 YMP/89-3

U.S. DEPARTMENT OF ENERGY

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REVIEW RECORD MEMORANDUM

EXPLORATORY SHAFT FACILITY (ESF) TITLE I DESIGN ACCEPTABILITY ANALYSIS AND COMPARATIVE EVALUATION OF ALTERNATIVE ESF LOCATIONS

VOLUME 3

FEBRUARY 3, 1989

DEPARTMENT OF ENERGY · UNITED STATES OF AMERICA

UNITED STATES DEPARTMENT OF ENERGY
NEVADA OPERATIONS OFFICE/YUCCA MOUNTAIN PROJECT OFFICE

CRITERIA 1

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.1.1.1, 1.1.2.1, 1.1.4.1, 1.1.5.1, 1.1.6.1, 1.1.7.1, 1.1.8.1, 1.1.8.2, and 1.1.9.1 [60.15(d)(1)]

1.1.1.1 (UTIL) The design of the main pad shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the main pad shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

1.1.2.1 (UTIL) The design of the surface utilities, including the waste water ponds and water handling system, shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the surface utilities shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

1.1.4.1 (ES-1) The design of the first shaft shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the first shaft shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

1.1.5.1 (ES-2) The design of the second shaft shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the second shaft shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

1.1.6.1 (UG EXC) The design of the underground excavation shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the underground excavation shall be performed in a manner that limits the potential for adverse impacts of the long term performance of the repository

1.1.7.1 (UG UTIL) The design of the underground utilities shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the underground utilities shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

1.1.8.1 (UG TEST) The design of the underground testing program shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and implementation and operation of the underground testing program shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

1.1.8.2 (UG TEST) Prior to implementing the underground testing program, or prior to implementing additional tests, an evaluation of the potential impacts of such testing on the waste isolation capability of the site shall be performed.

and

1.1.9.1 (DECOM) The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES _____NO _____DON'T KNOW

RATIONALE:

10 CFR 60.15(d)(1) requires that investigations to obtain the required site characterization information be conducted in such a manner as to limit adverse effects on the long term performance of the geologic repository to the extent practicable. The approach taken in this TAR to evaluate the adequacy of the ESF Title I Design was to consider 10 CFR 60.15(d)(1) as an upper level requirement and assess the adequacy of the design on the basis of whether or not it was considered adequate with respect to a hierarchy of lower level criteria. Specifically, this approach involves considering the criteria developed for the Design Criteria of 10 CFR 60 in the evaluation of the impact on the ability of the site to comply with the Performance Objectives. A table was prepared that shows how the lower level requirements roll up into the higher requirements of 10 CFR 60.112, 60.113(a)(1)(ii)(A), and 60.113(a)(1)(ii)(B) then to 60.15(d)(1). This table (see Appendix I or Figure 2.3-1) indicates that in order to show compliance with 60.15(d)(1) one must demonstrate that there are minimal and acceptable impacts on the ability of the site to comply with the post closure Performance Objectives in 60.112, 60.113(a)(1)(ii)(A), and 60.113(a)(1)(ii)(B). Demonstration of compliance with the lower level requirements identified in the Table will assist in the evaluation of the Performance Objectives.

Evaluations of the Title I Design of the ESF indicate a number of design features were specifically embodied in the design both to assist the site in complying with the engineered barrier system release rate Performance Objective and to limit impacts to the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet

the performance objective. These design features include separation of the ESF tests from potential emplacement drifts, control of drainage directions, control of water use, blasting control, sealing of boreholes and shafts, and the use of air gaps between the container and the rock mass. The evaluations conclude that the ESF is designed with features that will enhance the capability of the repository to meet the total system release performance objective of 10 CFR 60.112 and the waste package to meet the performance objectives for waste package containment or controlled releases from the engineered barrier of 10 CFR 60.113.

A design that incorporates the features identified in the Design Criteria of 10 CFR Part 60 is not automatically assured of either being in compliance with the Performance Objectives of 10 CFR part 60 or not impacting the ability of the site to comply with the Performance Objectives. However, the Design Criteria of 10 CFR Part 60 encompass virtually all options open to a designer to ensure that a design does not impact the ability of the site to meet the Performance Objectives and where possible, enhances the ability of the site to meet the Performance Objectives.

The general approach found to be embodied in the Title I Design was the conscious incorporation of design features specifically intended both to assist the site in complying with the engineered barrier system release rate Performance Objective and to limit impacts to the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet the performance objective. These design features comprise both physical items, including aspects of the configuration, and control of activities.

ADEQUACY:

The assessment that the ESF Title I Design adequately addresses the requirement contained in 10 CFR 60.15(d)(1) primarily is predicated on the assessments of whether the Design adequately addresses the criteria developed for the postclosure performance objectives of 10 CFR Part 60. Those criteria generally require that that the ESF be designed, constructed, and operated in a manner that does not compromise the ability of the repository to meet the performance objectives. The assessment of those criteria also considered facets of the design and controls on activities that were specifically included in the design to limit impacts to the site that could compromise the ability of the site to meet the Performance Objectives. In many instances these features and controls are expected to contribute to the ability of the repository to meet the Performance Objectives with confidence, meeting one intent of the Additional Design Criteria of 10 CFR Part 60.

The potential impacts to the site from underground construction of exploratory shaft facility drifts and testing alcoves are evaluated in Section 8.4.2.3.5.4 of the SCP. The analyses discussed in Section 8.4.3.2.1 indicate that water introduced to the rock formations from underground construction will change the saturation of the rock only slightly. This change will generally be limited to approximately 10 m from the opening. The initial changes to saturation will be transient because equilibration is expected to occur within several months. The changes to saturation will generally be transient and will not significantly increase either the percolation flux at the repository horizon or the value of the unsaturated hydraulic conductivity. The fraction

of volume excavated within the ESF is small and is also not expected to significantly alter the flow field, or percolation flux, around the excavated opening; the effects of ventilation may further reduce the transient effects to flux and hydraulic conductivity caused by introducing water to the rock formations.

Changes in geochemistry could potentially affect the site, primarily by altering the environment near waste emplacement. West (1988) did not identify any interactions between fluids and materials used during construction that would have a significant, permanent impact on the site. The design of the ESF prudently places controls on fluids and materials The construction of the underground drifts and testing alcoves will cause some small permanent changes to the rock near the excavated openings. Because of the distance between the openings and emplaced waste, however, these geochemical changes are not expected to significantly alter the environment near the waste emplacement.

The potential geochemical impact from chemicals introduced during testing should be a very local effect near the test. These changes should not affect the environment near waste package emplacement, the capability of the tuff to retard transport of radionuclide, or the ground-water flux at the repository horizon.

The underground drifts and testing alcoves within the ESF will be permanent features, but are not expected to function as preferential pathways for either liquid or gaseous radionuclides. The changes in conductivity around the drift are expected to be increased by less than a factor of 2 to 3 at distances greater than approximately 5 meters from the wall. Changes to the site from introducing fluids and materials are expected to be generally transient and insignificant. The permanent changes are not expected to significantly impact the hydrologic, geochemical, and thermal/mechanical conditions of the site.

Hydrologic disturbances from ESF testing activities could potentially impact site performance by increasing the water flux at the repository horizon or by changing the hydrologic properties of the unsaturated zone. The currently identified tests will not introduce a significant amount of water to the unsaturated zone, and the water used in these tests will not result in permanent changes.

Of the design criteria related the site and surface utilities , the treatment of only two were found to be inadequate in any way. Of the design criteria related to ES-1 and ES-2, 34 criteria were judged to be adequately addressed with respect to waste isolation impacts, although the degree of adequacy varied. Criteria judged to be adequately addressed include appropriate location of shafts with respect to planned underground construction and operations, fluid control, shaft configuration, construction methods and control of deleterious rock movement, and shaft separation.

Criteria were also developed that address the potential performance related and waste isolation impacts from underground testing. Sixteen criteria were jujed to have been treated adequately. These included criteria related to fluids and materials control, thermal and thermalmechanical effects of testing, and appropriate location of boreholes. Those criteria that were considered to have been inadequately addressed related mostly to procedural controls (e.g., for water use in testing) and the disposal of waste water from

underground construction, operations, and testing. The Title I design contains insufficient information to permit assessment.
Of the criteria considered for the Underground Excavation, Underground Utilities, and Decommissioning, only five were considered to be inadequately addressed. Three of the five findings of inadequacy relate to the two-drift diameter spacing criterion for underground excavation.

The assessment that the ESF Title I design is adequate is also based on evaluations of the impacts that the design could have on the ability of the site to comply with the performance objectives. These assessments are largely abstracted from section 8.4.3 of the SCP. Many of the data, calculations and analyses supporting the Section 8.4 assessments were also reviewed as part of this TAR. The results of that evaluation bear on the assessment of adequacy of the ESF Title I Design and are summarized in section 2.4.4. Nearly all of the data and analysis reports reviewed for data reasonableness and appropriateness in support of Title I Design were judged to have used appropriate data and methods. Likewise, the treatment of uncertainty was considered appropriate. There were no issues identified by the reveiwers that questioned the adequacy of Title I Design. The concerns identified by the reviewers addressed evaluations warranted for Title II Design, and errata to the SCP to be treated in progress reports.

RECOMMENDATIONS AND CORRECTIVE MEASURES:

A number of recommendations and possible corrective measures were identified during the Design Acceptability Analysis conducted as part of this Technical Assessment Review. The majority address perceived shortcomings in the level of detail or explicitness judged to be present in the Title I Design. These shortcomings are not judged to signify inadequacy in the Title I Design for its intended purpose; in no case was an explicit recommendation made to redo any portion of the Title I Design. Specific recommendations, summarized from the evaluations of the lower level criteria are as follows:

Sensitivity analyses would provide additional confidence supporting statements about the benefit gained from separating testing and waste emplacement areas and are recommended for Title II design.

The design does not specify excavation techniques for controlling overbreak or limiting rock mass damage during underground construction or excavation of the main pad, particularly the northwest portion. Controls should be imposed on excavation techniques for pad construction as part of the Title II design. In particular, specify the diameter and length of blast holes, and the types of explosives which may be used. Also, require a Blasting Plan to be submitted for approval by the Contracting Officer at least 4 hours prior to each blast, and implement a vibration monitoring program.

The treatment of procedures planned for use in controlling water inflow is marginally adequate in the current design description and evaluations. The Title II design should provide more detail on these requirements. Contingency plans for controlling water flow should be more extensive in the Title II design. These procedures should include water use in testing, construction, as well as perched water.

Recommendations the of West (1988) report should be addressed in further design work. Procedures should also be established for control of all materials entering or leaving the ESF, particularly related to the limitation of the introduction of hydrocarbons, solvents, and chemicals.

The results of future microbial studies needs to be evaluated in future design documents to assure there are no long term adverse effects from the introduction of growth substrates.

Statements concerning rock-water chemistry and the use of J-13 water for the ESF may need to be reevaluated during the earliest stages of construction (i.e.: shaft and underground construction) when additional information on the chemistry of UZ pore water is available.

Comparative evaluations of alternatives for major design features will be required if the features are found to be important to waste isolation. The methodology for this determination is under development, and should be examined for adequacy when it is completed.

The MPBH's should be integrated into the requirements for and design of the ESF.

Analyses planned for Title II design evaluations should include sensitivity evaluations as appropriate to allow interpretations to be drawn as necessary as variable underground conditions are encountered in construction.

The Title II design should include drawings of the entire layout of the ESF main test level, the location of existing and planned boreholes that penetrate the repository horizon, and the standoff distance required (where appropriate) from the boreholes to the drifts, so that potential interference between tests can be better evaluated.

Drift-borehole 15m standoff criterion should be interpreted with respect to the MPBH's and borehole USW G-4, considering the localized drainage within the designated test area. Special consideration should be given to the manner in which the MPBH's minimally penetrate the repository horizon, and their proximity to the much greater shaft and connecting drift openings.

The sensitivity should be examined about the effectiveness of the separation distances between the waste emplacement area and the dedicated test area to more conclusively demonstrate that testing will not impact waste isolation.

Maintain the capability to extend ES-1 into the Calico Hills unit, if it is deemed necessary and prudent. Prepare a risk-benefit analysis early in Title II design if possible, providing analyses as described in SCP Section 8.4.2.1.6.1.

Construction specifications should be developed for the Title II design to indicate where pressure grouting during construction is to be avoided.

Future design planning should consider examining the effects of fire in the underground testing are where tests might be affected by fires.

The water disposal system (specifically the pond and sewer system) should be carefully examined to determine the impact of the planned location on waste isolation. The distance from the planned water disposal areas at the surface, to the repository boundary should be evaluated with respect to postclosure performance. The analysis should be done early enough in Title II design to allow a decision to be made regarding whether or not it is necessary to move the pond and sewer system or to line the pond.

The impact of thermal loads on the ES liners should be included in the Title II design before construction of the exploratory shafts.

A three-dimensional thermomechanical analysis of the ESF should be performed for the Title II design. The analysis should cover time-steps up to 10,000 years after waste emplacement. This analysis should evaluate the extent and nature of changes in the hydrologic conditions around the ESF resulting from thermal and thermomechanical effects of the repository.

REVIEWER	SIGNATURE	DATE
MICHAEL D. VOEGELE	Michael Voegele	Jan 29, 1989
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.2.1 [60.15(d)(1)]

1.1.2.1 (UTIL) The design of the surface utilities, including the waste water ponds and water handling system, shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the surface utilities shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989
ORGANIZATION SAIC		

1

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.4.1 [60.15(d)(1)]

1.1.4.1 (ES-1) The design of the first shaft shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the first shaft shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.5.1 [60.15(d)(1)]

1.1.5.1 (ES-2) The design of the second shaft shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the second shaft shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jun 29, 1989
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.6.1 [60.15(d)(1)]

1.1.6.1 (UG EXC) The design of the underground excavation shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the underground excavation shall be performed in a manner that limits the potential for adverse impacts of the long term performance of the repository

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.7.1 [60.15(d)(1)]

1.1.7.1 (UG UTIL) The design of the underground utilities shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and construction and operation of the underground utilities shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.8.1 [60.15(d)(1)]

1.1.8.1 (UG TEST) The design of the underground testing program shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and implementation and operation of the underground testing program shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.8.2 [60.15(d)(1)]

1.1.8.2 (UG TEST) Prior to implementing the underground testing program, or prior to implementing additional tests, an evaluation of the potential impacts of such testing on the waste isolation capability of the site shall be performed.

