSR within the Thermal Effects on Flow KTI.

The fourth subissue deals primarily with postclosure performance. It is concerned with three main topics: (i) design and construction of seals (including material selection); (ii) long-term stability of seals and their components; and (iii) importance of seals in meeting the postclosure performance objectives. The RDTME and total system performance assessment (TSPA) KTIs will jointly address these topics in the future.

This version of the RDTME IRSR specifically addresses the first component of the first subissue (i.e., the design control process for the ESF) and the second component of the second subissue (i.e., the seismic design methodology), and documents the status of resolution of these components at the staff level. The specific questions being answered in this version of the RDTME IRSR are: (i) "Is the design control process employed by DOE in the design, construction, and operation of the ESF acceptable to the staff?"; and (ii) "Is the (preclosure) seismic design methodology proposed by DOE acceptable to the staff?"

A number of other components related to the general issue of GROA design are not listed here. Only the most important or potentially contentious topics, or items for which there is little or no regulatory experience or precedence are selected for focused studies under this KTI. Other potentially important components may be selected for focused study by NRC pending availability of resources during the upcoming years.

3.0 IMPORTANCE OF ISSUE TO REPOSITORY PERFORMANCE

3.1 Relationship of the Issue with DOE's WCIS

DOE has formulated several hypotheses that, if confirmed, would demonstrate that waste can be isolated at the proposed Yucca Mountain (YM) site for long periods of time (DOE WCIS, dated July 19, 1996, Ref. 2). These hypotheses include:

(1) Fracture flow occurs within a limited volume of the repository host rock at any given time.

(2) Seepage into the emplacement drifts will be limited to a small fraction of the incident percolation flux.

(3) Transport properties of both engineered and natural barriers will significantly reduce radionuclide concentrations due to depletion, diffusion, and dispersion.

(4) The amount of movement on faults through the repository horizon will be too small to bring waste to the surface and too small and infrequent to significantly impact containment during the next few thousand years.

(5) The severity of ground motion expected in the repository horizon for tens of thousands of years will only slightly increase the amount of rockfall and drift collapse.

In addition to the above strategies, DOE has made an assumption that the preclosure facilities (both surface and underground) can be designed to withstand the effects of vibratory ground motion and fault displacements, and these facilities can be built and operated with minimal maintenance over a period of 150 years.

Testing these hypotheses and design assumption will necessitate an understanding of DOE's design and the effects of time-dependent TM coupled processes taking place in the jointed rock mass on the GROA, including WPs and seals. The relationships between the RDTME subissues and DOE WCIS are indicated in Table 1 below.

Table 1. Relationship between RDTME KTI Subissues and DOE WCIS

SUBISSUE	ELEMENT OF WASTE CONTAINMENT AND ISOLATION STRATEGY				
	Seepage into Drifts	Fracture Flow	Transport Properties	Movements of Faults	Ground Motion
Design Control Process	X	X	X	X	X
Seismic Design Method			X	X	X
TM Effects	X	X	X		
Long-Term Performance of Seals	X		X		

3.2 Importance to Preclosure Performance

3.2.1 Design Control Process

Part 60 (Subpart G) specifies the QA requirements for a geologic repository. These requirements cover site characterization activities, and, therefore, also cover the design, construction, and operation of the ESF. Part 60 (Subpart G) invokes Appendix B to 10 CFR Part 50, which provides 18 criteria that govern an effective QA program. Because the ESF is anticipated to eventually become part of the GROA, the 18 criteria of Appendix B are considered applicable to the ESF also. Design control is one of the most important of the 18 criteria because it defines the means by which the design organization will establish a design baseline, track changes with respect to the baseline, and document that regulatory requirements (RRs) related to design have been fulfilled. Meeting the QA requirements is an important aspect of demonstrating compliance with preclosure design criteria during the licensing review. Prelicensing reviews by NRC staff have identified several weaknesses in the DOE QA program and design control process. Therefore, the staff considers implementation of an effective design control process by DOE to be an important programmatic issue with major preclosure performance implications.

3.2.2 Seismic Design Methodology

There are two preclosure performance objectives in Part 60, namely, meeting 10 CFR Part 20 requirements [Section 60.111(a)] and meeting the retrievability requirements [Section 60.111(b)]. DOE designs for both the surface and underground facility structures, systems, and components (SSCs) must adequately address seismic effects and direct fault disruption to demonstrate compliance with these two performance objectives. Failure of any of the structures, systems, and components important to safety (SSCIS) due to vibratory ground motion or direct fault displacement could severely impact the GROA performance during the preclosure period of 100 to 150 years. Because of this long operational period for which there is no regulatory experience for meeting public and worker radiation safety requirements and because of the unusual requirements associated with retrievability of HLW, the seismic design is considered one of the most important factors affecting preclosure performance.

3.2.3 TM Effects

Consideration of TM effects is important in the design of an effective and efficient ventilation system, which in turn is very important to meeting radiological safety objectives during the operational period. Thermal loads have considerable effects on the stability of underground openings which in turn affects waste retrievability, should that become necessary. Therefore, the evaluation of TM effects is considered important to preclosure performance.

3.2.4 Design and Long-Term Contribution of Seals to Performance

This subissue is of primary concern to postclosure performance.

3.3 Importance to Postclosure Performance

3.3.1 Design Control Process

The DOE design control process plays a major role in demonstrating compliance with the design requirements and performance objectives. Although the majority of the design requirements in Part 60 are explicitly focused on preclosure performance, many (especially for the underground facility) play a significant role in meeting postclosure performance requirements as well. Thus, the design control subissue dealing with traceability of design changes and flowdown from RRs is equally important to postclosure performance. The design control process subissue affects all the key elements of system abstraction under the engineered system shown in the attached flowdown diagram of TSPA (Figure 1).

3.3.2 Seismic Design Methodology

Design of the GROA for the effects of seismic events and direct fault disruption has several postclosure implications. The particular effects of seismic events and direct fault disruption, and consequently their importance to long-term performance, are design dependent. In general, the GROA design and the methodology used to develop that design must consider: (i) seismic effects on the WPs and other engineered barriers; and (ii) key aspects of the emplacement configuration, particularly fault offset distance.

The WPs backfill, drip shields, and other elements of the EBS that DOE may choose to deploy, as well as the surrounding rock mass, will all be subjected to repeated episodes of seismic loading during the postclosure period. The potential effects on these engineered and natural components are complex functions of the presence and properties of the various barriers. For example, degradation of rock mass strength and consequent rockfalls could be quite important if backfill is absent, but have relatively little effect if backfill is present. In contrast, the absence of backfill would tend to mitigate the effects of direct fault displacement because of the large free space available around the WP. Backfill would act to more directly transfer load to the WPs, thus having a potentially detrimental effect with respect to direct fault disruption.

These examples highlight the complexity of design considerations related to seismic effects and direct fault disruption. Furthermore, they point to the need for the PA methodology to be sufficiently flexible to address the performance implications of a range of possible designs.

In subsequent revisions of the IRSR, sensitivity studies using the total performance assessment code will be used to evaluate the effects of these phenomena on repository performance. Processes, such as rock falls and mechanical disruptions to WPs and other EBS components, will be evaluated. The seismic design methodology subissue provides inputs to "mechanical disruption of WP" key element as indicated in the attached flowdown diagram for TSPA (Figure 2).

