
Draft Technical Position on Regulatory Considerations in the Design and Construction of the Exploratory Shaft Facility

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ABSTRACT

The staff of the U.S. Nuclear Regulatory Commission has prepared this technical position to compile and further clarify previous staff positions on the regulatory considerations in the design and construction of the exploratory shaft facility. This position lists the key regulations in 10 CFR Part 60 that should be considered in the design and construction of the exploratory shaft facility and presents the staff position statements and corresponding discussions.

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DRAFT TECHNICAL POSITION ON REGULATORY CONSIDERATIONS IN THE DESIGN AND CONSTRUCTION OF THE EXPLORATORY SHAFT FACILITY

1.0 INTRODUCTION

The U.S. Department of Energy (DOE) is required by the Nuclear Waste Policy Act of 1982 (NWPA), as amended, and by 10 CFR Part 60 to conduct a program of site characterization before submitting a license application. As part of its site characterization program, DOE will construct an exploratory shaft facility (ESF). The ESF will generally consist of surface-support facilities, shafts/ramps, underground main test area, and exploratory drifts. The primary purpose of the ESF is to support site characterization activities. However, since the ESF may become a part of an eventual geologic repository operations area (GROA), the ESF design will be required to satisfy applicable GROA design requirements.

In reviewing DOE's ESF Title I design and related documents (e.g., DOE's acceptability analysis of the ESF Title I design, Reference 1), the U.S. Nuclear Regulatory Commission (NRC) staff noted that several 10 CFR Part 60 requirements applicable to GROA design were not considered (Reference 2). The NRC staff had several interactions with the DOE and provided written comments on this subject (Reference 2). This technical position (TP) is a compilation of previous NRC staff positions on this subject and provides further clarification of the staff position on regulatory considerations in the design and construction of the ESF.

In the ESF and the GROA, the surface and the underground facility will be connected by shafts or ramps. (The term "shaft," as used in 10 CFR Part 60, is understood to include both shafts and ramps.) Proper coordination between ESF design and GROA design is essential to ensure that the ESF, as constructed, will not interfere with the waste isolation capability of the site, and will facilitate site characterization activities.

This TP provides an approach acceptable to the NRC staff for implementation of applicable 10 CFR Part 60 requirements related to the ESF. It covers topics that include certain aspects of the design control process, coordination of ESF design with GROA design, consideration of alternatives, excavation methods, test interference, and site characterization. The positions and discussion in this TP are based on the premise that the ESF will eventually become a part of a future GROA. Therefore, all 10 CFR Part 60 requirements applicable to the GROA design are considered applicable to the ESF design. Figure 1 gives an example of an approach that DOE can use to achieve compliance of the ESF design with 10 CFR Part 60 requirements.

In reviewing DOE's work on the ESF design and related documents, including the ESF alternatives study, the NRC used the following two general guidelines: (1) the ESF design, construction, and operation should limit adverse impacts on waste isolation capabilities of the site; and (2) the ESF design, construction, and operation should not preclude the collection of needed site data. This TP gives the specific guidelines by which the NRC can assess DOE's work on the ESF design and documents related thereto.

An important purpose of the ESF is to collect site characterization data for use in designing the GROA. Therefore, the design of the ESF must be completed on the basis of only very limited subsurface information, in situ testing, and exploration. Consequently, uncertainties associated with the available, limited data should be accounted for in the design of the ESF.

Section 2.0 of this document focuses on the key 10 CFR Part 60 requirements that relate to the design and the construction of the GROA and are, therefore, applicable to the ESF. The technical position statements are listed in Section 3.0. Section 4.0 of this paper provides a discussion of the supporting rationale behind the stated technical positions. Appendix A to this draft is reserved for the staff's response to public comments on this TP. This response will be included in the final TP after comments on this document have been satisfactorily resolved.

Technical positions are issued to describe and make available to the public methods acceptable to the NRC staff for implementing specific parts of the Commission's regulations, or to provide guidance to the Department of Energy. Technical positions are not substitutes for regulations, and compliance with them is not required. Methods and solutions different from those given in the position will be acceptable if they provide a basis for the findings requisite to the issuance or continuance of an authorization or license by the Commission.

The NRC staff has issued technical positions to provide guidance in the following related areas: design information needs in the site characterization plan (SCP) (Reference 3), in-situ testing (Reference 4), and borehole and shaft sealing (Reference 5). The DOE should consider these TPs in conjunction with this TP.