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jun 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.1.9.1 [60.15(d)(1)]

1.1.9.1 (DECOM) The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.1.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.1.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.1.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.4.1, 1.2.5.1 [60.15(d)(3)]

1.2.4.1 (ES-1) The shaft pillar is the buffer zone surrounding the shaft beyond which any instability of other underground openings has a negligible effect on shaft stability. Within the shaft pillar area, all facilities and openings shall be designed to be stable for a 100 year life and to limit any adverse effects on the stability of the shafts that could impact the ability of the site to isolate waste.

1.2.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the SDRD interface drawings, the descriptions, drawings, and appendices in the ESF Title I design report (Vols. I, II, and IV), and selected thermomechanical calculations published to date, I conclude that the facilities and openings in the shaft pillar area have been design with due consideration to stablility concerns for the 100 year life requirement. The repository exclusion area defined on ESF/REPOS Interface Drawing R07048A in Appendix "A" of the ESF Subsystems Requirements Document (SDRD) is the shaft pillar associated with the shafts of the ESF. All repository development is outside of this exclusion area. In this exclusion area excavation is limited to that required to install the site characterization experiments and the needed auxiliary support facilities and no waste will be stored in this area.

The design of individual openings in this ESF exclusion area and the total extraction within the area will be limited to ensure that the facility will meet the 100 year operational life requirement. The feasibility of meeting this lifetime requirement is substantiated by analyses completed to this time. These analyses of both ESF and repository openings are synopsized in SAND88-2294 "A Synopsis of Analyses (1981 - 1987) Performed to Assess the Stability of Underground Excavations at Yucca Mountain. A draft of this report is included as Appendix B.1 of the ESF Title I Design Summary Report. Quite obviously, additional evaluations specific to the Title II design are expected to be performed and it is recommended that these analyses include sensitivity evaluations as appropriate to allow interpretations to be drawn as necessary as variable underground conditions are encountered in construction.

ADEQUACY OF TREATMENT: Adequate treatment of the criteria is evidenced in the design and supporting evaluations.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

RECOMMENDATIONS AND CORRECTIVE MEASURES: Analyses planned for Title II design evaluations should include sensitivity evaluations as appropriate to allow interpretations to be drawn as necessary as variable underground conditions are encountered in construction.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.4.2, 1.2.5.2 [60.15(d)(3)]

1.2.4.2 (ES-1) The exploratory shafts shall be located, to the extent practicable, where shafts are planned for the repository facility.

1.2.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: As evidenced by the ESF Title I design and the conceptual design of the repository (see SAND84-2541 and SCP Ch. 6), the exploratory shafts have been located such that they can be readily incorporated into the repository design. The conceptual design of the repository uses the exploratory shafts for part of the intake air for the waste emplacement side of the ventilation system.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.4.1, 1.2.5.1 [60.15(d)(3)]

1.2.4.1 (ES-1) The shaft pillar is the buffer zone surrounding the shaft beyond which any instability of other underground openings has a negligible effect on shaft stability. Within the shaft pillar area, all facilities and openings shall be designed to be stable for a 100 year life and to limit any adverse effects on the stability of the shafts that could impact the ability of the site to isolate waste.

1.2.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the SDRD interface drawings, the descriptions, drawings, and appendices in the ESF Title I design report (Vols. I, II, and IV), and selected thermomechanical calculations published to date, I conclude that the facilities and openings in the shaft pillar area have been design with due consideration to stablility concerns for the 100 year life requirement. The repository exclusion area defined on ESF/REPOS Interface Drawing R07048A in Appendix "A" of the ESF Subsystems Requirements Document (SDRD) is the shaft pillar associated with the shafts of the ESF. All repository development is outside of this exclusion area. In this exclusion area excavation is limited to that required to install the site characterization experiments and the needed auxiliary support facilities and no waste will be stored in this area.

The design of individual openings in this ESF exclusion area and the total extraction within the area will be limited to ensure that the facility will meet the 100 year operational life requirement. The feasibility of meeting this lifetime requirement is substantiated by analyses completed to this time. These analyses of both ESF and repository openings are synopsized in SAND88-2294 "A Synopsis of Analyses (1981 - 1987) Performed to Assess the Stability of Underground Excavations at Yucca Mountain. A draft of this report is included as Appendix B.1 of the ESF Title I Design Summary Report. Quite obviously, additional evaluations specific to the Title II design are expected to be performed and it is recommended that these analyses include sensitivity evaluations as appropriate to allow interpretations to be drawn as necessary as variable underground conditions are encountered in construction.

ADEQUACY OF TREATMENT: Adequate treatment of the criteria is evidenced in the design and supporting evaluations.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

RECOMMENDATIONS AND CORRECTIVE MEASURES: Analyses planned for Title II design evaluations should include sensitivity evaluations as appropriate to allow interpretations to be drawn as necessary as variable underground conditions are encountered in construction.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.4.2, 1.2.5.2 [60.15(d)(3)]

1.2.4.2 (ES-1) The exploratory shafts shall be located, to the extent practicable, where shafts are planned for the repository facility.

1.2.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: As evidenced by the ESF Title I design and the conceptual design of the repository (see SAND84-2541 and SCP Ch. 6), the exploratory shafts have been located such that they can be readily incorporated into the repository design. The conceptual design of the repository uses the exploratory shafts for part of the intake air for the waste emplacement side of the ventilation system.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.6.1 [60.15(d)(3)]

1.2.6.1 (UG EXC) Exploratory boreholes shall be located so that they do not intersect any underground openings

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the ESF Title I design and the locations for surface-based exploratory boreholes identified in the SCP, it is evident that the boreholes have been planned or constructed so that they do not intersect any underground openings that are part of the ESF. I evaluated compliance with this criteria by overlaying onto the ESF-repository interface control drawing (drwg. R07048A) the locations of completed and planned boreholes in the vicinity of the ESF that will extend to the repository horizon. Since this evaluation is to be required again relative to the Title II design, it would seem appropriate for the Title II design report or drawings package to include a drawing that contains this information or reference to where the information is graphically displayed.

ADEQUACY OF TREATMENT: The ESF Title I design adequately meets the criteria.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The Title II design report or drawings package should include a drawing that contains the entire layout of the ESF main test level, the location of existing and planned boreholes that penetrate the repository horizon, and the standoff distance required (where appropriate) from the boreholes to the drifts.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.6.2, 1.11.6.5 [60.15(d)(3)]

1.2.6.2 (UG EXC) For sealing purposes, exploratory boreholes shall be located a minimum distance of 15 m from underground openings.

1.11.6.5 (UG EXC) The distance of underground facility openings from exploratory boreholes drilled from the surface should be at least 15 m.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the ESF layout in the Title I report, the locations and depths of existing boreholes identified in the Site Atlas, and the locations and depths of the proposed boreholes (Surface-Based Investigations Plan), it is believed that the exploratory boreholes that extend significantly below the repository horizon will not be within 15m of the ESF underground openings. At present, there are 3 holes (USW G-4, USW H-5, and USW WT-2) that are located within the repository underground layout boundary and extend to the water table. The current ESF layout does not show any drifts within 15 m of these holes.

The MPBH holes are within the ESF exclusion (dedicated test) area defined on drawing R07048A of Appendix A of the ESF/SDRD. These holes will not intersect any of the drifting in the ESF dedicated testing area. The MPBHs are not part of the current Title I design; however, if preliminary locations indicated in SCP Figure 8.4.2-19 are selected as the final locations for the MPBHs, they would not meet the 15 m standoff criteria. It is also not clear to this reviewer that they should be expected to meet this criteria since the 15 m standoff criteria is for sealing purposes related to preventing pathways for radionuclide migration to the water table and the MPBHs are not planned to extend significantly, if at all, below the repository horizon. It seems to me a bit illogical to apply this criteria to the MPBHs and thereby enforce a 15 m standoff from two, six-inch or so diameter boreholes while allowing drifts to connect directly with the shafts (14 feet diameter excavations). Prior to the start of Title II design, it is recommended that this criteria be defined with regard to whether or not it applies to the MPBHs. Because of the drainage capacity that exists within the ESF area and the relative isolation of the area from waste emplacement areas, specific interpretation should also be made regarding the need to apply the criteria to separation from USW G-4. Because it seems illogical to apply the criteria to the MPBHs and because the MPBHs were not a part of the Title I design, I consider that the Title I design meets the criteria and expect that the Title II design will consider this matter in detail.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: The SDRD for the ESF Title II design should make clear the intended application for this criteria relative to the MPBHs and USW G-4.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.6.3 [60.15(d)(3)]

1.2.6.3 (UG EXC) Borehole ~~adjustments~~ alignment JRT 1/31/89 and location shall be monitored, surveyed, and the results included on all underground working maps.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES ✓ NO _____ DON'T KNOW

RATIONALE: Currently not addressed in any of the Title I design-related documents.

ADEQUACY OF TREATMENT: Adequate for ESF Title I design as this criteria is appropriate only for the level of detail expected in Title II specifications.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Include this criteria as appropriate in SDRD for ESF Title II design.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.8.1 [60.15(d)(3)]

1.2.8.1 (UG TEST) MPBH boreholes shall be located in pillars to the extent practicable

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES (qualified) _____ NO _____ DON'T KNOW

RATIONALE: A "qualified yes" has been indicated relative to this criteria because the ESF Title I design does not include the MPBHs but evaluations (SCP section 8.4.2.3.1) of the design recognize the planned tentative locations as being in the shaft pillars. Furthermore, given that the purposes of the holes include providing information useful for sinking the shafts as well as monitoring potential fluid movement resulting from shaft construction, it is expected that the holes would be located in the shaft pillars. ESF criteria related to these holes are expected to be in the SDRD for the Title II design and the layout would be expected to identify their location.

ADEQUACY OF TREATMENT: Marginal, it would have been desirable to have seen provisions made in the design but the presence of the MPBHs is not likely to significantly impact the design configuration.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Adequate integration of the MPBHs into the requirements for and design of the ESF should be indicated in the ESF Title II SDRD and design.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.8.2 [60.15(d)(3)]

1.2.8.2 (UG TEST) Boreholes drilled from the underground portion of the ESF shall not penetrate significantly below the base of the TsW2 host rock, unless the impacts of doing so, on the waste isolation performance of the site, have been evaluated and found to be acceptable.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the ESF Title I designs and the test descriptions in the SCP, I did not identify any test that require drilling significantly below the TsW2 host rock. Detailed drawings of experiment areas for the Title II design should indicate, if practical, the extent of holes drilled from the ESF testing areas.

ADEQUACY OF TREATMENT: Adequate for ESF Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Title II design drawings for ESF test areas should indicate, if practical, the extent of holes drilled from the drifts to facilitate evaluations of compliance with these criteria.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R. Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.1, 1.3.5.1 [60.133(A)(1)]; 1.11.4.1, 1.11.5.1 [60.133(a)(1)]

1.3.4.1 (ES-1) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.3.5.1 (ES-2) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.11.4.1 (ES-1) The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

1.11.5.1 (ES-2) The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: The exploratory shafts have been specifically designed to not detract from and contribute where possible to the isolation capability of the site. The proposed locations of the shafts are above the pmf, considering debris flows, which should preclude significant quantities of surface water from entering the shaft in post closure time even if the shafts were not sealed. The proposed construction technique for the shafts is smooth wall blasting. This should limit the extent of fracturing around the shafts and enhance the effectiveness of future sealing. Effects of water entering the shafts are examined in Section 8.4.3 of the SCP. These show that conservative estimates of amounts of water entering the shafts appear to be within the drainage capacity of the shafts without leading to possible flooding of the repository. Sealing of the shafts would inhibit this inflow and provide additional protection to the repository. The shafts are smaller diameter than the other repository shafts and should, accordingly have a smaller mechanical and hydrological effect on the repository. Also, a decision has been made (see SCP section 8.4.2.1.6) not to penetrate the Calico Hills unit until a risk benefit analysis has been completed.

Additionally, as part of this Technical Assessment Review, a comparative evaluation of significant differences in the waste isolation potential of the five alternative exploratory shaft locations identified in the report by Bertram. That evaluation concluded that the presence of a shaft at any of the locations would not be expected to affect significantly the waste isolation capability of the repository, and that the relative differences among the alternative shaft locations are not significant to waste isolation.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: The design aspects individually enable the site to comply with this criteria; taken together they suggest that the design will comply conservatively.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Maintain the capability in the design to support penetration of the Calico Hills and, if possible, prepare risk benefit analysis early in Title II Design. If possible, provide sensitivity or scoping calculations to enable assessment of safety margin in drainage related calculations.

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

1.3.4.2 (ES-1) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.3 (ES-1) The exploratory shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.4 (ES-1) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.5 (ES-1) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.2 (ES-2) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.3 (ES-2) The exploratory shaft shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.4 (ES-2) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.5 (ES-2) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.1 (UG EXC) The Exploratory Shaft Underground Facility layout, including drift size, should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the layout is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.2 (UG EXC) The Exploratory Shaft Underground Facility support system should be designed, consistent with the other goals of site characterization, to limit the impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.3 (UG EXC) The Exploratory Shaft Underground Facility operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES ___✓___ NO _____ DON'T KNOW

RATIONALE: The Title I Design does not contain comparative evaluations of alternatives for major design features that are are important to isolation. (The referenced criteria equate the major design features to the ESF permanent items).

ADEQUACY OF TREATMENT: The comparative evaluations will be required if the identified major design features are found to be important to isolation. A QA Task force is currently developing the Methodology to be used for ESF Title II Design to determine those items of the ESF that are important to isolation. The lack of these evaluations at the Title I design is not considered a significant inadequacy. Construction of the ESF without the comparative evaluations, however, would probably be imprudent considering the current plans for the ESF to be incorporated in the repository.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Complete development of the QA Procedures for determining items important to isolation and implement in early stages of Title II. If the major design features are found to be important to isolation, comparative evaluations of alternatives should be performed

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jul 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

1.3.4.2 (ES-1) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.3 (ES-1) The exploratory shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.4 (ES-1) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.5 (ES-1) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.2 (ES-2) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.3 (ES-2) The exploratory shaft shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.4 (ES-2) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.5 (ES-2) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.1 (UG EXC) The Exploratory Shaft Underground Facility layout, including drift size, should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the layout is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.2 (UG EXC) The Exploratory Shaft Underground Facility support system should be designed, consistent with the other goals of site characterization, to limit the impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.3 (UG EXC) The Exploratory Shaft Underground Facility operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES ✓ NO _____ DON'T KNOW

RATIONALE: The Title I Design does not contain comparative evaluations of alternatives for major design features that are are important to isolation. (The referenced criteria equate the major design features to the ESF permanent items).

