

**COMPLIANCE DETERMINATION STRATEGY**  
**RRT 5.5 RADIATION PROTECTION FOR ENGINEERED BARRIER SYSTEMS**

**APPLICABLE REGULATORY REQUIREMENT:**

10 CFR 60.21(c)(1)(ii)(E)  
10 CFR 60.21(c)(2)  
10 CFR 60.21(c)(3)  
10 CFR 60.21(c)(6)  
10 CFR 60.21(c)(7)  
10 CFR 60.21(c)(14)  
10 CFR 60.111(a)  
10 CFR 60.130  
10 CFR 60.131(a)(1-6)  
10 CFR 60.135(b)(3)

**TYPES OF REVIEW:**

Acceptance Review (Type 1)  
Safety Review (Type 3)

**RATIONALE FOR TYPES OF REVIEW:**

**Acceptance Review (Type 1) Rationale:**

This regulatory requirement topic is license application-related because, as specified in 10 CFR 60.31(a), it is information that the Commission should consider in determining if there is reasonable assurance that the types and amounts of radioactive materials described in the application can be received processed, and disposed of in a geologic repository operations area (GROA). As presented in the applicable regulatory requirements of 10 CFR Part 60 and the license application contents requested in Section 5.5 of the regulatory guide "Format and Content for the License Application for the High-Level Waste Repository (FCRG)," it must be addressed by the U.S. Department of Energy (DOE) in its license application. Therefore, the staff will conduct an Acceptance Review of the license application for this regulatory requirement topic.

**Safety Review (Type 3) Rationale:**

This regulatory requirement topic will only be related to radiological safety for workers for the engineered barrier systems (EBS). The radiological safety of individual members of the public is addressed in Section 4.5.1 ("Protection Against Radiation Exposures and Releases of Radioactive Material to Individual Members of the Public") of the license application and its attendant review plan. This regulatory requirement topic (5.5) concerns how DOE's design for the EBS will provide for the control of radiation exposures and radiation levels, and releases of radioactive materials to workers (during the pre-closure period) and in doing so, comply with NRC's regulations concerning radiological safety. It is a requirement for which compliance is necessary to make a safety determination for construction authorization as defined in 10 CFR 60.31(a) (i.e., regulatory requirements in Subparts E, G, H, and I

of 10 CFR Part 60). Therefore, the staff will conduct a Safety Review of the license application to determine compliance with the applicable regulatory requirements.

There appears to be no lack of certitude as to the methodology needed to determine or demonstrate compliance with the GROA regulatory requirements for the control of radiation exposures to and intake of radioactive materials by workers, for the EBS. The factor considered in making this determination is the knowledge that technology exists to safely control radiation exposures to and intake of radioactive materials by workers. The technology for limiting doses, based on applicable radiation protection standards, is considered to be available because of the past and current experience in similar nuclear operations. Therefore, the type of review for this topic will be a (Type 3) Safety Review.

Radiation protection for the EBS does not appear to pose a risk of noncompliance with the applicable performance objectives based on current knowledge, and as a result, has no Key Technical Uncertainties. However, if Key Technical Uncertainties applicable to this regulatory requirement topic are identified in the future, the strategy for compliance determination will be revised.

### **REVIEW STRATEGY:**

#### **Acceptance Review:**

In conducting the Acceptance Review of the U.S. Department of Energy's (DOE's) design for the control of radiation exposures and radiation levels, and releases of radioactive materials to workers for the engineered barrier systems (EBS), the reviewer should determine if the information, present in the license application and its references for demonstrating compliance with the applicable regulatory requirements, is complete in technical breadth and depth with respect to information requested by Section 5.5 of the regulatory guide "Format and Content for the License Application for the High-Level Waste Repository (FCRG)." The reviewer should determine that all the appropriate information for the staff to review the pre-closure radiation protection design features of DOE's EBS design, is presented such that assessments of compliance with NRC's regulations, can be performed.

The reviewer should determine whether the information presented in the license application is presented in such a manner that the assumptions, data, and logic leading to a demonstration of compliance with the regulatory requirements are clear and do not require the reviewer to conduct extensive analyses or literature searches. The reviewer should also determine that controversial information and appropriate alternative interpretations and models have been acceptably described and considered.