2.0 REGULATORY FRAMEWORK

The 10 CFR Part 60 requirements to be considered in the design of the ESF are listed in Appendix B of this document. While the list has been developed to provide general guidance, it is recognized that some of the requirements may not in fact impact the design of the ESF and that other requirements may have relevance even though not listed in Appendix B. Some of the key regulations are stated below, and the text of these regulations, including the term "site characterization," is provided in Appendix C of this document. For the text of remaining applicable 10 CFR Part 60 requirements, refer to Title 10, Chapter I of the Code of Federal Regulations (Reference 6).

- 10 CFR 60.15(c) addresses the site characterization requirements. These requirements state that (1) the manner of investigations should limit adverse impacts on long-term performance of repository; (2) the number of exploratory boreholes and shafts should be limited to the extent practical; (3) to the extent practical, the exploratory boreholes and shafts should be located where shafts are planned for underground facility construction and operation or where large unexcavated pillars for repository are planned; and (4) the ESF design should be planned and coordinated with the geologic repository operations area design.

- 10 CFR 60.17(c) requires the DOE to submit to the NRC the site characterization plan that shall contain a conceptual design for the GROA that takes into account likely site-specific requirements.

- 10 CFR 60.21(c)(1)(ii)(D) requires the DOE to assess the effectiveness of engineered and natural barriers, including barriers that may be themselves a part of the geologic repository operations area, against the release of radioactive material to the environment. The analysis shall also include a comparative evaluation of alternatives to the major design features that are important to waste isolation.

- 10 CFR 60.112 states the requirements for selecting the geologic setting and design of the engineered barrier system and the shafts, boreholes, and their seals to meet the overall system performance objectives for the geologic repository after permanent closure with respect to both anticipated and unanticipated processes and events.

- 10 CFR 60.131 and 10 CFR 60.133 specify design criteria for the underground facility in the geologic repository operations area. (For text of these regulatory requirements, refer to 10 CFR Part 60 (Reference 6).)

- 10 CFR 60.134 specifies general criteria for the design of seals and the selection of materials and placement methods.

- 10 CFR 60.151 and 10 CFR 60.152 require the DOE to implement a quality assurance program based on the criteria of Appendix B to 10 CFR Part 50, as applicable. If the components of the exploratory shaft facility are determined to be important to safety or waste isolation, they and the activities that affect their performance should be covered by the applicable quality assurance program.

3.0 TECHNICAL POSITIONS

(1) Approach for Compliance with 10 CFR Part 60 Requirements

A defensible approach should be developed to consider and implement 10 CFR Part 60 GROA design requirements applicable to the ESF design. An example of an acceptable approach is given in Figure 1.

(2) Quality Assurance

Items and activities of the exploratory shaft facility that are potentially important to safety and waste isolation should be identified in accordance with the NRC staff guidance in NUREG-1318 (Reference 7). The identified structures, systems, and components should be designed, constructed, and operated under the appropriate parts of the quality assurance program. The quality assurance program, including the design control process, should be established and implemented in accordance with the NRC staff positions identified in the "Review Plan for High-Level Waste Repository Quality Assurance Program Descriptions" (Reference 8).

(3) Planning and Coordination of ESF Design with GROA Design

A conceptual design of the GROA should be considered in the design of the ESF. For example, the shafts, ramps, and drifts for the ESF should be selected in locations where these features are planned for the GROA unless a need for different design can be justified and their impact on the waste isolation capability of the site and impact on data collected from site characterization are acceptable.

(4) Consideration of Alternatives for Design Features

For the design of the ESF, a comparative evaluation of alternatives to major GROA design features should be considered with particular attention to the alternatives that would provide longer radionuclide containment and

isolation. Such GROA design features include the following: (a) waste emplacement depth; (b) underground facility boundary; (c) location, number, and size of shafts or ramps; (d) excavation methods; (e) drainage design; and (f) sealing methods.

(5) Excavation Methods

To the extent practical, the methods of constructing the ESF should be selected to limit, rather than attempt to account for, mechanical, hydrological, or chemical damage to rock and to limit the creation of potential pathways for radionuclide migration around the shafts, ramps, and the underground openings. The excavation methods should be selected to provide confidence that the ESF will not adversely impact the waste isolation capability of the site and will facilitate site characterization.