ADEQUACY OF TREATMENT: The comparative evaluations will be required if the identified major design features are found to be important to isolation. A QA Task force is currently developing the Methodology to be used for ESF Title II Design to determine those items of the ESF that are important to isolation. The lack of these evaluations at the Title I design is not considered a significant inadequacy. Construction of the ESF without the comparative evaluations, however, would probably be imprudent considering the current plans for the ESF to be incorporated in the repository.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Complete development of the QA Procedures for determining items important to isolation and implement in early stages of Title II. If the major design features are found to be important to isolation, comparative evaluations of alternatives should be performed

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

1.3.4.2 (ES-1) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.3 (ES-1) The exploratory shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.4 (ES-1) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.5 (ES-1) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.2 (ES-2) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.3 (ES-2) The exploratory shaft shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.4 (ES-2) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.5 (ES-2) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.1 (UG EXC) The Exploratory Shaft Underground Facility layout, including drift size, should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the layout is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.2 (UG EXC) The Exploratory Shaft Underground Facility support system should be designed, consistent with the other goals of site characterization, to limit the impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.3 (UG EXC) The Exploratory Shaft Underground Facility operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES ✓ NO _____ DON'T KNOW

RATIONALE: The Title I Design does not contain comparative evaluations of alternatives for major design features that are are important to isolation. (The referenced criteria equate the major design features to the ESF permanent items).

ADEQUACY OF TREATMENT: The comparative evaluations will be required if the identified major design features are found to be important to isolation. A QA Task force is currently developing the Methodology to be used for ESF Title II Design to determine those items of the ESF that are important to isolation. The lack of these evaluations at the Title I design is not considered a significant inadequacy. Construction of the ESF without the comparative evaluations, however, would probably be imprudent considering the current plans for the ESF to be incorporated in the repository.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Complete development of the QA Procedures for determining items important to isolation and implement in early stages of Title II. If the major design features are found to be important to isolation, comparative evaluations of alternatives should be performed

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

1.3.4.2 (ES-1) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.3 (ES-1) The exploratory shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.4 (ES-1) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.4.5 (ES-1) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.2 (ES-2) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.3 (ES-2) The exploratory shaft shaft diameter should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the diameter is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.4 (ES-2) The exploratory shaft liner should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the liner is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.5.5 (ES-2) The exploratory shaft operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.1 (UG EXC) The Exploratory Shaft Underground Facility layout, including drift size, should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the layout is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

1.3.6.2 (UG EXC) The Exploratory Shaft Underground Facility support system should be designed, consistent with the other goals of site characterization, to limit the impacts on isolation. If the support system is determined to be important to waste isolation a c mparative evaluation of alternatives shall be performed

1.3.6.3 (UG EXC) The Exploratory Shaft Underground Facility operational seals should be designed, consistent with other goals of site characterization, to limit impacts on isolation. If the seals are determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES ___✓___ NO _____ DON'T KNOW

RATIONALE: The Title I Design does not contain comparative evaluations of alternatives for major design features that are are important to isolation. (The referenced criteria equate the major design features to the ESF permanent items).

ADEQUACY OF TREATMENT: The comparative evaluations will be required if the identified major design features are found to be important to isolation. A QA Task force is currently developing the Methodology to be used for ESF Title II Design to determine those items of the ESF that are important to isolation. The lack of these evaluations at the Title I design is not considered a significant inadequacy. Construction of the ESF without the comparative evaluations, however, would probably be imprudent considering the current plans for the ESF to be incorporated in the repository.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Complete development of the QA Procedures for determining items important to isolation and implement in early stages of Title II. If the major design features are found to be important to isolation, comparative evaluations of alternatives should be performed

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.1, 1.3.5.1 [60.133(A)(1)]; 1.11.4.1, 1.11.5.1 [60.133(a)(1)]

1.3.4.1 (ES-1) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.3.5.1 (ES-2) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.11.4.1 (ES-1) The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

1.11.5.1 (ES-2) The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_✓_ YES _____ NO _____ DON'T KNOW

RATIONALE: The exploratory shafts have been specifically designed to not detract from and contribute where possible to the isolation capability of the site. The proposed locations of the shafts are above the pmf, considering debris flows, which should preclude significant quantities of surface water from entering the shaft in post closure time even if the shafts were not sealed. The proposed construction technique for the shafts is smooth wall blasting. This should limit the extent of fracturing around the shafts and enhance the effectiveness of future sealing. Effects of water entering the shafts are examined in Section 8.4.3 of the SCP. These show that conservative estimates of amounts of water entering the shafts appear to be within the drainage capacity of the shafts without leading to possible flooding of the repository. Sealing of the shafts would inhibit this inflow and provide additional protection to the repository. The shafts are smaller diameter than the other repository shafts and should, accordingly have a smaller mechanical and hydrological effect on the repository. Also, a decision has been made (see SCP section 8.4.2.1.6) not to penetrate the Calico Hills unit until a risk benefit analysis has been completed.

Additionally, as part of this Technical Assessment Review, a comparative evaluation of significant differences in the waste isolation potential of the five alternative exploratory shaft locations identified in the report by Bertram. That evaluation concluded that the presence of a shaft at any of the locations would not be expected to affect significantly the waste isolation capability of the repository, and that the relative differences among the alternative shaft locations are not significant to waste isolation.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: The design aspects individually enable the site to comply with this criteria; taken together they suggest that the design will comply conservatively.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Maintain the capability in the design to support penetration of the Calico Hills and, if possible, prepare risk benefit analysis early in Title II Design. If possible, provide sensitivity or scoping calculations to enable assessment of safety margin in drainage related calculations.

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

1.3.4.2 (ES-1) The exploratory shaft ground support system should be selected, consistent with other goals of site characterization, to limit impacts on isolation. If the support system is determined to be important to waste isolation a comparative evaluation of alternatives shall be performed

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2

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REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

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REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jul 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

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REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1985

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

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REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

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REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

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REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.2, 1.3.4.3, 1.3.4.4, 1.3.4.5; 1.3.5.2, 1.3.5.3, 1.3.5.4, 1.3.5.5; 1.3.6.1, 1.3.6.2, 1.3.6.3 [60.21(C)(1)(ii)(D)]

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REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.1.1 [60.21(c)(11)]

1.4.1.1 (SITE) The pad shall be designed to permit the ground to be restored to a contour compatible with its initial conditions.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my review of numerous surface construction drawings by F&S as well as the civil and buildings drawings by H&N and text in Volumes 1 and 2 of the ESF Title I design report, I conclude that the pad has been designed to permit the ground to be restored to a contour compatible with its initial conditions. The pad is constructed primarily as a cut-and-fill operation with predominately earthen material and concrete present. Discussions in Chapter 8 of the Title I design report indicate consideration of this type of criteria as it states "The balance of the surface facilities, including the substation and power poles, drainage control structures, concrete structures and all utilities, are disassembled and removed from the site for savage or disposal. ... The site is then graded and contoured using stockpiled topsoil and reclaimed using appropriate reclamation techniques."

ADEQUACY OF TREATMENT: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.4.1, 1.4.5.1 [60.21(c)(11)]

1.4.4.1 (ES-1) The shaft liner shall be designed to be removable prior to permanent closure.

1.4.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the design of the shaft liners depicted in the ESF Title I design and the evaluations of the feasibility of liner removal provided in SAND85-0598, I conclude that the shaft liners have been designed to be removable prior to permanent closure. The following features common to the liners for both ESF shafts will aid in assuring that they are fully removable:

- the shaft liners are not heavily reinforced
- the liners are not tied to the rock by rock bolting or other means

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.4.2, 1.4.5.2 [60.21(c)(11)]

1.4.4.2 (ES-1) To prevent complications of seal evaluations and emplacement and limit chemical alteration in future seal environments, no pressure grouting shall take place during the construction period of the shaft at locations of potential seal testing or emplacement. Specifically, no pressure grouting shall be performed within 50 feet of the original ground surface and within 50 feet (above and below) the contact of the Pah Canyon and Topopah Spring tuffs.

1.4.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES __√__ NO _____ DON'T KNOW

RATIONALE: No indication is available in the Title I design, design requirements or design evaluations to explicitly indicate zones where pressure grouting during construction is to be avoided although it could be argued that this is a contingency operation and therefore not appropriate for consideration in the Title I design.

ADEQUACY OF TREATMENT: Inadequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: The SDRD, the Title II design, and the construction specifications developed for the ESF should reflect planned adherence to this criteria.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R. Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.4.3, 1.4.5.3 [60.21(c)(11)]

1.4.4.3 (ES-1) Furnishings in the shafts shall be designed to be removable, if necessary, prior to permanent closure.

1.4.5.3 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Numerous ESF Title I design drawings and the planned use of the exploratory shafts during repository operations indicate that the shafts are being designed for the furnishings to be removable. For example, furnishings are depicted in, among others, drawings FS-GA-0100, -0102, -0112, and -0113. These furnishings that could be removed include items such as access ladders, spillage hoppers, ventilation ducts, skip/cage hardware, sump liners, compressed air lines, timber guides, power cables, water supplies, steel partitions and buntons, and counterweights.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.4.1, 1.4.5.1 [60.21(c)(11)]

1.4.4.1 (ES-1) The shaft liner shall be designed to be removable prior to permanent closure.

1.4.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the design of the shaft liners depicted in the ESF Title I design and the evaluations of the feasibility of liner removal provided in SAND85-0598, I conclude that the shaft liners have been designed to be removable prior to permanent closure. The following features common to the liners for both ESF shafts will aid in assuring that they are fully removable:

- the shaft liners are not heavily reinforced
- the liners are not tied to the rock by rock bolting or other means

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.4.2, 1.4.5.2 [60.21(c)(11)]

1.4.4.2 (ES-1) To prevent complications of seal evaluations and emplacement and limit chemical alteration in future seal environments, no pressure grouting shall take place during the construction period of the shaft at locations of potential seal testing or emplacement. Specifically, no pressure grouting shall be performed within 50 feet of the original ground surface and within 50 feet (above and below) the contact of the Pah Canyon and Topopah Spring tuffs.

1.4.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES __√__ NO _____ DON'T KNOW

RATIONALE: No indication is available in the Title I design, design requirements or design evaluations to explicitly indicate zones where pressure grouting during construction is to be avoided although it could be argued that this is a contingency operation and therefore not appropriate for consideration in the Title I design.

ADEQUACY OF TREATMENT: Inadequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: The SDRD, the Title II design, and the construction specifications developed for the ESF should reflect planned adherence to this criteria.

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Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.4.3, 1.4.5.3 [60.21(c)(11)]

1.4.4.3 (ES-1) Furnishings in the shafts shall be designed to be removable, if necessary, prior to permanent closure.

1.4.5.3 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Numerous ESF Title I design drawings and the planned use of the exploratory shafts during repository operations indicate that the shafts are being designed for the furnishings to be removable. For example, furnishings are depicted in, among others, drawings FS-GA-0100, -0102, -0112, and -0113. These furnishings that could be removed include items such as access ladders, spillage hoppers, ventilation ducts, skip/cage hardware, sump liners, compressed air lines, timber guides, power cables, water supplies, steel partitions and buntons, and counterweights.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.6.1 [60.21(c)(11)]; 1.11.6.8 [60.133(a)(1)]; 1.14.4.3, 1.14.5.3, 1.14.6.3 [60.133(d)]

1.4.6.1 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with postclosure sealing concerns.

1.11.6.8 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

1.14.4.3 (ES-1) Same as for 1.11.6.8.

1.14.5.3 (ES-2) Same as for 1.11.6.8.

1.14.6.3 (UG EXC) Same as for 1.11.6.8.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, plans for seal and repository designs (see SCP-CDR, SCP Chapter 6, and SCP section 8.3.3), and the repository interface drawings in the SDRD, I conclude that the drainage plan for the ESF and long exploratory drifts are consistent with planned repository operations and postclosure sealing concerns. As regards the two shafts, my conclusions are related to the fact that the shaft design is consistent with the performance allocation presented in the SCP for sealing. Specifically, the bottoms of the shafts are well below the main test levels (about 50 feet for ES-1 (drwg. FS-GA-0057) and about 100 feet for ES-2 (drwg. FS-GA-0113)) and because the design of the proposed liner is such that it can be removed during decommissioning if necessary to aid in sealing the repository. As regards the underground excavations, my conclusions are related again to the consistency between the ESF Title I design, the repository conceptual design, and the performance allocation presented in the SCP for sealing. Specifically, the proposed exploratory drifts in the ESF are consistent with the planned repository drifts as evidenced by the agreement between the ESF Title I design (drwgs. FS-GA-0195, -0196, -0197, -0198, and -0199) and the ESF-Repository interface drawing (R07048A in Appendix A of the SDRD). This will aid in assuring that the drifts in the repository are graded to allow the slope to be from (rather than toward) emplacement drifts in which waste has been stored. Additionally, the intersections between the long lateral drifts and the dedicated test areas are both above the elevation of the shaft breakouts with the breakout for ES-1

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

representing the lower of the two breakouts (see drwgs. FS-GA-0057, -0113, and -0195). As a result, the drainage in the dedicated test area would generally be toward ES-1 (see drwg. R07048A in ESF SDRD). The only exception to this drainage toward ES-1 in the current design of the dedicated test area is, I believe, the vertical testing drift (about 230 feet long) in the waste package environment test (drwg. FS-GA-0166); the grade of this drift is obviously based on the testing need for instrumentation access.