Finally, the reviewer should determine whether DOE has either resolved all the NRC staff objections related to the applicable regulatory requirements or provided all the information requested in Section 1.6.2 of the FCRG, for unresolved objections. The reviewer should evaluate the effects of any unresolved objections, both individually and in combinations with others, on: (1) the reviewer's ability to conduct a meaningful and timely review; and (2) the Commission's ability to make a decision regarding construction authorization within the statutory three-year period.

#### **Safety Review:**

The scope of this regulatory requirement topic addresses radiation protection for GROA workers for the EBS and concerns only those design basis events that can be reasonably expected to occur prior to permanent closure. It is not concerned with those radiation protection measures intended to protect the

individual members of the public; this subject will be addressed in Section 4.5.1 ("Protection Against Radiation Exposures and Releases of Radioactive Material to Individual Members of the Public") of the license application and its attendant review plan. Those sections of the license application which may be related to the Safety Review of the program described in this plan are listed in Table 5.5-1.

The Safety Review of the radiation protection aspects of the design of structures, systems, and components important to safety will be addressed separately in Sections 4.2 ("Assessment of Compliance with Design Criteria For Surface Facility"), 4.3 ("Assessment of Compliance with Design Criteria For Shafts and Ramps"), and 4.4 ("Assessment of Compliance with Design Criteria For Underground Facility") of the license application.

In conducting the Safety Review, the reviewer should determine whether the information presented in the license application and its references is an acceptable demonstration of compliance with the applicable regulatory requirements. The reviewer should assess the adequacy of the data and the analyses presented in the license application to support the DOE's demonstration of compliance with the applicable regulatory requirements. In general, the reviewer should assess the adequacy of the EBS design for the control of radiation exposures to and intake of radioactive materials by workers. The reviewer should determine if reasonable effort has been made to maintain radiation exposure and radiation levels, and releases of radioactive materials, in effluents, "as low as is reasonably achievable" (ALARA), as required by 10 CFR Part 20 (*Code of Federal Regulations*, Title 10, "Energy"). Those design enhancements that are necessary for the implementation of ALARA need to be identified as part of the EBS design.

DOE's demonstration of compliance with the applicable regulatory requirements is expected to consist of the following: (1) identification of those conditions and events, associated with normal operations and those events that can be reasonably expected to occur prior to permanent closure (such as those events referred to in American Nuclear Society Standard, ANSI/ANS-57.9-1984, as Design Events I, II, and III), that could lead to radiation exposures or releases of radioactive materials to workers; (2) estimation of the probabilities (numerical or qualitative) that these conditions and events may occur, and determination of the regulatory limits for the estimated conditions and events; (3) analyses of the source terms (quantities, concentrations, and specifications of potential releases and direct radiation exposure and levels) that are expected to occur for applicable conditions and events; (4) identification and analyses of receptors (locations and work characteristics of individuals potentially exposed); (5) use of models to determine potential radiological impacts to workers; and (6) planning and design considerations used to meet the criteria of 10 CFR Part 20.

The NRC staff's evaluation of compliance will also consist of six steps, paralleling the steps in DOE's demonstration of compliance. The specific aspects of the license application on which a reviewer will focus are discussed below, and the Acceptance Criteria are identified in Section 3.0 of this Review Plan. The scope of this review plan includes:

- (1) identification of the conditions and events, associated with normal repository operations and those conditions and events that can be reasonably expected to occur prior to permanent closure, that could lead to radiation exposures or releases of radioactive material to workers from the EBS. DOE is expected to use event tree analyses, fault tree analyses, and similar methods to identify repository conditions potentially leading to radiological impacts on workers. The NRC staff will review DOE's submittal, but will not independently develop its own identification of repository conditions;