(6) Test Interference

To the extent practical, the ESF design features, including test layout, test sequencing, and separation between test area and proposed future repository, should be selected to avoid, rather than attempt to account for, the potential for interference with site characterization.

(7) Establishment of Ranges of Site Parameters

The layout, spacing, extent, and the orientation of the ESF design features, such as shafts, ramps, drifts, boreholes, and test area should facilitate gathering of data to establish the geologic conditions and ranges of parameters important to repository performance and to site characterization.

4.0 DISCUSSION

The following discussion follows the order of the list of technical position statements given in Section 3.0.

(1) Approach for Compliance with 10 CFR Part 60 Requirements

As a pre-requisite to the ESF design, it is essential that DOE develop an approach to meet the applicable GROA design requirements contained in 10 CFR Part 60. These include site characterization requirements given in 10 CFR 60.15 and other applicable GROA requirements, if the ESF is to become a part of a future repository.

It is important that a defensible logic is used in developing the approach to comply with applicable 10 CFR Part 60 requirements. The logic should be based on two general principles: (1) the ESF design limits adverse impacts on the waste isolation capability of the geologic repository, and (2) this design does not preclude the gathering of sufficient data necessary to demonstrate site suitability and for the design of the GROA. The ESF design and construction should also permit flexibility to modify, if necessary, the reference conceptual design of the GROA based on data collected during site characterization.

An example of an acceptable approach to achieving compliance of the ESF design with the requirements contained in 10 CFR Part 60 is given in Figure 1. It is recognized that there could be many different ways in which compliance of ESF design with 10 CFR Part 60 requirements could be achieved. However, DOE should use an approach suited to its particular design needs. Furthermore, the various steps shown in this figure should not be interpreted as an NRC staff suggestion to DOE that it develop separate evaluation documents, each corresponding to a particular step in the process.

In the example approach, GROA design criteria are first developed to assure that the GROA design will comply with applicable 10 CFR Part 60 requirements. Based on these design criteria, a number of preliminary GROA design concepts are developed. Next, these design concepts should be reviewed to verify that the required design criteria identified in the first step are met. The GROA design concepts should be revised until they meet all the required design criteria.

The next step in the example approach is to determine which GROA design features are potentially important to waste isolation. NUREG-1318 (Reference 7) provides guidance in this regard. For those design features identified, major attributes of the features (e.g., location, size, extent, method of construction, etc.) should be listed and a comparative evaluation performed to evaluate which alternatives would provide longer radionuclide containment and isolation. Based on these evaluations, preferred GROA design concept(s) should be selected and reference GROA conceptual design(s) should be developed.

The ESF design effort needs to be coordinated with the reference GROA conceptual design(s). The ESF design criteria are developed to assure minimum impact on waste isolation and collection of needed site characterization data. The ESF design concepts are then developed taking into consideration the reference GROA conceptual design(s) developed earlier. These concepts need to be reviewed to ensure that the two main objectives related to minimization of waste isolation impact and site characterization requirements are met. The ESF design concepts are revised until these objectives are met. Finally, an ESF design concept is selected and the detailed design is developed.

The design may need to be modified during construction of the ESF based on in-situ conditions discovered at the site. In making any design modifications, the ESF design process selected by DOE should be revisited to ensure that the applicable 10 CFR Part 60 requirements are complied with.

(2) Quality Assurance

The ESF design process should be subjected to a quality assurance (QA) program to assure compliance with 10 CFR 60.151 and 60.152. Adequate implementation of the QA program is considered vital to successful coordination of the ESF design with the GROA design. Section 3.0 of the NRC "Review Plan for High-Level Waste Repository Quality Assurance Program Descriptions (Revision 2)" provides acceptance criteria for those activities related to design control. The DOE's design control process would be considered acceptable if it complies with the requirements given in Section 3 of the QA review plan.

As previously noted, NUREG-1318 provides guidance on how to identify items and activities important to safety and important to waste isolation. The DOE should review all of the structures, systems, and components associated with the ESF, using the methodology described in NUREG-1318, to identify those that may be potentially important to safety or waste isolation. The identified structures, systems, and components should then be designed, constructed, and operated under an appropriate QA program. Those aspects of design that may affect waste isolation should be translated into requirements that consider the need to meet the performance objectives for the geologic repository for the next 10,000 years. Moreover, the design process should ensure that the 10 CFR Part 60 requirements are incorporated into the various stages of design.