3.3.3 TM Effects

The potential influences of TM processes on underground design and performance during the postclosure period come into play beginning with the early stages of construction. The construction methods employed for the underground facility, the geometry of underground openings (shape, size, orientation, slopes, and waste emplacement configuration), distribution

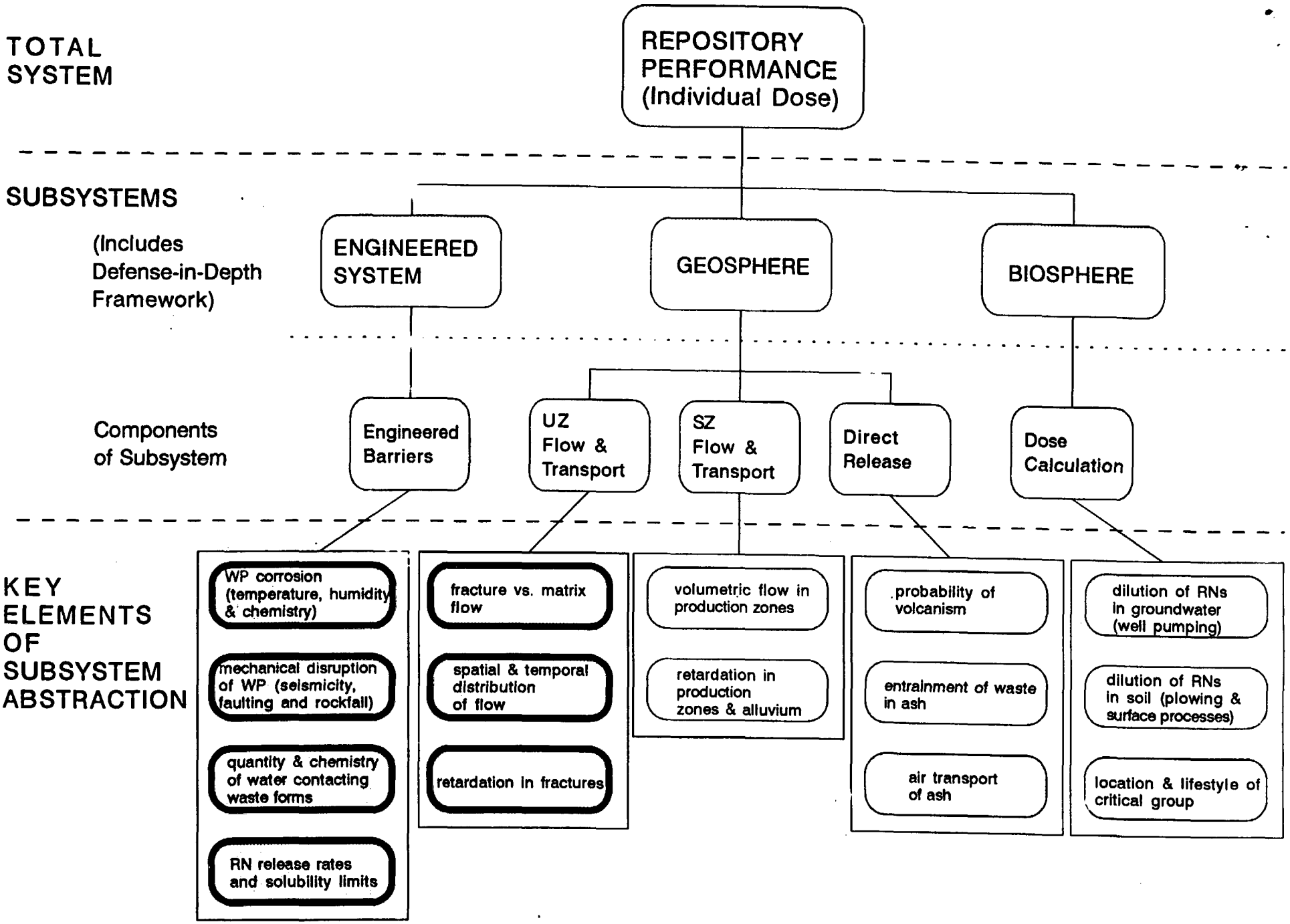

Figure 1. Inputs from design control process subissue to postclosure performance

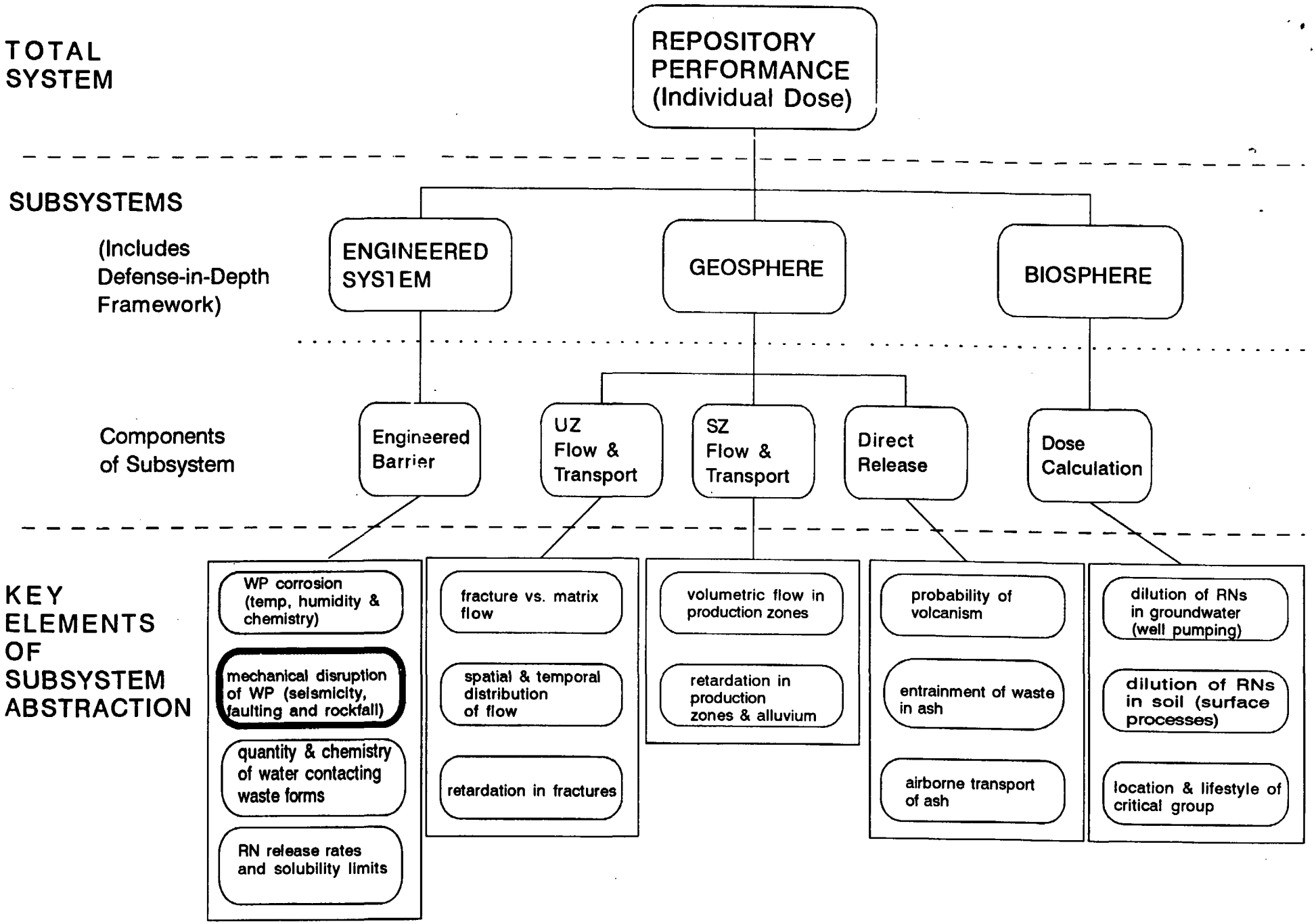

Figure-2. Inputs from seismic design methodology subissue to postclosure performance

of heat load, presence or absence of backfill, and the quality and quantity of roof support are some of the parameters that have a potentially profound effect on the long-term performance of the repository. As waste emplacement proceeds, TM effects begin to be manifest in the EBS and surrounding rock mass. TM effects combine with seismic loads to affect drift stability—particularly with unbackfilled designs. TM stresses resulting from excavation-induced changes and heat produced by the WP will be superimposed on the existing in situ lithologic stresses throughout the postclosure period.

In addition, the effect of TM interactions on the hydrologic properties of the surrounding rock mass must be considered in design and PA. Hydrologic changes caused by the thermal-mechanical stresses may affect flow in the WP near-field environment. Thus, an understanding of thermal effects is important to the staff's independent evaluation of DOE's PA. Subsequent sensitivity studies related to this subissue will evaluate the relative importance of TM effects on: (i) WP corrosion; (ii) mechanical disruption of WPs; and (iii) the quantity and chemistry of water contacting WP and waste forms. The TM effects subissue provides direct inputs to all key elements under the EBS and indirect inputs to many key elements under the geosphere subsystem, especially those under the UZ Flow and Transport component of the attached flowdown diagram for PA (Figure 3).

3.3.4 Design and Long-Term Contribution of Seals to Performance

Section 60.134 provides a specific design requirement that calls for appropriate material selection and design methods for borehole and shaft seals so that they do not become preferential pathways during the postclosure period. At the present time, it is not certain how important the seals will be in meeting the postclosure performance objectives at the YM site. The staff has taken a position that until DOE demonstrates that seals are unimportant from a postclosure performance perspective, or the staff efforts on TSPA suggest that seals do not significantly contribute to meeting the performance objectives, this subissue will remain open The seal design subissue is expected to provide inputs to "quantity and chemistry of water contracting waste form" key element in the attached flowdown diagram of PA (Figure 4).