ADEQUACY OF TREATMENT: Adequate evidence exists to indicate that the drainage plan for the ESF is consistent with planned repository operations and postclosure sealing concerns and specifically that the drainage in the dedicated test area is generally toward ES-1 and that the slopes of the long drifts are compatible with the repository grades.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.6.2 [60.21(c)(11)]

1.4.6.2 (UG EXC) Nonpermanent components in the underground openings shall be designed to be removable, if necessary, prior to permanent closure.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: Numerous drawings in Volume 2 of the ESF Title I design report indicate that the nonpermanent items have been selected to allow removal as necessary prior to permanent closure. Specifically, drawings related to the ventilation, water, waste water, compressed air, electrical, communication, instrumentation, and fire protection systems indicate that items would generally be removable. Similarly, equipment mobile enough for use in construction would also be capable of being removed. Another example is that selected instrumentation related to the tests could be removed if necessary during decommissioning.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.9.1 [60.21(c)(11)]; 1.17.9.1 [60.133(h)]

1.4.9.1 (DECOM) The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

1.17.9.1 (DECOM) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Numerous features provided in and criteria met by the ESF Title I design give adequate evidence that the shafts, underground excavations, and ESF-related exploratory boreholes are designed to be constructed to allow adequate backfilling and sealing. Examples of this assurance are provided by the criteria related to maintaining usable openings for 100 years (1/60.15(d)(3)/4/1 & 5/1), provisions for liner removal, removable fixtures in the shafts, and removable non-permanent items (1/60.21(c)(11)/4/1, 5/1, 4/3, 5/3, and 6/2), lateral separation between drifts and shafts to preclude mechanical interference, drainage considerations, and location of the entrances to the shafts above the elevations of flow from the probable maximum floods.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.5.8.1, 1.5.8.2 [60.74(a)]

1.5.8.1 (UG TEST) The testing program and underground layout shall be designed with sufficient flexibility that tests that are deemed appropriate by the NRC can be performed. Prior to incorporating such tests, an evaluation of potential impacts on waste isolation shall be performed.

1.5.8.2 (UG TEST) Performance confirmation testing shall be carried out to meet the requirements of 10 CFR 60, Subpart F. Prior to incorporating such tests, an evaluation of potential impacts on waste isolation shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests (including performance confirmation testing) in the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or post-closure performance impacts.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to allow reasonable expansion for additional testing if needed. It should be noted that upon completion of their review of the CD-SCP, the NRC did not recommend any additional tests be performed, with the exception of tests related to sealing concepts, which are being addressed in SCP Sections 8.3 and 8.4. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate reasonable expansion of the testing program. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

If the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required. It would also be expected that, for any future testing, potential impacts on the site would be provided in a manner similar to those completed for the planned tests.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.5.8.1, 1.5.8.2 [60.74(a)]

1.5.8.1 (UG TEST) The testing program and underground layout shall be designed with sufficient flexibility that tests that are deemed appropriate by the NRC can be performed. Prior to incorporating such tests, an evaluation of potential impacts on waste isolation shall be performed.

1.5.8.2 (UG TEST) Performance confirmation testing shall be carried out to meet the requirements of 10 CFR 60, Subpart F. Prior to incorporating such tests, an evaluation of potential impacts on waste isolation shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests (including performance confirmation testing) in the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or post-closure performance impacts.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to allow reasonable expansion for additional testing if needed. It should be noted that upon completion of their review of the CD-SCP, the NRC did not recommend any additional tests be performed, with the exception of tests related to sealing concepts, which are being addressed in SCP Sections 8.3 and 8.4. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate reasonable expansion of the testing program. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

If the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required. It would also be expected that, for any future testing, potential impacts on the site would be provided in a manner similar to those completed for the planned tests.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.6.1.1, 1.6.2.1, 1.6.4.1, 1.6.5.1, 1.6.6.1, 1.6.7.1, 1.6.8.1, 1.6.8.2, and 1.6.9.1 [60.112]

1.6.1.1 (SITE)	The Exploratory Shaft Facility pad shall be designed and constructed so that it does not lead to creation of pathways that compromise the repository's capability to meet the performance objective of 10 CFR Part 60.112
1.6.2.1 (UTIL)	The surface utilities shall be designed and constructed so that they do not affect the capability of the repository to meet the performance objective of 10 CFR 60.112
1.6.4.1 (ES-1)	The shaft opening shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objectives of 10 CFR Part 60.112
1.6.5.1 (ES-2)	The shaft opening shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objectives of 10 CFR Part 60.112
1.6.6.1 (UG EXC)	The Exploratory Shaft Facility underground excavation shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objective of 10 CFR Part 60.112
1.6.7.1 (UG UTIL)	The underground utilities shall be designed and constructed so that they do not affect the capability of the repository to meet the performance objective of 10 CFR 60.112
1.6.8.1 (UG TST)	The testing program shall not affect the capability of the underground repository to meet the performance objective of 10 CFR 60.112
1.6.8.2 (UG TST)	Borehole openings shall be designed so that, following permanent closure, they do not become pathways that compromise the repository's ability to meet the performance objectives of 10 CFR Part 60.112

and

1.6.9.1 (DECOM)	The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES _____NO _____DON'T KNOW

RATIONALE:

Evaluation of the ESF Title I Design indicates that a number of design features and controls are incorporated both to assist the site in complying with the total system release performance objective, and to limit impacts to conditions and processes that could lead to significant impacts on the ability of the site to meet the performance objective. The following text summarizes information drawn from evaluation of the design with respect to relevant design criteria.

The following text is organized in two principal sections, addressing: (1) design features intended to limit potential construction and operations related impacts; and (2) design features intended to limit potential testing-related impacts. In the first of these sections, discussion related to construction and operations impacts is further divided into three categories which group together the physical features of the ESF: Site and Surface Utilities; First and Second Shafts; and Underground Excavation, Utilities, Decommissioning, and Underground Testing. Figure 2.3-1 indicates which specific design criteria were considered relevant to each ESF physical feature.

Following the summaries of potential impacts and design features, an evaluation of the overall impact on the ability of the site to comply with the criteria related to the performance objective is presented. The information summarizing impacts and design features is insufficient by itself to support a comprehensive assessment of the impact on the ability of the site to comply with the criteria related to the performance objective in 60.112; accordingly, supplemental information related to disruptive scenario classes from Section 8.4 is summarized.

1. Design features planned to limit potential impacts to the site from ESF construction and operation

(a) Summary of Site and Surface Utility design features

Shaft collar locations are above the PMF, considering debris flow. Various design features of the shaft collars, main pad, and surrounding areas are incorporated to prevent water influx into the shafts, from the runoff associated with a probable maximum flood. Such features include: the areas around the shaft collar are designed to prevent water influx; the pad will have a 2% slope away from shaft entrances; drainage channels and ditches will be used to control flows in the water courses; the existing wash above the pad will be deepened to further reduce the potential for influx; and an earthen berm will be constructed on the uphill side of the pad to deflect uncontained runoff that might flow onto the pad from above.

The site has a very high potential for water evaporation, so that much of the water used on the surface for pad compaction or dust control will evaporate

naturally. Water storage tanks are located away from or down-gradient from the entrances to the shafts so that tank rupture will not result in water entering either shaft. The design calls for off-site disposal of mine wastewater and sewage.

A preliminary fluid and material usage evaluation (West, 1988) identified no restrictions on the surface usage of solvents and hydrocarbons. Nevertheless, ESF pad and surface facilities will be designed, constructed, and operated to limit the use of substances such as water, oil, and chemicals that might have an impact on waste isolation.

Construction of the main pad using controlled blasting methods is likely to produce a damaged zone that is restricted enough and far enough above the repository horizon, so as not to interfere with waste isolation. Detailed procedures have not been written for blasting during site construction. Such procedures should reasonably limit the size of blasts to ensure that waste isolation (and possibly site characterization) is not affected. The procedures will be examined in detail when they are written.

(b) Summary of First and Second Shaft design features

The exploratory shafts are designed to have no adverse effect on waste isolation. The standing decision to excavate the exploratory shafts using drill-and-blast methods appears to be valid. There is no evidence to suggest that this method poses any more detriment to waste isolation than shaft drilling. In addition, there appears to be more control and less uncertainty associated with the effects of this method.

Shafts have been sited where they can be readily incorporated into the repository, assuming a ventilation intake function, and thereby reducing the total impact of repository construction on the site. The ESF design reflects a decision not to extend the ESF into the Calico Hills unit until risk/benefit analysis has been completed, and maintains the capability to extend the ESF into the Calico Hills unit, consistent with goals of site characterization.

Water used during construction will be limited to that needed for proper equipment operation and dust control, and for site characterization testing. Cleaning of shaft or drift walls in the ESF for mapping or other purposes will be done using an air/water mix to minimize water use. If necessary, water will be controlled during excavation of the shafts and drifts by constructing a sump at or near the working face, and pumping the water into the minewater collection system or into holding tanks for removal. Off-site disposal of minewater and sewage is planned.

The water distribution and minewater collection and disposal systems in the shafts are designed to prevent water losses that could adversely impact waste isolation. Vacuum relief devices are utilized for riser pipe protection, and various design features will dampen the effects of water hammer, preventing damage from sudden flow reduction. Excess flow shut-off valves will limit water flow in case of a line rupture in the shaft. The mine waste water system is fully redundant in that each MTL sump pump is duplicated, and each shaft discharge pipe is capable of handling the 500-gpm design flow compared to the 250-gpm expected flow. The 300-foot shaft separation identified in the

ESF Title I design is reasonable with respect to avoiding postclosure performance impacts resulting from the water systems. While concerns related to the water systems are minor relative to shaft separation, the distance between shafts should be limited to avoid long, high-pressure pipe runs through the underground excavation.

The shaft collars are designed to prevent water influx from flooding. The shaft entrances are above grade and the pad slopes away from the entrances with a 2% slope. The entrance to ES-1 will be located 16 feet above the maximum height of a probable flood and the entrance to ES-2 will be over 37 feet above the probable maximum flood. A collection ring located at the bottom of the collar is designed to collect and stop water that enters the top of the shaft. Water that flows past this ring can be collected in the sump at the bottom of the shaft and pumped to the surface. Redistribution of water that will be retained in the rock mass as a result of shaft sinking operations is not expected to significantly change the matrix saturation in the rock mass containing the shafts, either near the ground surface or at depth. The farther the water moves from the shaft wall, the smaller the local change in matrix saturation will tend to be.

The Title I ESF design is consistent with the position that water in the unsaturated zone does not occur naturally in amounts that will require the installation of operational seals in the ESF underground excavations. The capability to control flow from boreholes that intercept perched water is provided for in the design. The MPBH's, shaft probe holes, and drift probe holes (to be used where exploratory drifts are expected to intersect geologic structures) will provide appropriate information on the occurrence of perched water, in advance of shaft or drift excavation.

Shaft ventilation is likely to result in the evaporation of water introduced during construction. Water entering and exiting the ESF will be carefully monitored, including measurement of quantity, location of efflux or influx, and water balance.

Major factors mitigating chemical changes from construction and operation of the ESF that could affect waste isolation, are the transitory nature of the changes, the small quantities of materials introduced, and the considerable separation of waste isolation areas from the ESF shafts and underground excavations. Volatile compounds will tend to be preferentially removed by the ventilation system. No effects of blasting products on waste isolation have been identified in preliminary evaluation. Local chemical changes will be associated with cement used in the ESF, but are not expected to impact the waste emplacement areas, nor to adversely affect the mobility of waste elements. There is no indication in the design documentation that amounts of cementitious materials will be used in excess of that required for proper design or construction.

The capability to enhance postclosure performance by removing the shaft liner is maintained in the Title I design for the liner. The design also includes passive features which provide appropriate flexibility to effectively plug and seal the facility at closure, even if a portion of a shaft is damaged by a disruptive event. The shaft construction method incorporating smooth-wall blasting was chosen to minimize the disturbance to the rock while minimizing the introduction of fluids; thereby explicitly recognizing the 60.133(e)(2)

requirement.

Numerous features of the Title I design, and criteria met by the design, ensure that the shafts are designed to facilitate backfilling and sealing. Examples are: facilities and openings in the shaft pillar area have been designed in accordance with a 100-yr. lifetime; total extraction in the designated test area will be limited to ensure compliance with 100-yr. shaft lifetime; provisions are made for removing non-permanent items from the shafts including furnishings; drift separation in the test area will be controlled to limit mechanical interference effects; and ESF drainage considerations, including drainage towards ES-1. These items reduce uncertainty in predicting performance, and will facilitate backfilling and implementation of seals.

(c) Summary of design features related to Underground Excavation, Underground Utilities, and Decommissioning

Many features of the design of the underground layout contribute to waste isolation, such as: orientation with respect to geologic fractures and in situ stresses; flexibility in the design to accommodate site specific conditions; separation of testing and waste emplacement areas; minimization of the number of interconnections with the repository; and limiting the size of the exploratory drifts to that needed for site characterization and other testing. Additional detail is provided below.

The ESF has been designed to maintain the flexibility of the repository to accommodate site specific conditions, or adjustments indicated by in situ testing and monitoring. This is chiefly because the ESF will be mostly confined to a small area separated from waste emplacement areas. Also, the number of interconnections with the repository is minimized, and the long exploratory drifts from the ESF are designed to be coincident with repository drifts.

Excavations at the main test level will be limited to the TSw2 unit, and more than 200m overburden will be maintained. Planned excavation will be within the conceptual perimeter drift boundary, except for the long exploratory drifts which will penetrate the Drill Hole Wash, and the imbricate normal fault bounding structures for characterization. Two interconnections are planned between the ESF designated test area and the conceptual repository layout; this is the minimum number from safety considerations.

Several features in the ESF Title I design are intended to limit the effects of excavation on waste isolation. Controlled (smooth-wall) blasting used during construction will limit changes in permeability of the rock mass adjacent to the drifts. Experiments are planned to investigate the effects of excavation construction (due to stress relief and blast damage) on the rock mass surrounding the shafts during the construction phase of ESF testing. Water use will be limited to the minimum required for proper equipment operation and dust control. If necessary, water will be controlled during excavation of the drifts by constructing a sump near the working face, and pumping the water into the minewater collection system or into holding tanks for later removal.