As the ESF is likely to become a part of a future repository, the systematic design and approval process should take into account 10 CFR Part 60 requirements that deal with site characterization, retrieval, containment, and long-term waste isolation. As previously noted, Appendix B of this document lists those 10 CFR Part 60 requirements that should be considered in the ESF design. The design process should establish a correlation between the NRC regulatory requirements and DOE's proposed design. There should be clear and systematic documentation regarding how

each relevant 10 CFR Part 60 requirement is translated into design requirements, drawings, specifications, and procedures as stated in Criterion III of Appendix B to 10 CFR Part 50 (applicable by virtue of 10 CFR 60.152). The principal QA measures should include the control of design interfaces, design verification, control of design changes, and use of appropriate standards.

(3) Planning and Coordination of ESF Design and Construction With GROA Design

Coordination of the ESF design and construction with GROA design is needed to ensure that the ESF construction does not adversely impact the waste isolation capability of the geologic repository. 10 CFR 60.15(c)(4) requires that the "subsurface exploratory drilling, excavation, and in situ testing before and during construction shall be planned and coordinated with geologic repository operations area design and construction." Also, 10 CFR 60.15(c)(3) requires that "to the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for underground facility construction and operation or where large unexcavated pillars are planned." To meet these requirements, it is necessary that a conceptual design of the GROA be developed so that the exploratory shaft(s) can be located where shafts or unexcavated pillars for the GROA are planned, to the extent practical. Also, the ESF test area and exploratory drifts should be at the same depth as that proposed for waste emplacement, and the shafts or ramps designed for the ESF should be selected from those planned for the GROA, to the extent practical.

In general, the requirements for the ESF should not unnecessarily increase the number of the repository shafts or ramps. To minimize the total number of penetrations through the geological barrier, coordination of the ESF design with the GROA design should permit the selection of ESF shafts or ramps and drifts that can be integrated with repository shafts, ramps, and drifts in the GROA design. Such coordination will allow compliance with the requirement to minimize the number of penetrations.

The location of ESF shafts or ramps should take into account possible uplift or subsidence caused by the thermal effects of waste emplacement, fault movement, and tectonics. The results of a preliminary analysis of the impact of ESF construction on GROA performance could be used to provide this information. Potential effects of fault movements caused by thermal or tectonic effects should also be considered when selecting the locations for the ESF access openings. The shaft or ramp locations, construction methods, and liner material for the access openings should accommodate future needs for sealing and drainage.

Exploratory shaft facility shaft(s) and/or ramp(s) will become the first major penetrations through the geological barrier. As such, they could become preferential pathways for water inflow into the repository, or for gaseous radionuclide releases. Recognizing that at the time of ESF construction considerable uncertainties will remain about what, ultimately, the likely dominant flowpaths may be, the approach to the selection, design and construction of these penetrations should account for these uncertainties. Suitable provisions should be made for proper drainage from the underground openings and the design should facilitate future sealing options.

(4) Consideration of Alternatives for Design Features

As required by 10 CFR 60.21(c)(1)(ii)(D), a comparative evaluation of several possible alternatives to the major design features should be performed at the initial stages of the GROA design. For example, this comparative evaluation should include a study of possible variations in the depth of waste emplacement area and its boundary, the location and number of shaft(s) and/or ramp(s), the excavation methods, and other major design and construction features. Preliminary design concept(s) for the GROA should be developed from these comparative evaluations of preliminary design(s), with particular attention to the alternatives to the major design features that provide longer radionuclide containment and isolation.

On the basis of the selected preliminary design concept(s), reference conceptual design(s) for the GROA should be developed. The ESF design should be planned and coordinated with the reference GROA design(s). The reference GROA design(s) may require changes as a result of data gathered during site characterization. Therefore, to the extent practical, the selected ESF design should allow sufficient flexibility to revise the reference GROA design(s) to allow adjustments where necessary to accommodate specific site conditions identified during site characterization.