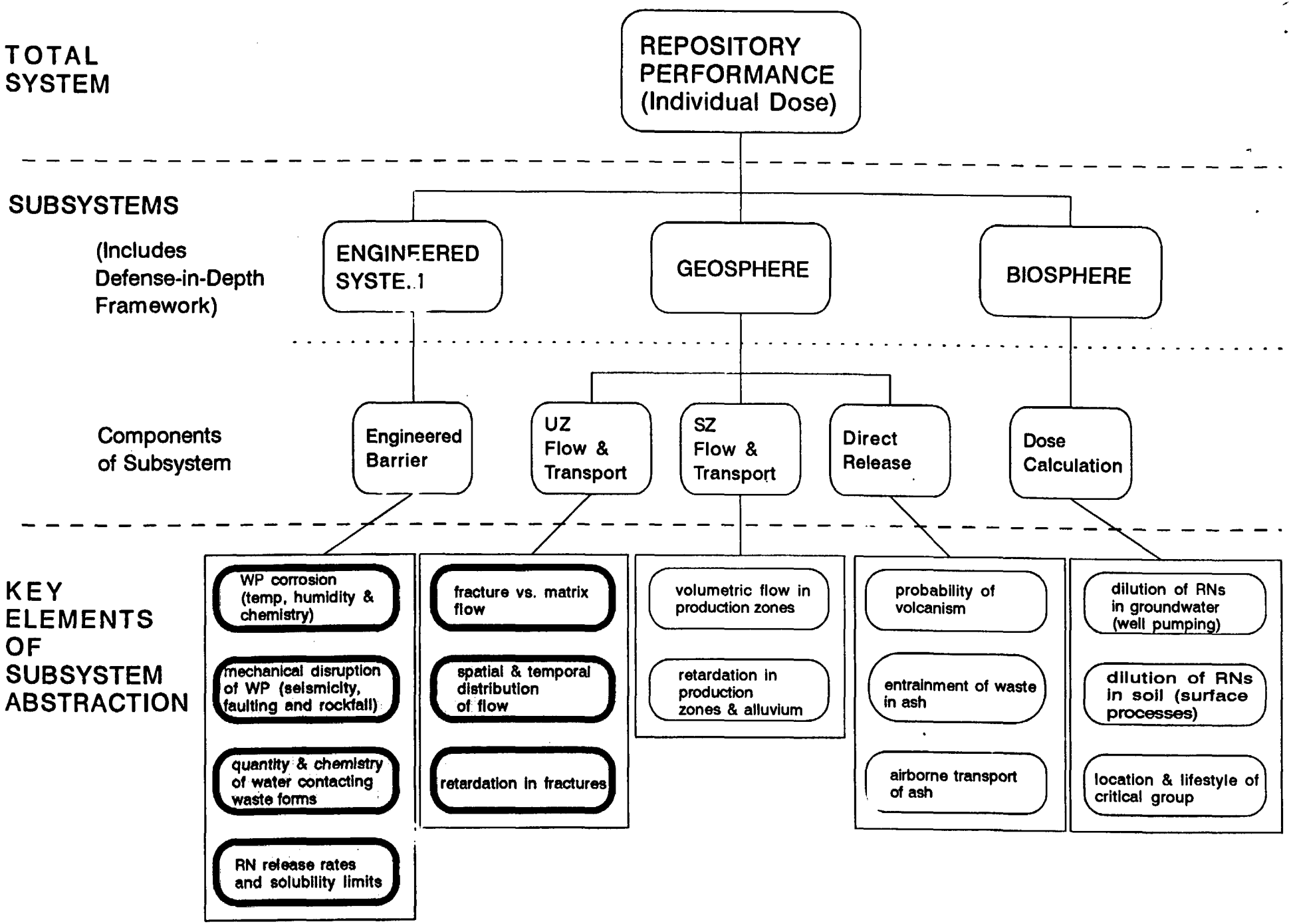

Figure-3. Inputs from TM effects subissue to postclosure performance

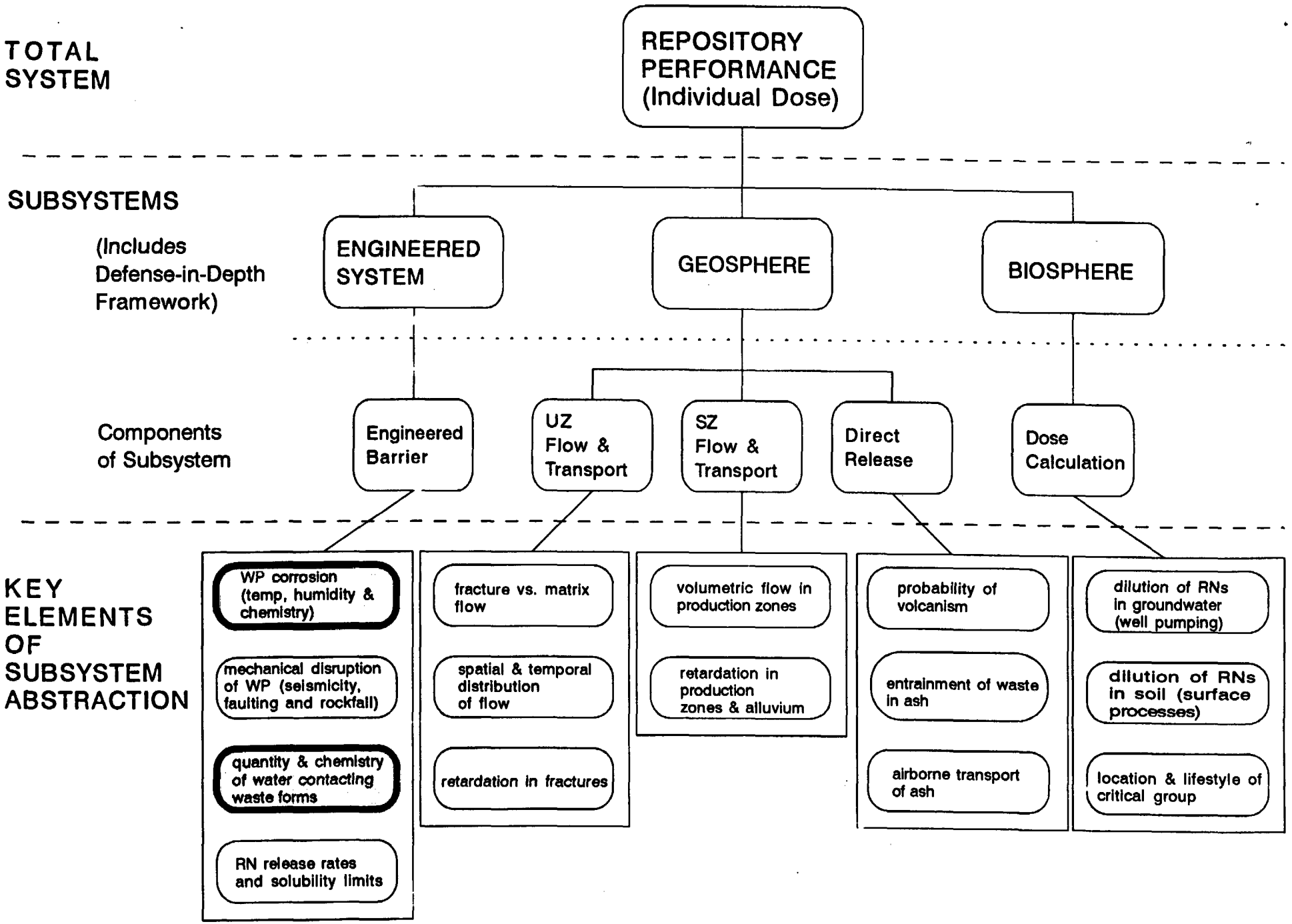

Figure-4. Inputs from seals subissue to postclosure performance

4.0 REVIEW METHODS AND ACCEPTANCE CRITERIA

Review methods and acceptance criteria for each of the four main subissues are presented and discussed in Sections 4.1 through 4.4. The first subsection of each of these sections provides simple statements of the acceptance criteria that the staff will use or has used in evaluating DOE's submittal on the particular subissue. In cases where DOE has used the Topical Report (TR) approach, criteria associated with staff reviews of the TRs are presented. These criteria will also be used in evaluating the license application to ensure that the methods proposed by DOE have been properly implemented and the resulting design meets the pertinent RRs.