The design includes passive features which provide appropriate flexibility to

effectively plug and seal the facility at closure, even if a portion of the shaft is damaged by a disruptive event (locations of seals and plugs have not been fixed). Similarly, the Title I design meets the criterion to limit the extraction ratio in the test area to 30%, with insignificant localized exceptions.

The ESF design meets the criterion for a two-diameter separation between adjacent drifts to avoid deleterious rock movement that might impact waste isolation, except for the following few areas:

(i) adjacent drifts to be constructed for: the Sequential Drift Mining Test, the Waste Package Vertical Test, and the Heated Room Test;

(ii) UPS alcove and Service Drift #4;

(iii) Science Shop and Heated Block alcove;

(iv) Canister Scale Heater Test alcove and Heated Block alcove; and

(v) Waste Package Vertical Test drift (tentatively located assuming that both horizontal and vertical testing are performed) and an access drift in the repository conceptual design (SCP-CDR).

The primary concern with respect to waste isolation is uncontrolled release of large amounts of water. The water distribution, minewater collection and removal, and surface sewage systems are designed with appropriate controls, redundancy, and capacity to ensure that significant quantities of water will not be lost, and to ensure that significant influx from the rock mass can be evacuated from the ESF. Water used in construction and operation of ESF-related drifts, and in planned testing, will be limited to that needed for dust control, proper equipment operation, and obtaining needed information for site characterization.

The ESF design provides for the capability to monitor water influx and efflux from the underground portion of the ESF, including moisture transported by the ventilation system, water distribution system, and minewater collection and removal system. Also, the design supports the capability to chemically tag all water introduced artificially into the underground openings.

The drainage plan for the ESF and long exploratory drifts is consistent with planned repository operations and postclosure sealing. The ESF test area drains towards ES-1. The long drifts are integrated with the repository drainage plan, such that they will drain away from areas where waste will be stored, and do not drain toward the exploratory shafts. The only exception to the consistency of the drainage pattern for ESF-related drifts is the vertical test drift for the Engineered Barriers Test in the ESF, which is designed to facilitate testing requirements.

The Title I ESF design is adequate to ensure that the effects of credible disruptive events do not spread throughout the facility and thus adversely affect waste isolation. Items such as automatic, excess flow valves are included at strategic locations in the piping systems to limit the amount of water released in the event of a line failure. In addition to flooding

considerations, the design adequately addresses protection from fire and explosion, will provide special monitoring and suppression systems in areas of high hazard, and provides monitoring capabilities with alarms and shutoffs. Also, the underground portion of the ESF will be constructed with mostly noncombustible materials. Materials identified for use in fire suppression (West, 1988) are not expected to adversely impact waste isolation.

Major factors mitigating chemical changes from construction and operation of the ESF that could affect waste isolation, are the transitory nature of the changes, the small quantities of materials introduced, and the considerable separation of waste isolation areas from the ESF shafts and underground excavations.

The design is supported by a decision-tree analysis (West, 1988) used to screen fluids and materials, and to test for interactions. No fluids and materials were identified that would have a significant effect on waste isolation. There is no indication in the design documentation that amounts of cementitious materials will be used in excess of that required for proper construction. Water used in the ESF will be pumped from well J-13 which produces from the Topopah Spring Member; no significant chemical changes are expected from introduction of this water in the ESF underground environment.

Volatile compounds will tend to be preferentially removed by the ventilation system. No effects of blasting products on waste isolation have been identified in preliminary evaluation. Local chemical changes will be associated with cement used in the ESF, but are not expected to impact the waste emplacement areas, nor to adversely the affect the mobility of waste elements.

The geochemical effects of fire should not adversely affect waste isolation, based on: the separation between the ESF and waste emplacement areas, fire protection and ventilation systems that retard the spread of fire, and the limited extent of any geochemical effects.

2. Potential impacts to the site from testing in the exploratory shafts and underground facility.

(a) Summary of design features related to Underground Testing

Based on the information available in the Title I design and related evaluations it is likely that underground testing will have no significant impact on the capability of the repository to isolate waste. Hydraulic disturbances from testing in the Exploratory Shaft could potentially impact compliance with the total system release performance objective by increasing the water flux at the repository horizon or by changing the hydrologic properties of the unsaturated zone. Tests that could impact the site are designed to be carefully controlled and physically separated from the waste emplacement areas. Potential impacts from testing will be assessed before the tests are conducted. Excess water entering or collecting in the ESF dedicated test area either through accidental flooding or from perched water zones will be removed to the surface, to the extent practicable.

Although not a feature of the ESF design per se, existing and planned

surface-based boreholes have been constructed and sited, respectively, so they do not intersect planned underground openings. The Title I design and associated descriptions of ESF testing do not show any boreholes extending significantly below the repository horizon or below the TSw2 unit.

The amounts of water used for testing and related operations will be limited to that required for dust control and proper equipment operation, and will be consistent with performance objectives. Cleaning of ESF walls for photogrammetry, mapping, and other testing will be done using compressed air/mist to limit the amount of water used.

Water entering the ESF will be carefully monitored, including measurement of quantity, location of influx, and water balance calculations. Not all test plans have been developed, but a process is in place to assure that they will be carefully reviewed when the plans are available to evaluate potential impacts on waste isolation.

Geochemical effects of testing are expected to be limited to a distance of less than 1 meter from the test location and thus not impact the ability of the site to isolate waste. Likewise, thermal effects of the tests are generally local in extent and thus not likely to impact the ability of the site to isolate waste. Additional evaluations to support these assessments can be found in SCP Section 8.4.3.

Analyses show that the thermal/thermomechanical effects of ESF testing will be localized to the test area and not cause significant changes to the rock mass along potential pathways from the repository to the accessible environment. The same analysis can also be used effectively to show that the hydrologic effects from ESF testing will be laterally separated from, and should therefore have no significant impact on, the saturation of the host rock in waste emplacement areas.

Analyses documented in SCP Section 8.4 show that the extent of the zone of increased temperature from ESF testing is limited such that the temperature in the units underlying the TSw2 is very unlikely to exceed 115 C.

(b) Summary of design features related to performance confirmation excavation and testing

The current ESF design provides both space and the support facilities for future testing as may be required. Section 8.3.5.16 of the SCP describes performance confirmation testing, which will be conducted in two phases. The initial, baseline phase, will involve the collection of a subset of the data from related tests, designed principally for site characterization. These results will be used to plan future performance confirmation tests.

Some site characterization tests (i.e., seal tests, room heater experiment, engineered barrier field system test) are planned to be continued as performance confirmation tests.

Other tests, not yet designed, may be planned during the site characterization program for implementation at any time. This is the main reason for maintaining flexibility in the ESF design. The Title I design is adequate in

this respect.

3. Summary evaluation of impacts on total system releases from construction, operation, and testing in the exploratory shafts and underground facility.

Limitation of the release of radioactive materials to the accessible environment following permanent closure is provided by natural barriers and design features, and controls on construction methods and testing operations. Construction methods will limit releases by means of: use of dry drilling techniques at surface locations within or in the immediate vicinity of the repository block; controlled use of water during excavation; controls on rock mass damage associated with excavation; and maintenance and preservation of natural surface water drainages. Major design features contributing to waste isolation include: lateral separation of the waste emplacement areas from shafts, underground tests, and boreholes; drainage control within the ESF away from waste emplacement areas; and the capability to seal boreholes, shafts, and drifts. These measures will contribute to limitation of releases to the accessible environment, by limiting the amount of water contacting the waste package, and by limiting changes to site conditions that could increase the mobility of radioactive materials.

Evaluations of the Title I ESF design, including construction and planned testing activities, against the design criteria related to the 10 CFR 60 requirements, show that the ESF and related activities are not likely to produce significant changes to the relevant site conditions or to the amount and direction of moisture flux, or lead to the creation of preferential pathways that could significantly affect waste isolation. Analyses in SCP Section 8.4.3 indicate that the effects on the site properties, with the exception of the penetration created by the excavation, are expected to be of short duration and limited laterally to within about 10 meters of the ESF. Appropriate measures are taken in the ESF Title I design to ensure that the ESF will be separate from, and minimally connected to, the repository. Design measures will also facilitate backfilling or sealing the drifts, alcoves, and boreholes of the ESF, as appropriate, to restrict movement of gaseous and liquid phases preferentially into or through ESF-related openings. In addition the ESF is laterally separated from waste emplacement areas by 30 meters or more, and the ESF drainage plan is designed to be separate from that of the repository.

Generally, the design criteria and the evaluation of whether the Title I ESF design meets these criteria, are consistent with the discussion in SCP Section 8.4.3.2.4 of repository design features that contribute to performance. Specifically, the TAR has confirmed that the ESF Title I Design provides: (1) separation of the ESF tests from potential emplacement drifts; (2) control of drainage direction; (3) low flooding potential for the shaft locations; (4) controls on the number and locations of associated boreholes; (5) flexibility for location of ESF tests; (6) controls on water use in construction and testing; (7) excavation methods to limit damage to the adjacent rock mass; (8) ventilation with the capability to remove water; (9) measures taken to avoid possible impoundment of surface water; and (10) removable shaft liners. The adequacy of the treatment of these items in Title I design is discussed in the sections that follow.

Note that SCP Section 8.4.3 also includes analyses that indicate that ESF activities are not reasonably expected to affect either the frequency of occurrence or the magnitude of the processes and events that may presently be considered likely to occur within the 10,000 year period of performance. That section also reached a similar conclusion with regard to disruptive scenarios.

ADEQUACY OF TREATMENT

The assessment that the ESF Title I design is adequate is partially based on evaluations of the impacts that the design could have on the ability of the site to comply with the performance objectives. These assessments are largely abstracted from section 8.4.3 of the SCP. Many of the data, calculations and analyses supporting the Section 8.4 assessments were also reviewed as part of this TAR. The results of that evaluation bear on the assessment of adequacy of the ESF Title I Design and are summarized in section 2.4.4. Nearly all of the data and analysis reports reviewed for data reasonableness and appropriateness in support of Title I Design were judged to have used appropriate data and methods. Likewise, the treatment of uncertainty was considered appropriate. There were no issues identified by the reviewers that questioned the adequacy of Title I Design. The concerns identified by the reviewers addressed evaluations warranted for Title II Design, and errata to the SCP to be treated in progress reports.

1. Adequacy of treatment of criteria pertaining to limiting the impact of ESF construction and operation on waste isolation

(a) Adequacy of treatment of criteria for Site and Surface Utility features

The design of the site and surface utilities is generally adequate with respect to waste isolation. Of the design criteria evaluated, the treatment of only two was found to be inadequate in any way.

The Title I design does not adequately assess the impacts on waste isolation performance from locating the sanitary disposal and unlined mine waste water disposal ponds approximately 2000 feet outside the conceptual repository perimeter. However, because it would be possible to line the mine waste water pond or move the ponds further away, this is not significant relative to the adequacy of the Title I design.

Also, the design does not specify excavation techniques for controlling overbreak or limiting rock mass damage during excavation of the main pad, particularly the northwest portion. The specific excavation technique can be developed in Title II Design.

(b) Adequacy of treatment of criteria for the First and Second Shafts

The ESF Title I design was evaluated against design criteria related to ES-1 and ES-2, with respect to waste isolation impacts. Thirty-four criteria were judged to be adequately addressed, although the degree of adequacy varied. Criteria judged to be adequately addressed include appropriate location of shafts with respect to planned underground construction and operations, fluid control, shaft configuration, construction methods and control of deleterious

rock movement, and shaft separation.

Comparative evaluations of alternatives for major design features will be required if the features are found to be important to waste isolation. The methodology for this determination is under development, so the lack of these evaluations in the Title I design is judged not to be inadequate.

The treatment of controls planned for use in controlling water inflow is marginally adequate in the current design description and evaluations. However, sufficient evidence exists to show that there is adequate consideration of drainage and pumping systems in the shaft designs for draining water away from testing and other working areas for collection and disposal.

Statements concerning rock-water chemistry and the use of J-13 water for the ESF may need to be revaluated during the earliest stages of construction (i.e., shaft construction) when additional information on the chemistry of UZ pore water is available.

The MPBH's may be closer to their respective shafts than the 15m borehole/ drift standoff; however, the exact location of the MPBH's can be finalized in Title II Design.

The adequacy of shaft design features to support repository-related shaft functions is supported by the repository conceptual design. The adequacy of lifetime evaluations is supported by documented calculations (see appendices to the Title I Design Report).

The linear-elastic evaluation by Costin and Bauer (1988) that predicts the extent of mechanical interference between ES-1 and ES-2, and shows that such interference is unlikely, is adequate to support Title I design.

Finally, several analyses are available which provide information pertaining to the ESF liner design, but do not specifically address the need to consider shaft response to thermal loading. The ESF Title I Design Summary Report contains the results of two possibly applicable studies that have not been post-processed to yield specific information relative to shaft liners.

(c) Adequacy of treatment of criteria for the Underground Excavation, Underground Utilities, and Decommissioning

Of the criteria considered under this category, only five were considered to be inadequately addressed. These are summarized below; note that three of the five findings of inadequacy relate to the two-drift diameter spacing criterion for underground excavation.

Comparative evaluations of alternatives for major design features will be required if the features are found to be important to waste isolation. The methodology for this determination is under development, so the lack of these evaluations in the Title I Design is judged not to be inadequate.

The treatment of the controls planned for use in controlling and limiting water inflow is marginally adequate in the current design description and

supporting documentation.

The ESF design is marginally adequate with respect to the two-diameter separation criterion for adjacent drifts. The two drift-diameter spacing requirement for ESF drifts is not met for the Sequential Drift Mining test drifts, the Waste Package Vertical test drifts, and several alcoves. Separation exceptions could be rectified by slight changes to the ESF layout and possibly the repository design. The applicability of the drift diameter standoff to the Sequential Drift Mining and Waste Package Vertical Test should be examined in the Title II Design. In addition, the width of the pillar between the southeast Waste Package Vertical drift and the adjacent repository drift is inadequate and should be increased in the Title II Design.

Bounding analyses applied to the ESF indicate that the effects of repository thermal loading on ESF underground openings should have no significant impact on waste isolation. However, analyses have not been completed which provide specific information on response of the shaft liners to repository thermal loading.

Analyses referenced in the Title I design report show that the repository drifts should remain stable even without specific benefit of ground support. The ESF drifts should also remain stable given that ground support based on conservative systems of rock mass classification will be used. The question of whether support will perform adequately in response to thermal loading is the subject of planned ESF testing.