The ESF and GROA coordination requirements are discussed in Item 3 of this Section. Theoretically, many possible ESF design options would meet the requirement for coordination of the ESF design and construction with the GROA design(s). Before a design is selected for the ESF, an evaluation should be made that considers potential merits of various options within the constraints of the reference GROA design(s). In this evaluation, it is important to pay particular attention to the requirements for geologic repository waste isolation and site characterization needs. If an ESF design option is determined to be better suited based on the site characterization needs and yet is not within the constraints of the GROA design(s), the need for such an ESF design should be justified and its impact on waste isolation of the geologic repository studied. Figure 1 contains an example of an acceptable approach for arriving at an ESF design.

(5) Excavation Methods

Since the ESF is likely to become a part of the GROA, the methods for constructing the underground openings for the ESF should be compatible with the requirements for the GROA to meet the applicable 10 CFR Part 60 requirements. Also, the degree of damage to the rock surrounding the openings and the extent of the damage zone should be limited so that the mechanical, hydrological, or chemical damage does not preclude adequate site characterization and performance. The construction and operation

should be compatible with data gathering activities at the site, such as geological, geotechnical, thermomechanical, hydrological, and geochemical testing.

The excavation methods should be selected to limit the creation of possible preferential pathways by which groundwater may contact the waste packages or by which the radionuclides may migrate to the accessible environment. The impact of foreign substances such as construction water, blasting fumes from chemical explosives, and diesel equipment fumes should be limited so that the characterization of the surrounding rock mass and the ability of the site to meet the performance objectives are not compromised.

(6) Test Interference

The ESF should be designed and constructed to avoid, to the extent practical, adverse impacts on site characterization. To maintain confidence in the reliability of data collected from site characterization, the tests should be conducted so that they do not interfere with each other and with construction activities, rather than attempt to account for such interference when interpreting site charaterization data. The distances between the ESF construction and operation activities and in situ tests must be sufficient to prevent interference with site characterization activities. Likewise, in situ tests should be designed, located, and sequenced to avoid interference between the tests themselves. The effects of ventilation air on the rock mass to be tested should also be considered.

Certain performance confirmation tests may need to be initiated during site characterization, and may need to be continued until permanent closure. This requirement emphasizes the need for coordination between the ESF design and the GROA design because it will be necessary to ensure that the GROA construction and operations do not unduly interfere with the

continuing performance confirmation testing. For cases where performance confirmation tests may be needed for a long duration, it would be prudent to account for uncertainties in predicting long-term rock behavior for estimating interference effects.

(7) Establishment of Ranges of Site Parameters

To establish the needed information related to the suitability of the site, the extent of site characterization should be planned to provide a sufficient range of data. The data should also provide adequate information for designing the GROA and analyzing the site performance. Therefore, the ESF design should ensure that the data collected will provide the ranges of conditions and processes throughout the site.

To some extent, site characterization has to be an iterative procedure. A better understanding of additional investigation needs will develop as site characterization results are analyzed. Sufficient flexibility should be built into the ESF design to allow for modifications and expansion of the site characterization efforts if such changes are indicated on the basis of the initial findings.

Extensive drifting may be the most promising approach to reduce certain data uncertainties. It also presents one of the more difficult challenges for coordination of the ESF design with the GROA design. Optimum drift orientation and length may not necessarily coincide with preferred GROA layout. A careful balancing of the site characterization needs with the geologic repository performance objectives will be essential.

5.0 REFERENCES

1. U.S. Department of Energy, "Review Record Memorandum - Exploratory Shaft Facility (ESF) Title I Design Acceptability Analysis and Comparative Evaluation of Alternative ESF Locations," February 3, 1989.

2. U.S. Nuclear Regulatory Commission, "NRC Staff Characterization Analysis of the Department of Energy's Site Characterization Plan, Yucca Mountain Site, Nevada," NUREG-1347, U.S. Nuclear Regulatory Commission, Washington, D.C., 1989.

3. U.S. Nuclear Regulatory Commission, "Generic Technical Position on Design Information Needs in the Site Characterization Plan," December 1985.

4. U.S. Nuclear Regulatory Commission, "Generic Technical Position on In-Situ Testing during Site Characterization for High-Level Nuclear Waste Repositories," December 1985.

5. U.S. Nuclear Regulatory Commission, "Generic Technical Position on Postclosure Seals, Barriers, and Drainage System in an Unsaturated Medium," August 1989.

6. U.S. Nuclear Regulatory Commission, Code of Federal Regulations, "Disposal of High-Level Radioactive Wastes in Geologic Repository," Part 60, Chapter I, Title 10, "Energy."