The second subsection of each section provides a discussion of the technical basis for the acceptance criteria and review methods. Included are descriptions of the DOE approach, summaries of staff evaluations of the DOE approach, and results of independent work conducted by the staff.

4.1 Implementation of an Effective Design Control Process within the Overall QA Program

4.1.1 Background

The focus of this component of the RDTME IRSR is on the staff evaluation of DOE's implementation of design control process for design, construction, and operation of the ESF. According to Part 60 (Subpart G) QA, QA comprises all those planned and systematic actions necessary to provide adequate confidence that the geologic repository and its subsystems or components will perform satisfactorily in service. Section 60.152 requires DOE to implement a QA program based on the criteria of Appendix B of Part 50. As a result of past NRC-DOE interactions in the area of ESF/GROA design and associated QA concerns, NRC had identified serious deficiencies in DOE's design control process. It has long been recognized by NRC that it is impractical for the Center for Nuclear Waste Regulatory Analyses (CNWRA) staff to conduct a thorough review of all DOE design documents given the limited resources at NRC's disposal. Consequently, NRC has utilized a "vertical slice" (audit) approach in which the staff selectively reviews some important aspects of DOE's ESF/GROA design packages and observes DOE's internal reviews, looking for trends that can be used as examples to provide feedback and guidance to DOE. NRC has paid particular attention to the design of the ESF because it will eventually become a part of the GROA if the YM site is found to be suitable and, therefore, many RRs applicable to GROA would also be applicable to the ESF. DOE had found it difficult to demonstrate to NRC the traceability of RRs and to provide the necessary documentary evidence to clearly show that all applicable requirements were indeed being applied to various design components. In order to thoroughly examine this issue, NRC conducted a phased in-field verification to evaluate DOE's design control process. There were a number of open items that resulted from this in-field verification and the past NRC-DOE interactions and from NRC review of ESF-GROA design documents related to this subissue. All these open items are being monitored under the RDTME KTI and a number of them were closed during FY 1996 as a result of staff reviews and interactions with DOE. Some of the main FY 1996 activities conducted to help resolve the remaining open items and subissues were reported under Section 7.3.2 of the "NRC Annual Progress Report for FY96" (NUREG/CR-6513, No. 1), Ref. 1.

4.1.2 Review Method and Acceptance Criteria

The staff will find DOE's design control process to be acceptable if the following generic criteria are satisfied:

(1) The applicable RRs are identified.

(2) The design bases associated with the RRs are defined.

(3) The RRs of (1) and the design bases of (2) are appropriately translated into specifications, drawings, procedures, and instructions.

(4) Appropriate quality standards are specified in the design documents.

(5) Any deviations from the standards specified under (4) are controlled properly.

(6) Measures are established for selection of materials, parts, equipment, and processes that are essential to functions of SSCs that are important to safety and waste containment and isolation.

(7) Design interfaces are identified and controlled and appropriately coordinated among participating design organizations.

(8) Procedures are established for review, approval, release, distribution, and revision of documents involving design interfaces.

(9) Measures are established for verifying or checking the accuracy of design calculations (e.g., performing design reviews using alternate or simplified calculational methods).

(10) If testing is employed for verification of design adequacy, the testing is conducted under the most adverse conditions anticipated.

(11) The design verification is done by independent and qualified professionals who are not among those who participated in the original design efforts.

(12) In addition to being applied to the original design, the design control process is also applied to design changes and to field changes, and the changes are documented properly.

4.1.3 Technical Basis for Review Method and Acceptance Criteria

4.1.3.1 ESF-GROA Relationship

The overall premise of staff reviews of DOE's design control process is that the ESF will eventually become a part of the GROA if the YM site is found to be suitable for the disposal of HLW. Therefore, it is important that all site characterization activities, including the design, construction, and operation of the ESF be carried out in such a way that all RRs applicable to the GROA be considered applicable to ESF, unless it can be shown to be otherwise. The staff

has used two main bases for judging the ESF construction and other testing activities: (1) design, construction, and operation of the ESF should not result in unmitigable impacts adversely affecting long-term waste containment and isolation capabilities of the site; and (2) design, construction, and operation of the ESF should not preclude gathering necessary site characterization information. In addition, the staff specifically looks for site characterization activities that might have a potential for test-to-test, construction-to-test, or construction-to-construction interference and, thus, adversely affect containment and isolation or DOE's ability to gather crucial data. The staff has effectively applied these criteria to judge the adequacy of DOE's site characterization plan (SCP) and various study plans at different stages of the program and raised a number of objections, comments and questions that have significantly affected the DOE program over the years. In response, DOE has developed a process which requires a "Determination-of-Importance-Evaluation" (DIE) at important stages of ESF construction and testing. Each DIE consists of a "Test-Interference-Evaluation" and a "Waste-Isolation-Evaluation", the results of which are used to make crucial decisions before major site activities are initiated. The staff may use the results of DIE reviews as bases for selecting certain design/site characterization activities for focussed review.

4.1.3.2 Regulatory Basis

As mentioned earlier, Part 60 invokes Appendix B to Part 50 (QA Criteria for Nuclear Power Plants), which in turn provides the underpinning technical/regulatory basis for the staff review methods and acceptance criteria. Specifically, Criterion III of the 18 criteria described in Appendix B has been restructured into the above-specific criteria (listed under Section 4.1.1) for reviewing DOE's design control process. These criteria will continue to be used to review DOE's design control process employed during the GROA design, construction, and operation.

4.1.3.3 Staff Technical Positions

Additional bases are found in the following two staff technical positions (STPs) on: (1) Items and Activities in the "High-Level Waste Geologic Repository Program Subject to Quality Assurance Requirements" (NUREG-1318, Ref. 3); and (2) "Regulatory Considerations in the Design and Construction of the Exploratory Shaft Facility" (NUREG-1439, Ref. 4).

NUREG-1318 provides guidance on approaches acceptable to the staff for identifying items and activities subject to QA in the HLW repository program for preclosure and postclosure phases. NUREG-1439 provides guidance on identifying RRs applicable to ESF and describes an approach acceptable to the staff for implementation of applicable Part 60 RRs. [Note: While NUREG-1318 needs updating to make it compatible with the revisions to Part 60 --specifically, definition of "Important to-Safety," the underlying principles of the STP still apply.]

4.1.4 Additional Bases

Staff's review of DOE's design control process has been molded by a number of past and continuing review activities, interactions, and correspondence on this subissue. It is important to keep in mind the historical background that has provided additional technical and review bases to the staff. Some of the important reviews, activities, interactions, and correspondence are described below.

4.1.4.1 QA Audits and Surveillances

From time to time, DOE conducts QA audits and surveillances of its contractors and subcontractors. The staff is invited to observe such audits and provide feedback. Over the years, the staff has chosen to observe numerous DOE audits and written Audit Observation Reports in which the staff has documented either its satisfaction or concerns related to particular issues. The staff has also conducted a limited number of independent audits of DOE and/or its supporting organizations and documented the results of such audits in trip/audit reports. Such reports are used as the bases for making generalized observations on the overall effectiveness of the DOE QA program.

4.1.4.2 Site Characterization Review

The staff has conducted detailed technical and programmatic reviews of DOE's SCP and several associated Study Plans (SPs). Review comments have been documented in NRC documents, such as the Site Characterization Analysis (SCA) and SP reviews. The results of such reviews have been used by the staff as bases for identifying concerns related to DOE's QA and technical programs.

4.1.4.3 Design Reviews

The staff has participated as observers during DOE's design reviews in which the participating design organizations coordinate their individual efforts and integrate different aspects of ESF and GROA design. Such design reviews used to take place at approximately the middle of a major effort (known as 50 percent design review) and towards the end (termed 90 percent design review). Depending on the design topic and the availability of resources, the staff has participated as observers and provided feedback to DOE on various aspects of ESF design. The staff has also, on a limited basis, conducted independent design reviews of specific design packages and documented the results of each review. For example, in accordance with NRC's "vertical slice approach," the staff has reviewed selected portions of ESF Design Requirements (ESFDRs), and various ESF Design Packages, such as Packages 2b and 2c, and DOE's Regulatory Compliance Review Report (RCRR). The results of RCRR review were transmitted to DOE on December 14, 1996 (Ref. 5). The results of such observations and limited independent reviews have been used as technical bases for staff's conclusions on the effectiveness of DOE's designs and design control process.