Statements about the benefit gained from separating testing and waste emplacement areas could be reinforced by conducting sensitivity analyses.

The extent of excavation, and the size of the area that will be used for testing in the ESF, is based on the testing programs developed for obtaining the information identified as necessary to address licensing issues. The extra space available within the test area is appropriate to accommodate ESF operations, needed flexibility to relocate tests, separation of tests to limit interference, separation of testing and ESF operations, and future testing.

Sufficient evidence exists to show that there is adequate consideration of drainage and pumping systems in the current designs of the shafts, underground excavations, and underground facilities for draining water away from testing and other working areas for collection and disposal.

Several analyses support the conclusion that the Title I design addresses the need to minimize the potential for deleterious rock movement or fracturing.

The Title I design does not specifically consider excavation techniques for controlling overbreak or limiting disturbance to the rock mass. Although the potential impact on waste isolation is small, controls should be imposed.

Based on the Case and Colossal (1987) study, it is reasonable to expect that the goal for limiting permeability changes in the wall rock as a result of excavation will be met. This is adequate for Title I design. Experiments to validate the results of Case and Kelsall is planned in the construction phase of ESF testing.

Existing analyses of the behavior of a number of repository openings under thermal loading are considered conservative approximations of the conditions around the ESF openings, and thus are bounding calculations for considering the impact of ESF openings on waste isolation.

Numerical analysis methods for designing underground support systems are generally inconclusive, with no standardized methods in existence. The widely accepted empirical rock mass classification approach described for the repository conceptual design (SCP Chapter 6) is therefore considered adequate for the ESF Title I design.

2. Adequacy of treatment of criteria pertaining to limiting the impact on waste isolation, of testing in the exploratory shafts and underground facility

In addressing the potential for impacts to waste isolation from underground testing, twenty-one criteria were developed. Of these, twenty criteria were considered applicable to the Title I design; the other criterion is related to construction controls on the MPBH's. Sixteen of the [illegible] applicable criteria were considered to have been adequately treated with respect to the Title I design. These included criteria related to fluids and materials control, thermal and thermomechanical effects of testing, and appropriate location of boreholes. Those criteria which were inadequately addressed are related mostly to procedural controls (e.g., for water use in testing) for which the Title I design contains insufficient information to permit assessment. These concerns are presented in the form of recommendations in the next section.

As indicated in the roll-up table for paragraph 60.112 (presented in Figure 2.3-1), the criteria used for considering the potential impacts of performance confirmation testing are similar to the criteria applied to site characterization testing. The only differences identified are in the application of 60.15(d)(3) and 60.137 to site characterization and performance confirmation, respectively. The treatment of performance confirmation concerns is generally considered adequate in the ESF Title I design, based on: availability of space in the ESF dedicated test area for future testing; flexibility to develop additional excavations; and the assumption that future testing will be similar to planned testing with respect to potential impacts on waste isolation, and the controls maintained on test performance.

RECOMMENDATIONS AND CORRECTIVE MEASURES

It is anticipated that none of the recommendations listed below will require revision of the Title I ESF design. Further discussion of the impact of these and other recommendations on the design is provided in section 2.5 of this document.

1. Site and Surface Utilities

Only three recommendations are made, each of which could be readily implemented in Title II ESF design:

(a) The distance from the planned water disposal areas at the surface, to the

repository boundary should be evaluated with respect to postclosure performance. The analysis should be done early enough in Title II design to allow a decision to be made regarding whether or not it is necessary to move the pond and sewer system or to line the pond.

(b) In Title II design, specify the excavation procedures to be used in excavating the main pad (including the maximum diameter and length of blast holes, as well as the types of explosives which may be used), and impose other controls including a Blasting Plan to be submitted 4 hours prior to each blast, and a vibration monitoring program whereby each shot is monitored independently by at least two instruments.

(c) The MPBH's should be integrated into the requirements for and design of the ESF.

2. First and Second Shafts

The following recommendations are made with respect to the shafts:

(a) Maintain the capability to extend ES-1 into the Calico Hills unit. Prepare a risk-benefit analysis early in Title II design if possible, providing analyses as described in SCP Section 8.4.2.1.6.1.

(b) Implement QA procedures for identifying items important to waste isolation in Title II design. Incorporate comparative evaluations of alternatives for major design features important to waste isolation, into the Title II design, if any such features are identified with respect to the shafts.

(c) Analyses for Title II ESF design should include sensitivity studies to support revaluation of lifetime, as necessary during construction as variable site conditions are encountered.

(d) The MPBH's should be integrated into the requirements for and design of the ESF.

(e) Title II design drawings for ESF test areas should indicate the location and extent of borings from the shafts.

(f) The drift-borehole 15m standoff criterion should be interpreted with respect to the MPBH's. Special consideration should be given to the manner in which the MPBH's minimally penetrate the repository horizon, and their proximity to the much larger openings of the shafts and connecting drifts.

(g) Contingency planning for water inflow, including the possible implementation of packer seals for exploratory boreholes, should be more extensive in the ESF Title II Design.

(h) The design should indicate that the use of J-13 water will be reevaluated during the earliest stages of construction, based on available information on UZ pore water chemistry obtained from construction phase hydrochemical studies.

(i) Develop procedural controls and limitations on introduction of hydrocarbons, solvents, special chemicals, and materials in the ESF.

(j) Assess results of studies of microbes to ensure that no adverse effects will occur from introduction of potential growth substrates.

(k) Analysis of the separation distance of waste water disposal areas from the repository boundary should be completed early in the design process to determine whether it is necessary to move the pond and sewer system or to line the pond.

(l) Additional calculations should be done to adapt the existing studies of thermoelastic, far-field repository effects to investigate the effects of thermal loading on the exploratory shaft liners.

3. Underground Excavations, Underground Utilities, and Decommissioning

Recommendations are as follows:

(a) The Title II design report or drawings should include a drawing which shows the location of existing or planned boreholes that penetrate the repository horizon superimposed upon the ESF layout.

(b) If not already planned, it is recommended that all borehole locations and alignments be plotted on all underground working maps.

(c) The MPBH's should be integrated into the requirements for and design of the ESF.

(d) Contingency planning for water inflow, including the possible implementation of packer seals for exploratory boreholes, should be more extensive in the ESF Title II design.

(e) Implement QA procedures for identifying items important to waste isolation in Title II design. Incorporate comparative evaluations of alternatives for major design features important to waste isolation, into the Title II design, if any such features are identified with respect to the shafts or underground excavations.

(f) Recommendations of the West (1988) report (related to limiting the use of water, solvents, and hydrocarbons underground) should be addressed in further design work. A program for controlling the use of fluids and materials in ESF construction and operation, including inventory of entry and exit of important substances, should be established.

(g) Further results of ongoing studies of microbes with respect to waste isolation, should be incorporated into the ESF design and design documentation, to the extent practicable.

(h) Sensitivity calculations should be made to ascertain the effectiveness of the separation between the waste emplacement area and the dedicated test area.

(i) It is recommended that a 3-D thermomechanical analysis of the ESF should be performed, covering time steps up to 10,000 years or to the time of significant response, in order to evaluate potential changes in the hydrologic

conditions around the ESF from thermomechanical effects of the repository.

(j) The two-diameter separation criterion for adjacent drifts should be reevaluated to assess whether it should stringently apply to short drifts or alcoves, and to ESF tests such as the Sequential Drift Mining and Heated Room tests. Appropriate adjustments should be made to the layout as required. Also the width of the pillar between the south east Waste Package Vertical drift and the adjacent repository drift should be increased to at least twice the diameter of the larger drift.

(k) Drift-borehole 15m standoff criterion should be interpreted with respect to borehole USW G-4, considering the localized drainage within the designated test area (that includes G-4).

4. Underground Testing

Several recommendations are made relative to the criteria for controlling testing impacts:

(a) The MPBH's should be integrated into the requirements for and design of the ESF.

(b) Relative to chemical effects of materials, it is recommended that:

(i) procedural controls on the use and inventory of fluids and materials be established,

(ii) future analyses consider the possibility of microbial activity and incorporate appropriate controls on the introduction of selected materials into the formation, and

(iii) compare water chemistry at Yucca Mountain with that of the J-13 water planned for use in construction.

(c) Examination of all detailed testing procedures, particularly for construction phase ESF testing, relative to potential performance impacts is also recommended.

(d) Develop procedural controls on water use in construction and testing, considering waste isolation impacts as well as test interference.

(e) Determine which boreholes drilled from the ESF will require dry drilling, and which can be drilled using more conventional methods. The basis for the information in Appendix C of the ESF SDRD apparently emphasizes test objectives and does not include waste isolation concerns, such as are needed to address criteria based on 60.133(d).

REVIEWERS	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Feb 2, 1989
Ernest L. Hardin	Eh Hardin	2/2/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.2.1 [60.112]

1.6.2.1 (UTIL) The surface utilities shall be designed and constructed so that they do not affect the capability of the repository to meet the Performance Objective of 10 CFR 60.112

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.4.1 [60.112]

1.6.4.1 (ES-1) The shaft opening shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objectives of 10 CFR Part 60.112

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.5.1 [60.112]

1.6.5.1 (ES-2) The shaft opening shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objectives of 10 CFR Part 60.112

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.6.1 [60.112]

1.6.6.1 (UG EXC) The Exploratory Shaft Facility underground excavation shall be designed and constructed so that, following permanent closure, it does not become a pathway that compromises the repository's ability to meet the performance objective of 10 CFR Part 60.112

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1984

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.7.1 [60.112]

1.6.7.1 (UG UTIL) The underground utilities shall be designed and constructed so that they do not affect the capability of the repository to meet t Performance Objective of 10 CFR 60.112

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES _____NO _____DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1984

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.8.1 [60.112]

1.6.8.1 (UG TST) The testing program shall not affect the capability of the underground repository to meet the performance objective of 10 CFR 60.112

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.8.2 [60.112]

1.6.8.2 (UG TST) Borehole openings shall be designed so that, following permanent closure, they do not become pathways that compromise the repositor ability to meet the performance objectives of 10 CFR Part 60.112

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 24, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.6.9.1 [60.112]

1.6.9.1 (DECOM) The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealin necessary to limit the release of radioactive material to the envi

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.6.1.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.6.1.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.6.1.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.7.6.1 [60.113(a)(1)(i)]

1.7.6.1 (UG EXC) The underground excavation shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: This criterion is related to a section of introductory text in 10 CFR Part 60 that describes, in general terms, requirements on the EBS. The specific numerical criteria that must be met to be in compliance with the Requirement of concern here are specified in 10 CFR 60.113(a)(1)(ii)(A) and 10 CFR 60.113(a)(1)(ii)(B). The criteria developed to address the latter Requirements are specified in 1.8.6.1, 1.8.7.1, and 1.8.8.1, and 1.9.6.1, 1.9.7.1, and 1.9.8.1, respectively. The conclusion that the Design is in compliance with the criterion of concern here is based on the assessments performed for the criteria in 1.8.6.1, 1.8.7.1, and 1.8.8.1, and 1.9.6.1 1.9.7.1, and 1.9.8.1. The rationale explaining why the ESF Title I Design is considered to be in compliance with the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this requirement, is contained in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this criterion is discussed in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this criterion are discussed in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.7.7.1 [60.113(a)(1)(i)]

1.7.7.1 (UG UTIL) The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period, and construction of the underground utilities shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: This criterion is related to a section of introductory text in 10 CFR Part 60 that describes, in general terms, requirements on the EBS. The specific numerical criteria that must be met to be in compliance with the Requirement of concern here are specified in 10 CFR 60.113(a)(1)(ii)(A) and 10 CFR 60.113(a)(1)(ii)(B). The criteria developed to address the latter Requirements are specified in 1.8.6.1, 1.8.7.1, and 1.8.8.1, and 1.9.6.1, 1.9.7.1, and 1.9.8.1, respectively. The conclusion that the Design is in compliance with the criterion of concern here is based on the assessments performed for the criteria in 1.8.6.1, 1.8.7.1, and 1.8.8.1, and 1.9.6.1 1.9.7.1, and 1.9.8.1. The rationale explaining why the ESF Title I Design is considered to be in compliance with the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this requirement, is contained in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this criterion is discussed in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this criterion are discussed in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.7.8.1 [60.113(a)(1)(i)]

1.7.8.1 (UG TST) The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period, and construction and operation of the underground testing program shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment and a release of radionuclides that is a gradual process after the containment period

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: This criterion is related to a section of introductory text in 10 CFR Part 60 that describes, in general terms, requirements on the EBS. The specific numerical criteria that must be met to be in compliance with the Requirement of concern here are specified in 10 CFR 60.113(a)(1)(ii)(A) and 10 CFR 60.113(a)(1)(ii)(B). The criteria developed to address the latter Requirements are specified in 1.8.6.1, 1.8.7.1, and 1.8.8.1, and 1.9.6.1, 1.9.7.1, and 1.9.8.1, respectively. The conclusion that the Design is in compliance with the criterion of concern here is based on the assessments performed for the criteria in 1.8.6.1, 1.8.7.1, and 1.8.8.1, and 1.9.6.1 1.9.7.1, and 1.9.8.1. The rationale explaining why the ESF Title I Design is considered to be in compliance with the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this requirement, is contained in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this criterion is discussed in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for the specific criteria of 10 CFR Part 60 related to this requirement, and hence with this criterion are discussed in the summary evaluations found under criteria 1.8.6.1 and 1.9.6.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	July 29, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.8.6.1, 1.8.7.1, and 1.8.8.1 [60.113(a)(1)(ii)(A)]

1.8.6.1 (UG EXC) The underground excavation shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

1.8.7.1 (UG UTIL) The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and construction of the underground utilities shall be performed in a manner intended to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

and

1.8.8.1 (UG TST) The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and implementation and operation of the underground testing program shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN

__✓__ YES ____ NO ____ DON'T KNOW

RATIONALE:

Evaluations about the Title I Design of the ESF indicate a number of design features were specifically embodied in the design both to assist the site in complying with the waste package containment performance objective and to limit impacts to the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet the performance objective. These design features include both physical items including aspects of the configuration, and control of activities. The rationale for concluding that the ESF Title I Design addresses the criteria developed for 10 CFR

60.113(a)(1)(ii)(A) is based upon a summary compilation of the evaluations about whether the Title I Design addresses the criteria developed for several other 10 CFR Part 60 Requirements as part of this Technical Assessment Review Figure 2.3-1 indicates the specific criteria considered relevant to the assessment of the ESF Title I Design with the 10 CFR Part 60 Requirements.