- (2) estimation of the probabilities (numerical or qualitative) that these repository conditions and events may occur, and determination of the regulatory limits for the estimated conditions and events. The NRC staff will review DOE's submittal, but will not independently develop its own probability estimates. The NRC staff will independently confirm that the proper regulatory limits have been applied to the potential radiological impacts of the applicable repository conditions and events;
- (3) analyses of the source terms (quantities, concentrations, and specifications of potential releases and direct radiation exposures and levels) that are expected to occur for applicable conditions and events. DOE's analyses of the source terms are expected to include the quantities and rates of discharges of radioactive materials to, and radiation fields for workers from the EBS as a result of those conditions and events that can be reasonably expected to occur prior to permanent closure. Analyses of the source terms are also expected to include any items intended to control or monitor radiological exposure as a result of those conditions and events that can be reasonably expected to occur prior to permanent closure that affect the concentration and exposure limits specified in 10 CFR Part 20. The NRC staff expects DOE's source term analyses to include estimates of the quantities of radionuclide releases and the field strengths associated with the EBS. The NRC staff will review DOE's analyses of source terms, but will not independently develop its own estimates;
- (4) identification and analyses of receptors (locations and work characteristics of individuals who are potentially exposed) for each potential release and radiation exposure. DOE's identification and analyses of receptors are expected to be based on projections of facility design, planned schedules, work conditions within the repository and on DOE's plans for reducing potential exposures to ALARA for the conditions and events that can be reasonably expected to occur prior to permanent closure. Thus, different receptor analyses may be developed for various conditions and events that can be reasonably expected to occur at the repository. The NRC staff will review DOE's identification and analyses of receptors, but will not independently develop its own analyses;
- (5) use of models to determine potential radiological impacts to workers. The NRC staff expects DOE's estimates of impacts to include: (a) anticipated concentrations of each radionuclide during the pre-closure period and the contribution of each to the radiation dose; (b) calculations and explanations of the measures used to support the shielding and airborne concentration models used to determine exposures; (c) annual whole body individual and collective doses determined to be attributed to the EBS; and (d) details specified in Section 5.5 of the FCRG, and the requirements specified in 10 CFR 60.135(b)(3). The NRC staff will review DOE's use of models to determine potential radiological impacts, but will not independently develop its own determinations; and
- (6) planning and design considerations used to meet the criteria of 10 CFR Part 20 for workers. The NRC staff expects DOE's planning and design considerations to include: (a) design criteria and plans for pre-closure activities related to the EBS, e.g., source terms, expected conditions and events, expected functions and handling scenarios for the EBS or its components; (b) planning and design objectives for pre-closure activities related to the EBS, e.g., limits of radiation exposure, shielding objectives, containment

integrity, and maintaining exposures ALARA; and (c) planning and design bases for pre-closure activities related to the EBS, e.g., codes or standards used for design, shielding codes used, calculational methods applied, and safety procedures. The NRC staff will review DOE's plans and design considerations, but will not independently develop its own planning and design parameters.

In conducting the Safety Review, the staff will determine if DOE has submitted a demonstration of compliance with the regulatory requirements for radiation protection for the EBS in the following:

- (1) an analysis of the design and performance of the structures, systems and components of the EBS to identify those that are important to safety. For the purposes of this analysis, it should be assumed that operations at the GROA will be carried out at the maximum capacity and rate of receipt of radioactive waste stated in the application.
- (2) a description and discussion of the design of the GROA related to the EBS including: (i) the principal design criteria and their relationship to any general performance objectives, (ii) the design bases and the relation of the design bases to the principal design criteria, (iii) information relative to materials of construction (including geologic media, general arrangement, and approximate dimensions), and (iv) codes and standards that DOE proposes to apply to the design and construction of the GROA related to the EBS;
- (3) a description and analysis of the design and performance requirements for structures, systems, and components of the EBS. This analysis should consider the margins of safety under normal operations and those events that can be reasonably expected to occur prior to permanent closure;
- (4) an identification and justification for the selection of those variables, conditions, or other items which are determined to be probable subjects of license specifications. Special attention should be given to those items that may significantly influence the final EBS design;
- (5) a description of the program for control and monitoring of radioactive effluents and occupational radiation exposures to maintain such effluents and exposures in accordance with the requirements of 10 CFR Part 20; and
- (6) an identification of those structures, systems, and components of the geologic repository, both surface and subsurface, related to the EBS which require research and development to confirm the adequacy of design.

The reviewer should review DOE's plans and designs to determine whether it will maintain radiation exposures to and intake of radioactive materials by workers within the limits specified in 10 CFR Part 20. At a minimum the reviewer should determine whether the DOE's plans and designs: (1) demonstrate a means to limit concentrations of radioactive material in air; (2) demonstrate a means to limit the time required to perform work in the vicinity of radioactive materials, including, as appropriate, designing equipment for ease of repair and replacement and providing adequate space for ease of operation; (3) provide suitable shielding; (4) demonstrate a means to monitor and control the dispersal of radioactive contamination; (5) demonstrate a means to control access to high radiation areas or airborne radioactivity areas; and (6) include a radiation alarm system to warn of significant increases in radiation levels,

concentrations of radioactive material in air, and of increased radioactivity released in effluents. DOE's alarm system should include provisions for calibration and for testing its operability.