7. U.S. Nuclear Regulatory Commission, "Technical Position on Items and Activities in the High-Level Waste Geologic Repository Program Subject to 10 CFR Part 60 Quality Assurance Requirements," NUREG-1318, 1988.

8. U.S. Nuclear Regulatory Commission, "Review Plan for High-Level Waste Repository Quality Assurance Program Descriptions," Revision 2, March 1989.

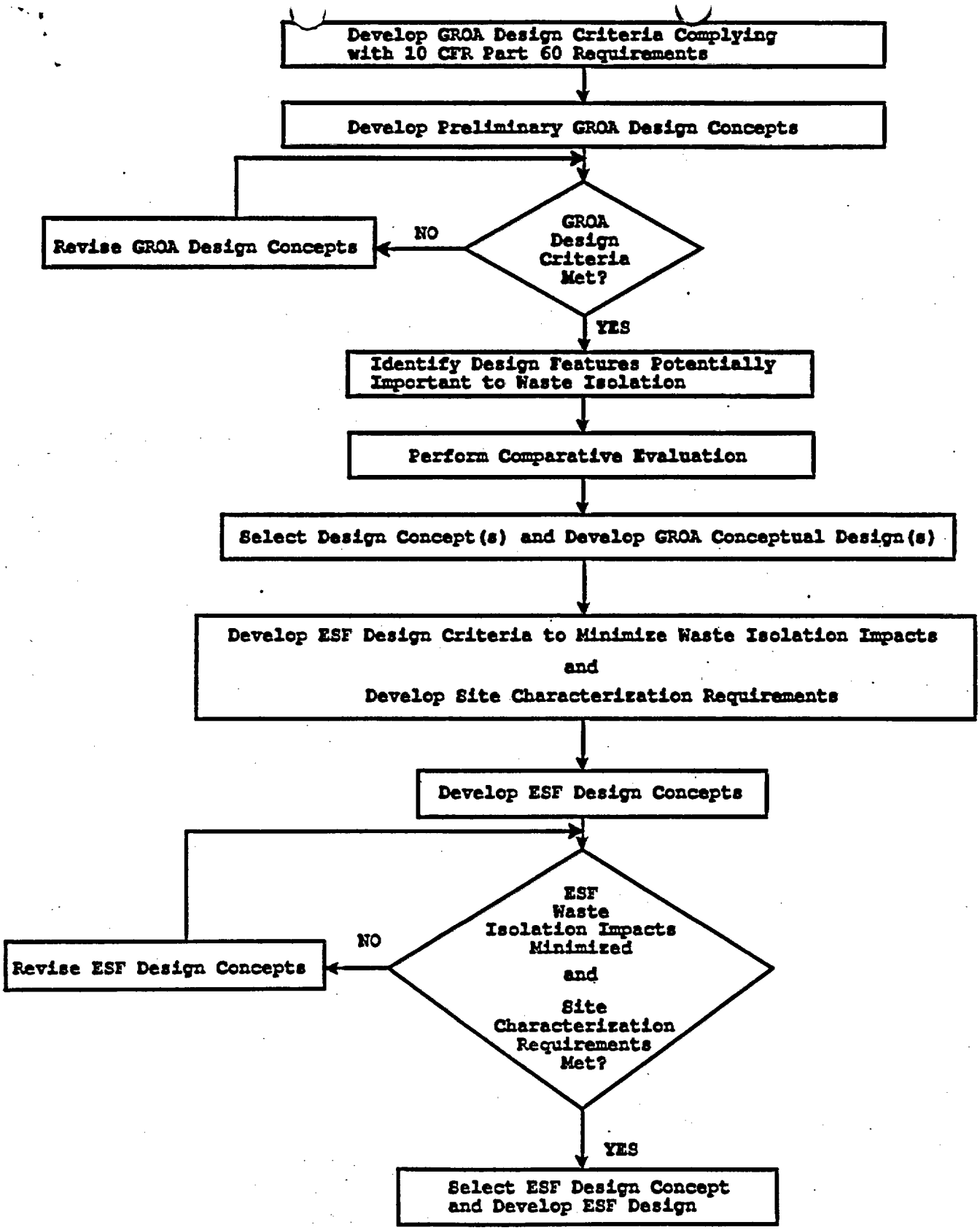

Figure 1. An Example of an Acceptable Approach to Achieve Compliance of the ESF Design with 10 CFR Part 60 Requirements

APPENDIX A

STAFF RESPONSE TO PUBLIC COMMENTS

This appendix will be added after receipt and resolution of public and Advisory Committee on Nuclear Waste (ACNW) comments.