Following the summaries of the rationale supporting the assessment that the ESF Title I Design addresses the criteria relevant to this evaluation, an evaluation of the overall impact on the ability of the site to comply with the criteria related to the performance objective is presented. The information is supplemented by information abstracted from SCP Section 8.4 that addresses assessment of the impact on the ability of the site to comply with the criteria related to the waste package containment performance objective.

1. Summary of Rationale for criteria related to 10 CFR 60.113(a)(1)(ii)(A) for Underground Excavation, Underground Utilities, Underground Testing,

A preliminary fluid and material usage evaluation (West, 1988) identified no restrictions on the surface usage of solvents and hydrocarbons. Major factors mitigating chemical changes from construction and operation of the ESF that could affect waste isolation, are the transitory nature of the changes, the small quantities of materials introduced, and the considerable separation of waste isolation areas from the ESF shafts and underground excavations. Volatile compounds will tend to be preferentially removed by the ventilation system. No effects of blasting products on waste isolation have been identified in preliminary evaluation. Local chemical changes will be associated with cement used in the ESF, but are not expected to impact the waste emplacement areas, nor to adversely the affect the mobility of waste elements. There is no indication in the design documentation that amounts of cementitious materials will be used in excess of that required for proper design or construction.

Water used in the ESF will be pumped from well J-13, which produces from the Topopah Spring Member; no significant chemical changes should be caused from introduction of this water.

The design is supported by a decision-tree analysis (West, 1988) used to screen fluids and materials, and to test for interactions. No fluids and materials were identified that would have a significant effect on waste isolation.

The capability to enhance postclosure performance by removing the shaft liner is maintained in the Title I design for the liner. The design includes passive features which provide appropriate flexibility to effectively plug and seal the facility at closure, even if a portion of the shaft is damaged by a disruptive event.

Several features of the ESF contribute to waste isolation, such as: orientation of the excavations with respect to geologic fractures and in situ stresses; tests planned to produce information on construction effects (such as stress relief and blast damage) during the construction phase; flexibility in the design to accommodate site specific conditions; separation of testing and waste emplacement areas, and minimization of the number of

interconnections between the repository and ESF drifts; and sizing of the exploratory drifts.

The drainage plan for the ESF and long exploratory drifts is consistent with planned repository operations and postclosure sealing. The ESF test area drains toward ES-1. The long drifts are integrated with the repository drainage plan, such that they will drain away from areas where waste will be stored, and do not drain towards the exploratory shafts. The only exception to the consistency of the drainage patterns for ESF-related drifts is the vertical test drift for the Engineered Barriers Test in the ESF, which is designed to facilitate testing requirements.

The Title I ESF design is adequate to ensure that the effects of credible disruptive events do not spread throughout the facility and thus adversely affect waste isolation. In addition to flooding considerations, the design adequately addresses protection from fire and explosion, provides special systems in areas of high hazard, and provides monitoring capabilities with alarms and shutoffs. Also, the shaft will be constructed with mostly noncombustible materials, and materials identified for use in fire suppression (West, 1988) are not expected to adversely impact waste isolation.

The geochemical effects of fire should not adversely affect waste isolation, based on: the separation between the ESF and waste emplacement areas, fire protection and ventilation systems that retard the spread of fire, and the limited extent of geochemical effects.

The ESF has been designed to maintain the flexibility of the repository to accommodate site specific conditions, or adjustments indicated by in situ testing and monitoring. This is chiefly because the ESF will be mostly confined to a small area separated from waste emplacement areas. Also, the number of interconnections with the repository is minimized and the long exploratory drifts from the ESF are designed to be coincident with repository drifts.

The Title I design meets the criterion to limit the extraction ratio in the test area to 30%, with insignificant localized exceptions.

Numerous criteria and features of the Title I design ensure that the shafts, underground excavations, and ESF-related exploratory boreholes are designed to facilitate backfilling and sealing. Examples are: the criteria related to maintaining usable openings for 100 years; provisions for removing the shaft liner, furnishings, and other non-permanent items; drift separation to limit mechanical interference; drainage considerations; and design of the shaft collars and main pad. These items reduce uncertainty in predicting performance, and facilitate implementation of the backfilling and sealing programs.

Analyses show that the thermal/thermomechanical effects of ESF testing will be localized to the test area and not cause significant changes to the rock mass along potential pathways from the repository to the accessible environment. The same analysis can also be used effectively to show that the

hydrologic effects from ESF testing will be laterally separated from, and should therefore have no significant impact on, the saturation of the host rock in waste emplacement areas.

Controlled blasting used during construction will limit the increase in permeability in the rock adjacent to the drifts. Experiments are planned to investigate the effects of excavation construction (due to stress relief and blast damage) on the rock mass surrounding the shafts. Water use will be limited to the minimum required for proper equipment operation and dust control. Cleaning of ESF walls for photogrammetry, mapping and other testing will be done using compressed air/mist to minimize the amount of water used.

The design of the ESF underground utility system, including ventilation, shall facilitate monitoring of moisture influx to the ESF from the rock mass and from ventilation, and moisture efflux from mine water removal and ventilation exhaust to limit possible impacts on DOE's capability to adequately characterize the site. Automatic, excess flow (line break) valves are utilized at strategic locations in the piping system to limit the amount of water being introduced into the rock mass. Natural drainage in the facility will be to the sump at the bottom of ES-1. At the shaft bottom, a sump will be excavated and pumps installed for removal of any excess water, which will be pumped to the surface for disposal.

Underground testing is likely to have no impact on the capability of the repository to isolate waste. Hydraulic disturbances from testing in the Exploratory Shaft could potentially impact compliance with the performance objective by increasing the water flux at the repository horizon or by changing the hydrologic properties of the unsaturated zone. Tests that could impact the site are designed to be carefully controlled or physically separated from other tests in the host rock. The potential impacts of testing will be assessed before testing. Excess water entering the dedicated test area, either through accidental flooding or from perched water zones, will be removed to the surface or, if small enough, allowed to drain into the formation.

Water used in operations and testing will be limited to that required for dust control and proper equipment operation and will be consistent with performance objectives. Water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance calculations. Not all test plans have been developed, but a process is in place to assure that they will be carefully reviewed when the plans are written to determine possible impacts on repository performance.

Geochemical effects of testing are expected to be limited to a distance of less than 1 meter from the test location and thus not impact the ability of the site to isolate waste. Likewise, thermal effects of the tests are generally local in extent and thus not likely to impact the ability of the site to isolate waste .

2. Evaluation of impacts on substantially complete containment from construction, operation, and testing in the exploratory shafts and underground facility.

Site characterization activities could affect the quantity of liquid water

contacting a container during the complete containment period (300 to 1,000 years after permanent closure) by altering the amount and distribution of ground-water flux at the repository horizon, changing the hydrologic properties of the unsaturated zone (primarily the hydraulic conductivity), or creating preferential pathways for liquid flow.

During construction of the exploratory shafts, drifts and alcoves, water will be used for dust control, drilling, and mining. The use of water during construction will be controlled to limit the potential impacts of construction on the site. Most of this water will be removed to the surface by mucking operations. Preliminary estimates indicate that only a small fraction (10 percent) of the water used in the ESF during construction will be retained in the rock mass around the shaft. Because the injection pressure of water introduced during ES construction will be low, the retained water is expected to be a local effect near the shafts. Evaluations in section 8.4.3 of the SCP concluded that constructing the ESF would not affect the ground-water flux at the repository horizon or create preferential pathways for liquid water flow. Therefore, the construction of the exploratory shafts, drifts, and alcoves should not increase the amount of water that contacts the waste containers.

During construction and operation of the ESF, the ventilation system will remove water from the exposed walls in the ESF. The system may remove, before waste emplacement, a volume of water comparable to that retained during construction, thereby further reducing any potential for construction water to reach a container in the waste emplacement area of the repository.

ESF testing activities will introduce a small, controlled amount of water to the unsaturated zone. A relatively small volume of rock will be affected by moisture redistribution in the thermal tests. These testing activities will be at least 30 m laterally from the waste emplacement areas of the repository. The introduction of water during testing and the movement of moisture by heating will not affect the ground-water flux at the repository horizon or the quantity of water contacting a container.

The mechanical disturbances (caused by stress relief, blast damage, etc.) to fracture apertures and hydraulic conductivity from borehole, shaft, drift and alcove construction are expected to be contained within 1 to 2 diameters of the penetrations. The increases in fracture permeability are not expected to create preferential pathways for water to flow to waste emplacement areas because (1) boreholes will be sealed; (2) boreholes will be located (where practicable) in pillars laterally separated from waste emplacement areas; and (3) shafts and drifts will be located 30 m laterally from waste emplacement areas.

During site characterization activities, fluids and materials will be introduced at the surface and into the ESF that may be a source of chemical change. The potential geochemical disturbances from fluids and materials introduced into the underground facilities will be local and not transported far from the source. Construction controls on the amount and use of chemicals also decrease the potential geochemical disturbances to the site. Because of the relatively short distance the fluids are expected to penetrate the rock mass and the approximately 30 m lateral distance from the shafts, drifts, and alcoves to waste emplacement areas in the repository, the fluids and materials from ESF construction are not expected to affect the waste package environment

or change the quality of water contacting the container. Therefore, site characterization activities should not cause geochemical disturbances that would affect the ground-water flux at the repository horizon or create preferential pathways for liquid flow that could affect the quality of water contacting a container.

The underground construction of alcoves is not expected to enhance block movement and affect rock-induced loads on the waste package because of the long horizontal distance from the alcoves to areas of waste emplacement. ESF testing activities are not expected to enhance block movement from gravitational forces or thermal cycles.

ADEQUACY OF TREATMENT

Evaluation of the ESF Title I Design indicates a number of design features were specifically embodied in the design, both to assist the site in complying with the engineered barrier system release rate performance objective and to limit impacts to the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet the performance objective. These design features include separation of the ESF tests from potential emplacement drifts, control of drainage directions, control of water use, blasting control, sealing of boreholes and shafts, and the use of air gaps between the container and the rock mass. The conclusion is that the ESF is designed with features that will enhance the capability of the waste package to meet the performance objective for waste package containment as stated in 10 CFR 60.113.

The following text outlines in summary fashion the significant observations about the adequacy of Title I Design that were identified in the evaluations about the relevant criteria:

The location and design of the shafts comply conservatively with the requirement to limit impacts on waste isolation.

Comparative evaluations of alternatives for major design features will be required if the features are found to be important to waste isolation. The methodology for this determination is under development, so the lack of these evaluations in the Title I design is judged not to be inadequate.

Statements concerning rock-water chemistry and the use of J-13 water for the ESF may need to be revaluated during the earliest stages of construction, when additional information on the chemistry of UZ pore water is available. The treatment of the controls planned for use in controlling and limiting water inflow is marginally adequate in the current design description and evaluations.

Statements about the benefit gained from separating testing and waste emplacement areas could be reinforced by conducting sensitivity analyses.

Criteria for evaluating the potential performance-related impacts of the underground testing were developed. Sixteen criteria were considered to have been adequately treated with respect to the Title I design. These included

criteria related to fluids and materials control and their chemical effects, thermal and thermomechanical effects of testing and appropriate location of boreholes. The only criteria related to ESF testing impacts considered to have been inadequately treated is related to the disposal waste water from underground construction, operation, and testing (see discussion under surface utilities). For two of the criteria related to water control during testing, a thorough evaluation of the criteria can only be done after detailed testing procedures are available.

As indicated in the criteria roll-up table (Figure 2.3-1) the criteria related to evaluating the potential performance impacts of performance confirmation tests which may be conducted in the ESF are almost identical to the criteria applied to the planned site characterization tests in the ESF. The only differences are in the application of the criteria related to 60.15(d)(3) and 60.137 to the site characterization and performance confirmation programs, respectively. Since the adequacy of the treatment of the criteria related to the performance impacts of site characterization testing is discussed above, only the concerns relative to the 60.137 requirement are described here. The treatment of performance confirmation concerns is generally considered adequate in the ESF Title I design. This is based in part on the availability of sufficient space in the dedicated test area to accommodate additional tests, the construction capacity for developing additional drifts, and the anticipation that essentially the same controls would be applied to all tests (including performance confirmation tests) as appropriate. A caveat of the evaluation is that special procedures will be required if tests using radioactive materials are planned in the ESF as part of performance confirmation

The assessment that the ESF Title I design is adequate is partially based on evaluations of the impacts that the design could have on the ability of the site to comply with the performance objectives. These assessments are largely abstracted from section 8.4.3 of the SCP. Many of the data, calculations and analyses supporting the Section 8.4 assessments were also reviewed as part of this TAR. The results of that evaluation bear on the assessment of adequacy of the ESF Title I Design and are summarized in section 2.4.4. Nearly all of the data and analysis reports reviewed for data reasonableness and appropriateness in support of Title I Design were judged to have used appropriate data and methods. Likewise, the treatment of uncertainty was considered appropriate. There were no issues identified by the reviewers that questioned the adequacy of the Title I Design. The concerns identified by the reviewers addressed evaluations warranted for Title II Design, and errors in the SCP to be treated in progress reports.

RECOMMENDATIONS AND CORRECTIVE MEASURES

A number of recommendations and possible corrective measures have been identified on the basis of the Design Acceptability Analysis conducted as part of this Technical Assessment Review. The majority address perceived shortcomings in the level of detail or explicitness judged to be present in the Title I Design. These shortcomings are not judged to signify inadequacy in the Title I Design for its intended purpose; in no case was an explicit recommendation made to redo any portion of the Title I Design. The following text outlines in summary fashion the significant observations about recommendations and proposed corrective measures relative to Title I Design

that were identified in this review.

Implement QA procedures for identifying items important to waste isolation in Title II design. Incorporate comparative evaluations of alternatives for major design features important to waste isolation, into the Title II design, if any such features are identified with respect to the shafts or underground excavations.