4.1.4.4 Meetings

DOE and NRC conduct several technical meetings on topics of mutual interest under the existing prelicensing agreement. DOE makes presentations on several aspects of QA and design, and the staff provides feedback to DOE during or after such meetings. The meeting minutes document issues and concerns that are also used as bases for staff positions on the effectiveness of DOE's program. Appendix 7 meetings are effectively used by the staff to conduct free and open discussions on topics of mutual interest. Although no formal meeting minutes are kept of Appendix 7 meetings, the impressions carried by the staff and deficiencies noted during discussions are used as additional bases for staff conclusions on DOE's design control process.

4.1.4.5 On-Site Representatives' Inputs

The NRC on-site representatives (OSRs) attend a number of DOE technical and management meetings and observe day-to-day proceedings at DOE and its Management and Operating (M&O) contractor. They also have access to site activities on a regular basis. They can acquire and review DOE documents that are still under preparation and, thus, can provide feedback to DOE on a real-time basis. The OSRs' reports are also used as bases for staff conclusions on DOE's design control process.

4.1.4.6 Site Visits and In-Field Verification

The staff visits the ESF periodically and observes construction and testing activities and reports on important matters and provides written feedback in its trip reports. The staff has also developed a procedure for conducting in-field verification of DOE activities (such activities may include design, construction, or operation). These procedures are part of the HLW Division Manual, Chapter 0330 (Ref. 3). The primary objective of the in-field verification is to determine if DOE is acceptably implementing the site characterization program and constructing and operating the ESF. The first in-field verification of DOE's program was conducted in phases starting in April 1995, and the results were documented in the in-field verification report (NRC-VR-95-01, Ref. 7). This report documents the objective evidence and technical bases for staff conclusions on the adequacy of ESF design and DOE's design control process.

4.1.4.7 Relevant NRC-DOE Correspondence and Interactions

The staff has actively pursued the design control process subissue beginning with NRC's objection to DOE's SCP) specifically the ESF Title-I design control process. The extensive correspondence and exchanges between NRC and DOE that have provided additional bases for the staff's review methods and review criteria and positions taken by the staff on this subissue are listed in the Appendix.

4.1.4.8 Summary of Technical Bases

The subissue regarding the DOE design control process is a very important and highly complex one that historically has played an important role in helping NRC staff monitor the DOE site characterization program. A number of staff activities at the management, programmatic and technical levels have been used to evaluate the adequacy of the ESF design and the design control process in the context of the overall GROA design and DOE QA program. The staff will continue to monitor the DOE program by conducting focussed reviews of selected vertical slices of GROA design documents prepared by DOE. The historical background that can be traced in the various NRC-DOE correspondences and interaction minutes will continue to serve as bases for future staff reviews.

4.2 Design of the GROA for the Effects of Seismic Events and Direct Fault Disruption

This version of the RDTME IRSR focuses on design of the GROA for the effects of seismic events and direct fault disruption. To date, DOE has addressed the first two components of this subissue (i.e., hazard assessment methodology and seismic design methodology). Furthermore,

DOE has limited the scope of its TR on design methodology to preclosure aspects. Consequently, the following discussion is similarly limited. Other components of this subissue will be addressed in future revisions of the RDTME and other companion IRSRs.

4.2.1 Review Method and Acceptance Criteria

The staff will find the TR adequate for further review if, during an initial acceptance review of TR-2, the following acceptance criteria are satisfied:

(1) The TR addresses all important-to-safety (or important-to-waste-isolation) issues pertaining to the scope of the TR.

(2) The subject of the TR is currently undergoing pre-licensing evaluation.

(3) NRC acceptance of the TR would result in increased efficiencies in the staff review of DOE's license application.

(4) The TR contains complete and detailed information on each element of the scope of the report.

The staff will find the methodology proposed in the TR adequate for use in ESF and repository design if the following criteria are satisfied:

(1) The proposed methodology is based on sound technical principles.

(2) The proposed methodology has been previously applied to the design of SSCIS or, if not, no serious problems have been identified that would impede applying the methodology.

(3) The proposed methodology does not contradict established methodologies and principles tested and documented in the license applications for nuclear power plants and independent spent fuel storage installations.

(4) There are no uncertainties associated with the proposed methodology that would significantly impact the repository design process and development of inputs to PAs.

(5) The various steps involved in the proposed methodology are transparent.

(6) The proposed design methodology depends upon site-specific test data; such data are available now, are being gathered now; or, there are plans for gathering such data during site characterization and before submittal of the license application.

(7) To the extent that the proposed methodology depends on analytical/computer models, such models have been verified, calibrated, and/or validated to the extent practical, or there are plans for such activities prior to license application submittal or during the performance confirmation period, as appropriate.

(8) Any major assumptions or limitations to the proposed methodology are identified and the implications regarding design and performance are discussed in the TR.

(9) Documented case histories of the performance of SSCIS designed using the proposed methodology are presented in the TR.

(10) The contents of TR-2 are consistent with the contents of TR-1 and, taken together, the two TRs support the development of inputs for design and PAs in accordance with TR-3.

4.2.2 Technical Bases for Review Method and Acceptance Criteria

4.2.2.1 TR Approach

Among several approaches to resolving potential licensing issues is the use of TRs. Historically, the purpose of the NRC TR program has been to provide a procedure whereby industrial organizations may submit reports on specific important-to-safety subjects to the NRC staff, and have them reviewed independently of any construction permit or operating license review. The benefits resulting from this program are a minimization of duplicative time and effort that the applicants and the NRC staff spend on these subjects and efficiencies in NRC reviews.

NRC staff has documented in its "Topical Report Review Plan" (Ref. 8) the conditions under which DOE can prepare a TR on a given issue, (such as a design or analytical method) and submit it for staff review. Under this TR process, DOE submits an annotated outline of the proposed TR to get agreement of the staff on the scope and content of the report before spending significant resources. Subsequently the completed TR is submitted for staff review that takes place in two stages, namely, an acceptance review (in which the staff checks the acceptability of the TR before accepting it for a detailed technical review), and a detailed, independent technical review by the staff. Several rounds of staff comments and DOE responses either during discussions in meetings and/or in writing may be required before the staff finally documents the status of the resolution of a particular issue or a subissue.

4.2.2.2 NRC-DOE Decision to Use the "TR" Approach

DOE decided and the staff agreed that the issue of seismicity and fault displacement is an appropriate one to be dealt with using the TR process. The issue of seismic design has a long history of potential for litigation and high public interest during licensing hearings of nuclear power plants. The TR approach is expected facilitate efficient reviews during the limited licensing review period available under the Nuclear Waste Policy Act.

After discussions with the staff, DOE decided that the issue of seismicity and fault displacement is too unwieldy to be covered under one TR. Therefore, DOE developed a plan to address the issue using three TRs. The first TR (TR-1) deals with the proposed DOE methodology to assess seismic hazards. The second TR (TR-2), which is one subject of this IRSR, deals with the proposed DOE seismic design methodology. The third TR (TR-3), which is slated for completion during FY 1998, deals with vibratory ground motion and fault displacement Inputs that will be used in repository design and PAs. Further details on these three TRs are as follows:

TR-1 Seismic Hazard. DOE, in its TR-1 (Ref. 9), has developed a five-step process for assessing the vibratory ground motion hazard at the YM site. First, the seismic sources are evaluated. Second, the maximum magnitude and rate of occurrence of each source are described. Third, ground motion/attenuation relationships are developed for the site region. Fourth, a probabilistic hazard curve for vibratory ground motion is generated. Finally, multiple seismic hazard curves are developed to incorporate the various uncertainties. After completing a detailed review of TR-1 in several stages, the staff documented the status of the resolution of the subissues covered under TR-1 in its letter to DOE (Ref. 10), in which it is stated that the staff has no further questions on TR-1 at this time.

TR-2 Seismic Design Methodology. TR-2, which is one subject of this IRSR, addresses preclosure seismic design methodology, keeping in mind that SSCIS must ultimately be built to a single design that meets all requirements, including those for postclosure performance. The seismic design methodology and criteria in REV. 0 of TR-2 (Ref. 11) were based on DOE's safety performance goals found in DOE standard 1020-94 (Ref. 12). Upon staff review and recommendation, DOE revised TR-2 (Rev. 1, Ref. 13) substantially to make it compatible with NRC NUREG-0800 (Ref. 14) for the repository design (as applicable to surface facilities) and DBEs as clarified in a recent Part 60 rulemaking (Ref. 15). Further pertinent details of TR-2 are provided in Section 4.4.

TR-3 Design Inputs. TR-3, which will develop and document all the seismic and fault displacement inputs for repository design and PA, is scheduled for completion during FY 1998. A review process similar to the one adopted for TR-1 and TR-2 will be used for the review of TR-3. Only after the completion of the review of TR-3 can the staff resolve the seismic issue and adopt the set of three TRs as an acceptable reference to the repository license application.