APPENDIX B

LIST OF 10 CFR PART 60 REQUIREMENTS TO BE CONSIDERED IN THE DESIGN OF THE EXPLORATORY SHAFT FACILITY

This appendix lists requirements of 10 CFR Part 60 that pertain to the portions of the geological repository operations area that incorporate or may be impacted by the ESF. These requirements should, therefore, be considered in the design of the ESF.

The appendix also includes requirements of 10 CFR Part 60 that pertain to site characterization. As the ESF is a facility that is to be used as part of the site characterization program, to establish needed background information related to the suitability of the site, these requirements must also be considered.

While the list has been developed to provide general guidance, it is recognized that some of the requirements may not in fact impact the design of the ESF and that other requirements may have relevance even though not listed below.

Table 1

SUBPART A - GENERAL PROVISIONS

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design*
60.1	
60.2	A
60.3	
60.4	
60.5	
60.6	
60.7	
60.8	
60.9	
60.10	

* The letter A appearing in this column indicates that the 10 CFR Part 60 requirement listed in the first column should be considered in the ESF design.

Table 1 (continued)

SUBPART B - LICENSES

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.15(a)	
60.15(b)	A
60.15(c)	A
60.16	A
60.17(a)	A
60.17(b)	A
60.17(c)	A
60.18	
60.21(a)	
60.21(b)(1)	
60.21(b)(2)	
60.21(b)(3)	
60.21(b)(4)	
60.21(b)(5)	
60.21(c)(1)(i)	
60.21(c)(1)(ii)(A-C)(F)	
60.21(c)(1)(ii)(D)	A
60.21(c)(1)(ii)(E)	A
60.21(c)(2)	
60.21(c)(3)	
60.21(c)(4)	
60.21(c)(5)	
60.21(c)(6)	
60.21(c)(7)	
60.21(c)(8)	

Table 1 (continued)

SUBPART B - LICENSES

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.21(c)(9)	
60.21(c)(10)	
60.21(c)(11)	A
60.21(c)(12)	
60.21(c)(13)	
60.21(c)(14)	
60.21(c)(15)	
60.22	
60.23	
60.24(a)	A
60.31	
60.32	
60.33	
60.41	
60.42	
60.43	
60.44	
60.45	
60.46	
60.51	
60.52	

Table 1 (continued)

SUBPART C - PARTICIPATION BY STATE GOVERNMENTS AND AFFECTED INDIAN TRIBES

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.62	
60.63	
60.64	
60.65	

Table 1 (continued)

SUBPART D - RECORDS, REPORTS, TESTS, AND INSPECTIONS

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.71	
60.72(a)	A
60.72(b)	A
60.73	
60.74	A
60.75	

Table 1 (continued)

SUBPART E - TECHNICAL CRITERIA

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.101	
60.102	
60.111(a)	A
60.111(b)(1)	A
60.111(b)(2)	
60.111(b)(3)	A
60.112	A
60.113(a)(1)(i)	A
60.113(a)(1)(ii)	A
60.113(a)(2)	A
60.113(b)(1)	
60.113(b)(2)	A
60.113(b)(3)	A
60.113(b)(4)	A
60.113(c)	
60.121	
60.122(a)(1)	A

Table 1 (continued)

SUBPART E - TECHNICAL CRITERIA

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.122(a)(2)	A
60.122(b)	A
60.122(c)	A
60.130	A
60.131(a)	A
60.131(a)(1)	
60.131(a)(2)	
60.131(a)(3)	
60.131(a)(4)	
60.131(a)(5)	
60.131(a)(6)	
60.131(b)(1)	A
60.131(b)(2)	A
60.131(b)(3)	A
60.131(b)(4)(i)	A
60.131(b)(4)(ii)	A
60.131(b)(5)	
60.131(b)(6)	A
60.131(b)(7)	
60.131(b)(8)	A
60.131(b)(9)	A
60.131(b)(10)	A
60.132(a)	
60.132(b)	
60.132(c)	
60.132(d)	
60.132(e)	

Table 1 (continued)