In addition to designing for radiological protection, DOE will need to evaluate the cost-effectiveness of exposure reductions for radiation control. In order to demonstrate that projected radiological exposures are ALARA, DOE is expected to determine both individual and collective radiological impacts, as well as economic costs, for reasonably available alternatives to the major structures, systems, and components of the EBS. The adequacy of DOE's evaluations of the structures, systems, and components including any possible interrelationship among such items, both individually or in combination with others, which would impact radiation protection for the EBS should also be assessed by the reviewer.

In order to conduct an effective review, the reviewer will rely on staff expertise and independently acquired knowledge, information, and data such as the results of research activities being conducted by the NRC's Office of Nuclear Regulatory Research, in addition to that provided by the DOE in its license application. It is incumbent upon the reviewer to acquire a body of knowledge regarding these and other critical considerations in preparing to conduct the review.

It should be noted that the information contained in Section 5.5 of the license application will be reviewed in parallel with the Safety Reviews of the information described in Table 5.5-1. If it is determined that the conclusions reached by the Safety Reviews described in Table 5.5-1 are inadequate to support the Safety Reviews called for in this section of the license application, then additional information will be requested from DOE before the Safety Review of this section can continue.

**Contributing Analysts:**

NRC: Robert D. Carlson, Banad N. Jagannath, Michael P. Lee, Mysore S. Nataraja, Tae Ahn, Richard Weller, and Robert B. Neel

CNWRA: Hengameh Karimi, John P. Hageman, and Chuck Tschoepe

**Date of Analyses:** June 15, 1993

**APPLICABLE REGULATORY REQUIREMENTS FOR EACH TYPE OF REVIEW:**

Type 1:

- 10 CFR 60.21(c)(1)(ii)(E)
- 10 CFR 60.21(c)(2)
- 10 CFR 60.21(c)(3)
- 10 CFR 60.21(c)(6)
- 10 CFR 60.21(c)(7)
- 10 CFR 60.21(c)(14)
- 10 CFR 60.111(a)
- 10 CFR 60.130
- 10 CFR 60.131(a)(1-6)
- 10 CFR 60.135(b)(3)

Type 3:

- 10 CFR 60.111(a)
- 10 CFR 60.130
- 10 CFR 60.131(a)(1-6)
- 10 CFR 60.135(b)(3)

**REFERENCES:**

American Nuclear Society (ANS), "Design Criteria for an Independent Spent Fuel Storage Installation (Dry Storage Type)," ANSI/ANS-57.9-1984. American National Standards Institute. La Grange Park, Illinois.

*Code of Federal Regulations*, "Standards for Protection Against Radiation," Part 20, Chapter I, Title 10. "Energy."

Nuclear Regulatory Commission, "Format and Content For the License Application for the High-Level Waste Repository," Office of Nuclear Regulatory Research. [Refer to the "Products List" for the Division of High-Level Waste Management to identify the most current edition in effect.]

**TABLE 5.5-1:** Sections of the License Application Which May be Related to the Safety Review of the "Radiation Protection for Engineered Barrier Systems" Section of the License Application.

<i>License Application Section</i>	<i>Section Title</i>
2.5	Radioactive Material
4.1	Description of the GROA Structures, Systems, and Components: <ul style="list-style-type: none"><li>4.1.1 Surface Facilities</li><li>4.1.2 Shafts and Ramps</li><li>4.1.3 Underground Facility</li><li>4.1.4 Radiation Protection Systems</li></ul>
4.2	Assessment of Compliance with Design Criteria For Surface Facility
4.3	Assessment of Compliance with Design Criteria For Shafts and Ramps
4.4	Assessment of Compliance with Design Criteria For Underground Facility
4.5.	Assessment of Integrated GROA Compliance with the Performance Objectives <ul style="list-style-type: none"><li>4.5.1 Protection Against Radiation Exposures and Releases of Radioactive Material to Individual Members of the Public</li><li>4.5.2 Retrievability of Wastes</li></ul>
7.2	Description of the Radiation Protection Program