4.2.2.3 Preclosure Seismic Design Methodology Presented by DOE

DOE's preclosure seismic design methodology and criteria are described in TR-2. If implemented properly by DOE, this methodology is expected to provide reasonable assurance that vibratory ground motions and fault displacements will not compromise the preclosure safety functions of SSCIS.

The seismic design methodology and criteria implement the requirements of Part 60, including the latest amendments related to DBEs. Accordingly, the report summarizes the DOE approach to identifying Category-1 and -2 design basis events (DBEs) and establishes hazard probability levels that are appropriate for determining the two levels of design basis vibratory ground motions and the two levels of design basis fault displacements.

DOE intends to use mean annual probabilities of 1×10^{-3} and 1×10^{-4}, respectively, as reference values in determining the frequency of the above two design basis vibratory ground motions. Acceptance criteria for both surface and underground facilities are provided for vibratory ground motion and fault displacement design. In addition, the report provides criteria for fault avoidance, which is the DOE preferred approach for mitigating fault displacement hazards. Seismic design considerations for WPs are also discussed in TR-2.

After reviewing NUREG-0800 for potential use in repository design, DOE considers that specific criteria and guidance contained therein are appropriate for use in surface facility preclosure seismic design. TR-2 identifies several review plans, such as SRP 3.7.1, 3.7.2, 3.7.3, 3.8, 3.9, and 3.10 along with specific exceptions, as applicable to the surface facility design.

Many of the standard seismic design methods that are applicable to the surface SSCs are also applicable to SSCs underground except that the vibratory ground motions are appropriately attenuated to account for the depth below surface. Therefore, many of the review plans mentioned above for the surface facilities are also considered applicable at the repository level. However, the design of underground openings requires a combination of empirical and analytical approaches to account for the interaction of excavation induced stresses and thermally superimposed stresses with the in situ stresses. TR-2 describes the empirical methods, such as Dowding and Rozen's observational method (Ref. 16), Rock Mass Quality Index Method (Ref. 17) and analytical methods, such as the Quasi Static Method and Dynamic Analysis Method (Ref. 18) that will be employed by DOE in the design of the underground facilities.

The TR-2 approach to fault displacement design, in general, is to avoid major faults, and whenever possible, to provide sufficient stand-off distance between SSCs and the fault. TR-2 adopts the guidance provided in the NUREG-1494 (Ref. 19) in establishing design criteria.

4.2.2.4 Staff Review of TR-2

DOE requested a scoping review of the Annotated Outline (AO) of TR-2 in August 1994 (Ref. 20). The staff reviewed and transmitted its comments on the AO to DOE in November 1994 (Ref. 21) DOE submitted a revised AO in January of 1995 (Ref. 22) which was considered acceptable. The staff notified its acceptance to DOE in its letter of February 14, 1995 (Ref. 23). DOE submitted Rev. 0 of TR-2 for NRC review in October 1995 (Ref. 24).

Using the criteria given in Section 4.2.1, the staff concluded that the TR-2 contained sufficient information and in sufficient detail to be considered for a detailed technical review. Staff's acceptance of TR-2 for a detailed review was transmitted to DOE in its letter of December 1995 (Ref. 25).

A detailed technical review of Rev. 0 of TR-2 was conducted using the generic guidance available in the TR Review Plan. In addition, the review criteria delineated in section 4.2.1 were developed specially for this TR which deals with a specific design methodology.

After a detailed technical review of Rev. 0 of TR-2, and two Appendix 7 meetings with DOE (March 13-14, 1996, in Las Vegas and April 23, 1996, in San Antonio), the staff concluded that the TR-2 (Rev. 0) would not meet most of the criteria stated in Section 4.2.1. In addition, there were other major concerns with TR-2, Rev. 0, such as:

(1) a lack of adequate consideration of postclosure performance issues that might impact preclosure design;

(2) incompatibility of DOE's proposed design methodology based on its Standard 1020 with the DBE definition provided in the recent amendments to Part 60;

(3) inadequate consideration of existing models and codes for conducting dynamic analyses of jointed rock behavior for the design of underground facilities; and

(4) lack of a clear rationale for the choice of criteria that will be used to deal with uncertainties in the DBEs for ground motion and fault displacements.

These and other concerns were conveyed to DOE in the staff letter of May 1996 (Ref. 26).

As a result of the staff review and recommendations, DOE revised TR-2 and submitted the report to NRC in October 1996 (Ref. 27) The most substantive change to the TR was that DOE dropped its proposed "performance- goal based design" approach (derived from DOE Standard 1020) and adopted an approach that (1) complies with the new definition of DBE provided in Part 60; (2) adopts the existing review criteria from NUREG-0800 for the design of surface facilities and some of the SSCs underground; and finally, (3) addresses the significant concerns raised during the review of TR-2, Rev. 0.

The staff completed a detailed technical review of TR-2, Rev. 1 using the same criteria that were used for the review of Rev. 0 and found Rev. 1 to be a significant improvement. The staff transmitted its review results along with several recommendations for clarifications in a letter in March 1997 (Ref. 28).

DOE finalized TR-2 in its third revision (Rev. 2), and submitted the report for staff acceptance on August 27, 1997 (Ref. 29). Based on a verification review to check if all clarifications sought in the staff's letter of March 21, 1997, were provided, the staff concluded that all concerns raised by the staff have been addressed satisfactorily by DOE

It should be noted here that the issue of seismic and fault displacement hazard and design cannot be reviewed in isolation, nor can the review process be completed without the review of inputs to design and PAs. Such inputs are the subject of the third and final TR which is currently under preparation by DOE and is expected to be completed in FY 1998. Many subissues that are considered resolved at the staff level at this time, may resurface later depending on the treatment given to such subissues in TR-3 and on the overall acceptability of the TR set as a reference to the license application.

The acceptance criteria found in NUREG-0800 have been used repeatedly and tested many times during the licensing hearings for many nuclear power plants. The technical bases for the criteria in NUREG-0800 and its references have been clearly documented. TR-2 identifies the appropriate sections of the particular review plans that will be used as guides for the seismic design of surface facilities and certain SSCs of the underground facility.

Additional staff guidance is available in the form of staff technical positions (STPs). NUREG-1451 (Ref. 30) describes a methodology acceptable to the staff for investigating seismic and fault displacement hazards at the YM site. It also establishes criteria for defining the region of interest and the types of faults to be investigated. The STP emphasizes those faults that might have an effect on design and performance. NUREG-1494 (Ref. 19) provides additional guidance and clarification on avoiding faults within the preclosure controlled area of the repository. TR-2 has adopted the guidance found in the above two STPs.

The empirical design methods and analytical/numerical methods that will be used for the seismic design of the underground facility, along with the associated uncertainties and how they will be handled are discussed in TR-2. Similarly, the approach used for the fault displacement design and the technical bases for the criteria chosen are also discussed in TR-2. All the comments made and concerns raised by the staff during Appendix 7 meetings and several rounds of reviews have been addressed in the revisions to TR-2. The final set of clarifications sought by the staff on Rev. 1 have been made in the latest version of the TR-2, namely, Rev. 2.

4.3 Consideration of Thermal-Mechanical Effects on Underground facility Design and Performance

This subissue will be addressed in subsequent revisions of this IRSR.

4.3.1 Review Method and Acceptance Criteria

The review method and acceptance criteria will be developed in subsequent revisions to this IRSR.

4.3.2 Technical Basis for Review Method and Acceptance Criteria

Technical bases will be described in future revisions to this IRSR.

4.4 Design and Long-Term Contribution of Repository Seals in Meeting Postclosure Performance Objectives

This subissue will be addressed in subsequent revisions of this IRSR.

4.4.1 Review Method and Acceptance Criteria

The review method and acceptance criteria will be developed in subsequent revisions to this IRSR.

4.4.2 Technical Basis for Review Method and Acceptance Criteria

Technical bases will be described in future revisions to this IRSR.

5.0 STATUS OF ISSUE RESOLUTION AT THE STAFF LEVEL

5.1 Design Control Process

The staff considers DOE's design control process implemented for the ESF is acceptable. This conclusion is based on the reviews of DOE responses to staff queries, QA audits, surveillances, review of DOE's RCRR, observation of design reviews, selective reviews of design packages, site visits, meetings, and in-field verification. The staff has no major concerns or questions related to the ESF design or the design control process employed for the ESF design, construction, or operation at this time. However the staff will continue to monitor the design control process being employed by DOE for the design of the GROA. Also, the following two items will continue to be under focussed review by the staff: (1) quality classification for the concrete inverts used for the ESF construction; and (2) hierarchy of documents that control site characterization, design, construction, and operations activities at the YM site.