SUBPART E - TECHNICAL CRITERIA

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.133(a)	A
60.133(b)	A
60.133(c)	A
60.133(d)	A
60.133(e)(1)	A
60.133(e)(2)	A
60.133(f)	A
60.133(g)	A
60.133(h)	A
60.133(i)	A
60.134(a)	A
60.134(b)	A
60.135(a)	
60.135(b)	
60.135(c)	
60.135(d)	
60.137	A

Table 1 (continued)

SUBPART F - PERFORMANCE CONFIRMATION PROGRAM

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.140(a)	
60.140(b)	A
60.140(c)	A
60.140(d)(1)	A
60.140(d)(2)	
60.140(d)(3)	
60.140(d)(4)	
60.141(a)	A
60.141(b)	A
60.141(c)	A
60.141(d)	A
60.141(e)	A
60.142(a)	A
60.142(b)	A
60.142(c)	A
60.142(d)	A
60.143(a)	A
60.143(b)	A
60.143(c)	A
60.143(d)	A

Table 1 (continued)

SUBPART G - QUALITY ASSURANCE

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.150	
60.151	A
60.152	A

Table 1 (continued)

SUBPART H - TRAINING AND CERTIFICATION OF PERSONNEL

10 CFR Part 60 Requirement	Requirement to be Considered in the ESF Design
60.160	
60.161	
60.162	

APPENDIX C

TEXT OF KEY 10 CFR PART 60 REQUIREMENTS

10 CFR 60.2

"Site characterization" means the program of exploration and research, both in the laboratory and in the field, undertaken to establish the geologic conditions and the ranges of those parameters of a particular site relevant to the procedures under this part. Site characterization includes borings, surface excavations, excavation of exploratory shafts, limited subsurface lateral excavations and borings, and in situ testing at depth needed to determine the suitability of the site for a geologic repository, but does not include preliminary borings and geophysical testing needed to decide whether site characterization should be undertaken.

10 CFR 60.15(c)

The program of site characterization shall be conducted in accordance with the following:

(1) Investigations to obtain the required information shall be conducted in such a manner as to limit adverse effects on the long-term performance of the geologic repository to the extent practical.

(2) The number of exploratory boreholes and shafts shall be limited to the extent practical consistent with obtaining the information needed for site characterization.

(3) To the extent practical, exploratory boreholes and shafts in the geologic repository operations area shall be located where shafts are planned for underground facility construction and operation or where large unexcavated pillars are planned.

(4) Subsurface exploratory drilling, excavation, and in situ testing before and during construction shall be planned and coordinated with geologic repository operations area design and construction.

10 CFR 60.17(c)

The site characterization plan shall contain a conceptual design for the geologic repository operations area that takes into account likely site-specific requirements.

10 CFR 60.21(c)(1)(ii)(D)

The assessment (of the site at which the proposed geologic repository operations area is to be located) shall contain:

> The effectiveness of engineered and natural barriers, including barriers that may not be themselves a part of the geologic repository operations area, against the release of radioactive material to the environment. The analysis shall also include a comparative evaluation of alternatives to the major design features that are important to waste isolation, with particular attention to the alternatives that would provide longer radionuclide containment and isolation.

10 CFR 60.112

The geologic setting shall be selected and the engineered barrier system and shafts, boreholes and their seals shall be designed to assure that releases of radioactive materials to the accessible environment following permanent closure conform to such generally applicable environmental standards for radioactivity as may have been established by the Environmental Protection Agency with respect to both anticipated processes and events and unanticipated processes and events.

10 CFR 60.134

(a) Seals for shafts and boreholes shall be designed so that following permanent closure they do not become pathways that compromise the geologic repository's ability to meet the performance objectives or the period following permanent closure.

(b) Materials and placement methods for seals shall be selected to reduce, to the extent practicable:

(1) The potential for creating a preferential pathway for groundwater to contact the waste packages or

(2) For radionuclide migration through existing pathways.

10 CFR 60.151

The quality assurance program applies to all systems, structures and components important to safety, to design and characterization of barriers important to waste isolation and to activities related thereto. These activities include: site characterization, facility and equipment construction, facility operation, performance confirmation, permanent closure and decontamination and dismantling of surface facilities.

10 CFR 60.152

DOE shall implement a quality assurance program based on the criteria of Appendix B of 10 CFR Part 50 as applicable, and appropriately supplemented by additional criteria as required by 10 CFR 60.151.