5.1.1 Status of Open Items Related to Design Control Process

5.1.1.1 Open items from SCP/SCA, and SPs

Item ID: OSC0000001347C121 Comment 121 SCA
Title: Seismic Design Criteria for ESF
Status: Closed
Basis: Staff review of revised ESFDR submitted by DOE (YMP/CM-0019,Rev.2), Appendix-A. Design input values are subject to verification under TR-3 review.

Item ID: OSC0000001347C130 Comment 130 SCA
Title: Part 60 Design Criteria Applicable to ESF
Status: Closed
Basis: Staff review of RCRR submitted by DOE in response to NRC letter of October 13, 1994.

Item ID: OSC0000001347Q003 Question 003 SCA
Title: Rationale for selecting the total area for repository development
Status: Closed
Basis: Design concepts for the repository have changed. The question will be re-examined when DOE submits up-to-date design concepts.

Item ID: OSC0000001347Q020 Question 020 SCA
Title: Vertical versus Horizontal Emplacement Orientation Decision
Status: Closed
Basis: Vertical emplacement is no longer an option.

Item ID: OSC0000001347Q021 Question 021 SCA
Title: Radiation shielding of host rock
Status: Closed
Basis: Question based on out-dated concepts of WP design and vertical emplacement that is no longer an option.

Item ID: OSC0000001347Q042 Question 042 SCA
Title: Stability of Vertical Emplacement Holes
Status: Closed
Basis: Vertical Emplacement Hole is no longer an option.

Item ID: OSC0000001347Q056 Question 056 SCA
Title: Fault Displacement Tolerance
Status: Closed
Basis: Question based on outdated vertical emplacement concept. Actual fault displacement design inputs are subject to verification during TR-3 review.

Item ID: OSC0000001347Q057 Question 057 SCA
Title: Borehole Drilling and Design Flexibility
Status: Closed
Basis: Question based on out-dated ESF design

Item ID: OSC0000001347Q058 Question 058 SCA
Title. Design to Accommodate In Situ WP Testing
Status: Closed
Basis: Question based on two vertical shafts rather than the current ramps

Item ID: OSC0000001347Q062 Question 062 SCA
Title: Separation distance between ESF and waste emplacement panels
Status: Closed
Basis: Question based on SCP conceptual design that is out-dated.

5.1.1.2 Open Items from NRC-DOE Correspondence/Interactions

Item ID: OQA013OCT1994C00 Comment 001
Title: The M&O QA Program is not being effectively implemented in a manner that will assure acceptability of the ESF (includes flowdown of RRs)
Status: Closed
Basis: See next three items

Item ID: OQA013OCT1994Q00 Question 001
Title: Phases of proposed design and construction of ESF
Status: Closed
Basis: See next two items

Item ID: OQA013OCT1994Q00 Question 002
Title: Potential of construction work to impact site characterization or the waste isolation capability of the site
Status: Closed
Basis: See next item

Item ID: OQA013OCT1994Q00 Question 003
Title: Current conceptual design, testing strategy, control mechanism
Status: Closed
Basis: The above four items are closed based on staff review of DOE responses of October 17, 1994; November 14, 1994; January 27, 1995; March 14, 1995; May 1, 1995; staff's observation of DOE QA audit of January 9-13, 1995; and staff's in-field verification of April 3-6, 1995. (see Appendix for details.)

5.1.1.3 Open Items from In-Field Verification

Item ID: In-field Verification Recommendation-1
Title: Numerical modeling of rock bolts
Status: Closed
Basis: Review of Book # 2, "Numerical Modeling of Rock Bolts," during Appendix 7 meeting at M&O office, June 11-12, 1997.

Item ID: In-field Verification Recommendation-2
Title: Reportable Geologic Condition
Status: Closed
Basis: Staff review of revised procedure, "YAP-30.27" (which superseded AP-6.14).

Item ID: In-field Verification Recommendation-3
Title: Quality Classification of Precast Concrete Inverts
Status: Open
Basis: Staff review of DOE response of September 25, 1995, and discussions during Appendix 7 meeting at the M&O Office, June 11-12, 1997, including review of Book #5 ("Invert Re-evaluation" and final draft of "White Paper on a Functional Reassessment of the ESF Inverts").

by another qualified invert. The staff, however, believes that, the concrete inverts are part of the roof support system and should be given the same QA classification as the rest of the roof support components, such as the steel sets and roof bolts. The staff also believes that the procedure of temporarily transferring the loads is not only cumbersome and complicated but also could potentially result in stressing the rocks and the steel sets in addition to posing increased worker-safety concerns.

The staff recommends that DOE take up appropriate actions necessary to document the quality of concrete used and its characteristics, such as physical, chemical and mechanical properties and conduct the necessary analyses to study any long-term adverse impacts.

5.2 Seismic Design Methodology

Based on the review of Rev. 2 of TR-2, the seismic design methodology presented by DOE is acceptable to the staff. The concerns related to repeated seismic loading for the preclosure design have been closed based on the rationale presented in TR-2. The staff has no further questions on this subissue at the present time.

The question of consideration of repeated seismic loading for the (postclosure) design of WP and TSPAs is expected to be covered during the review of TR-3. As stated earlier, the staff will review TR-3 on seismic and fault displacement inputs for design and PAs and consider the set of three TRs in the context of how the TRs together address the issue of simplifying the licensing review. The staff will continue to be involved in observing DOE's expert elicitation during the preparation of final hazard curves for the YM site along with the identification of design basis accelerations and fault displacements. The IRSRs planned for 1998 are expected to document the complete review results of all three TRs. It should be noted that this IRSR does not take any position with respect to the acceptability of DOE's seismic and fault displacement design of the GROA. Such a finding will be made during the license application review.

5.2.1 Status of Open Items Related to Seismic Design Methodology

There are currently no open items related to the seismic design methodology subissue. However, questions on the seismic design of the ESF and the bases for the seismic inputs have been raised in the past. The open items resulting from such past reviews have been tracked under the design control process subissue (see Section 5.1.1).

5.3 TM Effects

This subissue will be addressed in subsequent revisions of this IRSR.

5.3.1 Status of Open Items Related to TM Effects

More work needs to be done in finalizing this section. Therefore, the status of open items presented here may be incomplete.

5.3.1.1. Open Items from SCP/SPs

Item ID: OSC0000001347C055 Comment 055 SCA
Title: Use of statistics in TM properties
Status: Open
Basis: TBD

Item ID: OSC0000001346C056 Comment 056 SCA
Title: Validation of Models/TM Properties
Status: Open
Basis: TBD

5.4 Design and Long-Term Contribution of Seals to Performance

This subissue will be addressed in subsequent revisions of this IRSR.

5.4.1 Status of Open Items Related to Seal Performance Issue

More work needs to be done in finalizing this section. Therefore, the status of open items presented here may be incomplete.

5.4.1.1 Open Items from SCP/SPs

Item ID: OSC0000001347Q025 Question 025 SCA
Title: Sealing program/Gaseous Transport
Status: Open
Basis: TBD

Item ID: OSC0000001347Q028 Question 028 SCA
Title: Impacts on Sealing Program/Calico Hills Penetration
Status: Closed
Basis: TBD

Item ID: OSP0000831421Q001 Question 001 SP831421
Title: Status of Borehole Seal Design
Status: Open
Basis: TBD

Item ID: OSP000831421Q002 Question 002 SP831421
Title: Specification for Sealing Boreholes
Status: Open
Basis: TBD

5.5 Other Open Items not Covered under the Four Subissues

Item ID: OAO030SEP1992C00 Comment 003 AO30SEP1992
Title: Planned Area/Controlled Area
Status: Open
Basis: TBD

Item ID: OAO030SEP1992C00 Comment 004 AO30SEP1992
Title: Legal Definition of Controlled Area
Status: Open
Basis: TBD

Item ID. OAO030SEP1992Q00 Question 001 AO30SEP1992
Title: Figure Reference/Underground Facility
Status: Open
Basis: TBD

Item ID: OSC0000001347C077 Comment 077 SCA
Title: Retrieval Accidents/Radiation Exposure
Status: Open
Basis: TBD

6.0 LIST OF REFERENCES (are numbered in order as they appear in the text)

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15. U.S. Nuclear regulatory Commission, "Disposal of High-Level Radioactive Waste in Geologic Repositories; Design Basis Events," 61FR 64257, December 4, 1996.

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22. U.S Department of Energy letter from R.A. Milner, to J.J Holonich of U.S. Nuclear Regulatory Commission, dated January 26, 1995.

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25. U.S. Nuclear Regulatory Commission letter from M.J. Bell, to S.J. Brocoum of U.S. Department of Energy, dated December 1, 1995.

26. U.S. Nuclear Regulatory Commission letter from M.J. Bell, to S.J. Brocoum of U.S. Department of Energy, dated May 21, 1996.

27. U.S. Department of Energy letter from S.J. Brocoum, to M.J. Bell of U.S. Nuclear Regulatory Commission, dated October 25, 1996.

28. U.S. Nuclear Regulatory Commission letter from M.J. Bell, to S.J. Brocoum of U.S. Department of Energy, dated March 21, 1997.

29. U.S. Department of Energy letter from S.J. Brocoum, to M.J. Bell of U.S. Nuclear Regulatory Commission, dated August 27, 1997.

30. McConnell, K.I., et al., "Staff Technical Position on Investigation to Identify fault Displacement Hazards and Seismic Hazards at a Geologic Repository," U.S. Nuclear Regulatory Commission, NUREG-1451, July 1992.

APPENDIX

This appendix lists important correspondences and interactions between NRC and DOE related to the subissue of ESF design and design control process and very briefly summarizes relevant details at the end of each item.

(1) U.S. Nuclear Regulatory Commission's letter from R.M. Bernero, to S. Rousso of U.S. Department of Energy, (Cover letter to NRC's Site Characterization Analysis), dated July 31, 1989.

[The letter/SCA raises two objections to DOE's continued deficiencies in its overall QA program and inadequacy of its ESF design and design control process.]

(2) U.S. Nuclear Regulatory Commission letters from R.M. Bernero, to Bartlett of U.S. Department of Energy, dated March 2, 1992, and November 2, 1992.

[The letters lift NRC objections 1 and 2 based in part, on DOE 's demonstration that it had revised its process of controlling ESF design and implementation of such a process.]

(3) U.S. Nuclear Regulatory Commission letters from J.J. Holonich to D. Shelor of U.S. Department of Energy, dated March 24, 1993, and May 5, 1993.

[The letters express renewed concerns related to ESF design and design control process.]

(4) U.S. Nuclear Regulatory Commission letter from B.J. Youngblood, to D.Shelor of U.S. Department of Energy, dated August 20, 1993.

[The letter requests specific information from DOE including an action plan for implementing an acceptable design control process before proceeding with further design activities.]

(5) U.S. Department of Energy letter from D. Shelor, to J.J. Holonich of U.S. Nuclear Regulatory Commission, dated November 1, 1993.

[This letter provides details related to its technical and regulatory design requirements and document hierarchy.]

(6) U.S. Department of Energy letter from D. Shelor, to B.J. Youngblood of U.S. Nuclear Regulatory Commission, dated November 18, 1993.

[This letter provides response to specific NRC requests made in (4) above.]

(7) NRC-DOE interactions related to ESF design and design control process, dated, September 17, 1993, October 4-5, 1993, December 8, 1993, and, January 5-7, 1994.

[The discussions held during these interactions provide additional responses and clarifications to earlier staff requests.]

(8) U.S. Nuclear Regulatory Commission letter from B.J. Youngblood, to D. Shelor of U.S. Department of Energy, dated March 30, 1994.

[This letter expresses limited satisfaction at the progress made by DOE and recommends further follow-up, such as QA audits and surveillances for further verification of DOE actions.]

(9) U.S. Nuclear Regulatory Commission from R.M. Bernero to D. Dreyfus of U.S. Department of Energy, dated October 13, 1994.

[This letter notifies DOE of the staff's continued concerns with DOE's and its M&O contractor's QA program and transmits one major comment related to DOE's and M&O s QA program and three specific questions related to ESF design and its interface with GROA conceptual design.]

(10) U.S. Department of Energy's letter from D. Dreyfus, to R.M. Bernero of U.S. Nuclear Regulatory Commission, dated October 17, 1994.

[This letter provides a quick initial response to staff's letter of October 13, 1994, and proposes a set of actions and commitments.]

(11) U.S. Department of Energy's letter from D. Dreyfus, to R.M. Bernero of U.S. Nuclear Regulatory Commission, dated November 14, 1994.

[This letter provides a detailed response to NRC letter of October 13, 1994, and a series of actions and commitments. The staff uses this letter to develop a checklist of 51 items to be verified during an in-field verification.]

(12) U.S. Department of Energy's letter from R.A. Milner, to J.J. Holonich of U.S. Nuclear Regulatory Commission, dated January 27, 1995.

[This letter provides a list of DOE commitments in response to staff recommendations.]

APPENDIX (cont'd)

(13) U.S. Nuclear Regulatory Commission letter from J.J. Holonich, to R.A. Milner of U.S. Department of Energy, dated March 9, 1995.

[This letter summarizes phase-1 staff review of DOE's detailed response of November 14, 1994, and concludes that the responses provided by DOE are acceptable and sets up a schedule for phase-2 in-field verification.]

(14) U.S. Department of Energy's letter from D. Dreyfus, to R.M. Bernero of U.S. Nuclear Regulatory Commission, dated March 14, 1995.

[This letter provides continued response to staff letter of October 13, 1994, and attaches the RCRR showing the allocation and traceability of Part 60 requirements to the ESF.]

(15) U.S. Nuclear Regulatory Commission letter from J.J. Holonich, to R.A. Milner of U.S. Department of Energy, dated March 16, 1995.

[This letter summarizes staff observations of DOE QA audit of M&O.]

(16) U.S. Nuclear Regulatory Commission conducts in-field verification (phase-2) during April 3-6, 1995

[See Ref. 6 for in-field verification procedures and Ref. 7 for the summary of findings.]

(17) U.S. Department of Energy's letter from R.A. Milner. to J.J. Holonich, dated May 1, 1995.

[This letter informs NRC of DOE's decision to lift a self-imposed "hold" on TBM progress beyond upper Paintbrush Tuff nonwelded (Ptn) contact.]

(18) U.S. Nuclear Regulatory Commission letter from J.G. Greeves, to R.A. Milner of U.S. Department of Energy, dated May 12, 1995.

[This letter concludes that an "objection" level concern does not exist with respect to "pneumatic pathway" issue and documents that establishing and/or lifting of "hold points" for TBM progress was a matter left to DOE's discretion.]

(19) U.S. Nuclear Regulatory Commission letter from J.J. Holonich, to R.A. Milner of U.S. Department of Energy, dated June 16, 1995.

[This letter transmits staff's in-field verification report, along with a commendation, closing out several open items from the 51 items of the checklist, and making three specific recommendations and proposals for follow-up.]

(20) U.S. Department of Energy's letter from D. Dreyfus, to C.J. Paperiello of U.S. Nuclear Regulatory Commission, dated August 3, 1995.

[This letter provides the balance of response to NRC letter of October 13, 1994, and provides the supplement to RCRR.]

(21) U.S. Department of Energy's letter from S.J. Brocoum, to J.J. Holonich of U.S. Nuclear Regulatory Commission, dated October 25, 1995.

[This letter acknowledges the "cumbersome" nature of demonstrating regulatory flow-down and reports on two specific design process improvements, namely: a) change to QA Procedure QAP-3-9; and b) modification to the structure and content of the Design Requirements Document.]

(22) U.S. Nuclear Regulatory Commission letter from M.J. Bell, to S.J. Brocoum of U.S. Department of Energy, dated December 14, 1995.

[This letter transmits the staff review of DOE's RCRR and concludes that DOE made an acceptable demonstration of regulatory flowdown via the example of design package 2C and considered most of the applicable RRs from Part 60. In addition, the staff requests two specific items: a) a design example conducted under the new and improved design QA/design procedure; and b) current versions of revised ESF Design Requirements Document along with DOE's latest description of "Document Hierarchy."]

(23) U.S. Department of Energy's letter from S.J. Brocoum, to M.J. Bell of U.S. Nuclear Regulatory Commission, dated September 1996.

[This letter responds to staff requests made in its December 14, 1995, letter and provides clarifications sought by the staff.]

(24) U.S. Nuclear Regulatory Commission conducts an Appendix-7 meeting on June 12-13, 1997, at DOE/M&O offices and at the YM site to gather data and conduct on-site reviews and complete activities intended to be covered under phase-3 of the in-field verification, which had to be cancelled because of personnel and budgetary reasons.

[The staff concludes that most of the checklist items that were not verified during phase-2 (April 3-6, 1995) could be closed out based on interviews with DOE/M&O staff and on-site reviews.]