Further results of ongoing studies of microbes with respect to waste isolation, should be incorporated into the ESF design and design documentation, to the extent practicable.

Final design should include provisions for inventory of hydrocarbons and solvents used underground, and for minimizing their use.

The design should indicate that the use of J-13 water will be revaluated during the earliest stages of construction, based on available information on UZ pore water chemistry obtained from construction phase hydrochemical studies.

Recommendations of the West (1988) report (related to limiting the use of water and hydrocarbons underground) should be addressed in further design work. A program for controlling the use of fluids and materials in ESF construction and operation, including inventory of entry and exit of important substances, should be established.

Several recommendations were made relative to the criteria applicable to testing impacts. These recommendations included integration of MPBH requirements into the ESF Title II SDRD and design, and that Title II design drawings indicate the extent of the holes drilled from the ESF to facilitate evaluations of compliance with the criteria.

Relative to chemical effects of materials, it is recommended that (1) the process for materials control be formalized, (2) future analyses consider the possibility of microcrobial activity and incorporate inventory controls and limitations on the introduction of selected materials into the formation, and (3) a comparison be made of water chemistry at Yucca Mountain with that of the water planned for use in construction.

An examination of test procedures relative to potential performance impacts was also recommended. Further, it was recommended that analyses related to surface disposal of water (see surface utilities discussion) be conducted early enough in Title II design to allow design modifications to be considered as needed.

Because of the use of essentially the same criteria for performance confirmation testing as for site characterization testing in the ESF, no additional recommendations or corrective actions specific to the performance confirmation testing are being made.

REVIEWERS	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Feb 2, 1989
Ernest L. Hardin	Ell Hardin	2/2/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.8.7.1 [60.11113(a)(1)(ii)(A)]

1.8.7.1 (UG UTIL) The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and construction of the underground utilities shall be performed in a manner intended to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.8.6.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.8.6.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.8.6.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.8.8.1 [60.11113(a)(1)(ii)(A)]

1.8.8.1 (UG TST) The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository, and implementation and operation of the underground testing program shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure substantially complete containment for a period not less than 300 years nor more than 1000 years after the permanent closure of the repository.

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.8.6.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.8.6.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.8.6.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.9.6.1, 1.9.7.1, and 1.9.8.1 [60.113(a)(1)(ii)(B)]

1.9.6.1 (UG EXC) The underground excavation shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

1.9.7.1 (UG UTIL) The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction of the underground utilities shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

and

1.9.8.1 (UG TST) The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

HAVE THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE:

Evaluations about the Title I Design of the ESF indicate a number of design features were specifically embodied in the design both to assist the site in complying with the engineered barrier system release rate performance objective and to limit impacts to the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet

the performance objective. These design features include both physical items including aspects of the configuration, and control of activities. The rationale for concluding that the ESF Title I Design addresses the criteria developed for 10 CFR 60.113(a)(1)(ii)(B) is based upon a summary compilation of the evaluations about whether the Title I Design addresses the criteria developed for several other 10 CFR Part 60 Requirements as part of this Technical Assessment Review. Figure 2.3-1 indicates the specific criteria considered relevant to the assessment of the ESF Title I Design with the 10 CFR Part 60 Requirements.

Following the summaries of the rationale supporting the assessment that the ESF Title I Design addresses the criteria relevant to this evaluation, an evaluation of the overall impact on the ability of the site to comply with the criteria related to the performance objective is presented. The information is supplemented by information abstracted from SCP Section 8.4 that addresses assessment of the impact on the ability of the site to comply with the criteria related to the engineered barrier system release rate performance objective.

1. Summary of Rationale for criteria related to 10 CFR 60.113(a)(1)(ii)(B) for Underground Excavation, Underground Utilities, Underground Testing,

Existing/planned surface-based boreholes have been constructed/sited so that they do not intersect planned underground openings. The Title I design and associated descriptions of ESF testing do not show any boreholes extending significantly below the repository horizon or below the TSw2 unit.

A preliminary fluid and material usage evaluation (West, 1988) identified no restrictions on the surface usage of solvents and hydrocarbons. Major factors mitigating chemical changes from construction and operation of the ESF that could affect waste isolation, are the transitory nature of the changes, the small quantities of materials introduced, and the considerable separation of waste isolation areas from the ESF shafts and underground excavations. Volatile compounds will tend to be preferentially removed by the ventilation system. No effects of blasting products on waste isolation have been identified in preliminary evaluation. Local chemical changes will be associated with cement used in the ESF, but are not expected to impact the waste emplacement areas, nor to adversely the affect the mobility of waste elements. There is no indication in the design documentation that amounts of cementitious materials will be used in excess of that required for proper design or construction.

Water used in the ESF will be pumped from well J-13, which produces from the Topopah Spring Member; no significant chemical changes should be caused by introduction of this water. The design is supported be a decision-tree analysis (West, 1988) used to screen fluids and materials, and to test for interactions. No fluids or materials were identified that would have a significant effect on waste isolation.

The capability to enhance postclosure performance by removing the shaft liner is maintained in the Title I design for the liner. The ESF design includes passive features which provide appropriate flexibility to effectively plug and seal the facility at closure, even if a portion of a shaft or drift is damaged by a disruptive event.

Several features of the design of the ESF contribute to waste isolation, such as: orientation of the excavations with respect to geologic fractures and in situ stresses; tests planned to produce information on construction effects (such as stress relief and blast damage) during the construction phase; flexibility in the design to accommodate site specific conditions; separation of testing and waste emplacement areas, and minimization of the number of interconnections; and sizing of the exploratory drifts.

Excavations at the main test level will be limited to the TSw2 unit, and a minimum of 200 m overburden will be maintained. Planned excavation will be within the conceptual perimeter drift boundary, except for two long exploratory drifts which are planned to characterize the bounding structures. Two interconnections are planned between the ESF designated test area and the conceptual repository layout; this is minimum number required from safety considerations.

The drainage plan for the ESF and long exploratory drifts is consistent with planned repository operations and postclosure sealing. The ESF test area drains toward ES-1. The long drifts are integrated with the repository drainage plan, such that they will drain away from areas where waste will be stored, and do not drain towards the exploratory shafts. The only exception to the consistency of the drainage pattern for ESF-related drifts is the vertical test drift for the Engineered Barriers Test in the ESF, which is designed to facilitate testing requirements.

The Title I ESF design is adequate to ensure that the effects of credible disruptive events do not spread throughout the facility and thus adversely affect waste isolation. In addition to flooding considerations, the design adequately addresses protection from fire and explosion, provides special systems in areas of high hazard, and provides monitoring capabilities with alarms and shutoffs. Also, the shaft will be constructed with mostly noncombustible materials, and materials identified for use in fire suppression (West, 1988) are not expected to adversely impact waste isolation.

The geochemical effects of fire should not adversely affect waste isolation, based on: the separation between the ESF and waste emplacement areas, fire protection and ventilation systems that retard the spread of fire, and the limited extent of geochemical effects.

The ESF has been designed to maintain the flexibility of the repository to accommodate site specific conditions, or adjustments indicated by in situ testing and monitoring. This is chiefly because the ESF will be mostly confined to a small area separated from waste emplacement areas. Also, the number of interconnections with the repository is minimized, and the long exploratory drifts from the ESF are designed to be coincident with repository drifts.

The shaft construction method incorporating smooth-wall blasting was chosen to limit the disturbance to the rock while minimizing the introduction of fluids; thereby explicitly recognizing the 10 CFR 60.133(e)(2) requirement. The blasting procedures and specifications provided with the Title I design for

the shafts, drifts, and stations, will control overbreak and limit disturbance to the surrounding rock mass, thus limiting the potential for creating pathways for ground water. Numerous features of the Title I design ensure that the shafts, underground excavations, and ESF-related exploratory boreholes are designed to facilitate backfilling and sealing. Examples are: the criteria related to maintaining usable openings for 100 years; provisions for removing the shaft liner, furnishings, and other non-permanent items; drift separation to limit mechanical interference; drainage considerations; and design of the shaft collars and main pad. These items reduce uncertainty in predicting performance, and facilitate implementation of the backfilling and sealing programs.

Bounding analyses applied to the ESF indicate that the effects of repository thermal loading on ESF underground openings should have no significant impact on waste isolation. However, analyses have not been completed which provide specific information on response of the shaft liners to repository thermal loading. Analyses show that the thermal/thermomechanical effects of ESF testing will be localized to the test area and not cause significant changes to the rock mass along potential pathways from the repository to the accessible environment. The same analysis also can be used effectively to show that the hydrologic effects from ESF testing will be laterally separated from, and should therefore have no significant impact on, the saturation of the host rock in waste emplacement areas.

Analyses referenced in the Title I design report show that the repository drifts should remain stable even without the specific benefit of ground support. The ESF drifts should also remain stable given that ground support based on conservative systems of rock mass classification will be used. The question of whether support will perform adequately in response to thermal loading is the subject of planned ESF testing.

Controlled blasting used during construction will limit the increase in permeability in the rock adjacent to the drifts. Experiments are planned to investigate the effects of construction (e.g., stress relief and blast damage) on the rock mass surrounding the excavations.

Water use will be limited to the minimum required for proper equipment operation and dust control. Cleaning of ESF walls for photogrammetry, mapping and other testing will be done using compressed air/mist to minimize the amount of water used. The design of the ESF underground utility system, including ventilation, shall facilitate monitoring of moisture influx to the ESF from the rock mass and from ventilation, and moisture efflux from mine water removal and ventilation exhaust, to limit possible impacts on DOE's capability to adequately characterize the site. Automatic, excess flow (line break) valves are utilized at strategic locations in the piping system to limit the amount of water being introduced into the rock mass. Natural drainage in the facility will be to the sump at the bottom of ES-1. Pumps will be installed for removing any excess water to the surface for disposal.

Underground testing is likely to have no impact on the capability of the repository to isolate waste. Hydraulic disturbances from testing in the Exploratory Shaft could potentially impact compliance with the performance objective by increasing the water flux at the repository horizon or by

changing the hydrologic properties of the unsaturated zone. Tests that could impact the site are designed to be carefully controlled or physically separated from other tests in the host rock. The potential impacts of testing will be assessed before testing.

Excess water entering the dedicated test area either through accidental flooding or from perched water zones will be removed to the surface or, if small enough, allowed to drain into the formation. Water used in operations or testing will be limited to that required for dust control and proper equipment operation and will be consistent with performance objectives. Water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance calculations. Not all test plans have been developed, but a process is in place to assure that they will be carefully reviewed when the plans are written to determine possible impacts on repository performance.

Geochemical effects of testing are expected to be limited to a distance of less than 1 meter from the test location and thus not impact the ability of the site to isolate waste. Likewise, thermal effects of the tests are generally local in extent and thus not likely to impact the ability of the site to isolate waste

2. Evaluation of impacts on engineered barrier system releases from construction, operation, and testing in the underground facility.

The performance of the engineered environment leading to the EBS releases following the containment period can be impacted by the quantity and quality of liquid water that can contact a container and the rock-induced load on the waste package. For site characterization activities to affect the quantity of water that can contact a container, they must provide a source of liquid water and a flow path for liquid water. For site characterization activities to affect the EBS release after the containment period, the effects would have to occur at least 300 years after permanent closure, i.e., they would have to be permanent, rather than transient effects. During this period, the thermal pulse from the emplaced waste would initially move water from near the EBS into the cooler host rock. To do this the site characterization activities would have to provide a source of increased flux or a preferential flowpath during the containment period that will change the quantity of water that contacts a waste package. Because the source of, and flowpaths for, liquid water would be similar after containment, no site characterization activities are expected to change the quantity of liquid water that can contact a container.

Site characterization activities may cause mechanical changes within 1 to 2 excavation diameters of penetrations. Because the distance between the construction of penetrations and the waste emplacement areas in the repository is greater than the expected range of mechanical changes, such changes are not expected to create preferential pathways for water to flow to waste emplacement boreholes and to affect the quantity of water that contacts a container. Therefore, no effects on the quantity of water contacting a container are expected from exploratory shaft construction, underground

construction of drifts and alcoves, or ESF testing activities.

The quality of water that can contact a container during the controlled release period also affects the engineered environment. To affect the quality of water, there must be a source of chemical change, a pathway for these chemicals to reach a container, and transport of the chemicals to the container. During the containment period, the chemicals would need to be transported 30 m laterally to contact a container. The current model of Yucca Mountain suggests that ground-water flux is predominantly vertical in the unsaturated zone, which should limit the lateral movement of water and the transport of chemicals to waste emplacement areas of the repository.

No enhanced geochemical changes that could contact a container are expected from thermal effects of site characterization. Therefore, no effects on the quality of water contacting a container are expected for exploratory shaft construction, underground construction of drifts and alcoves, or ESF testing activities.

Site characterization activities are not expected to enhance rock block movement due to the rock responding to gravitational forces or thermal cycles. Construction controls limiting the number of penetrations of the unsaturated zone, the standards for construction of the underground facility and the distance from site characterization activities to waste emplacement areas all help decrease the potential for enhancing rock-block movement.

To affect the gaseous release during the controlled release period, the site characterization activities would have to introduce water in the vicinity of the waste packages or provide preferential pathways to enhance gaseous transport. Boreholes and shafts within the conceptual perimeter drift boundary will be laterally separated from waste emplacement areas and will be sealed so that they will not introduce water to the vicinity of the waste packages. Evaluations in section 8.4.3 of the SCP suggest that, if the air conductivity of shaft fill is less than about 3×10^{-4} m/min, boreholes and shafts would not be preferential pathways for gaseous transport. Therefore, penetrations from site characterization activities are not expected to provide preferential pathways for gaseous transport and affect gaseous releases from the waste form.

In summary, site characterization activities are not expected to affect the performance of the system elements that are relied upon for EBS releases as specified by 10 CFR 60.113(a)(1)(ii).

ADEQUACY OF TREATMENT

Evaluations about the Title I Design of the ESF indicate a number of design features were specifically embodied in the design both to assist the site in complying with the engineered barrier system release rate performance objective and to limit impacts to the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet the performance objective. These design features include separation of the ESF tests from potential emplacement drifts, control of drainage directions, control of water use, blasting control, sealing of boreholes and shafts, and

the use of air gaps between the container and the rock mass. The evaluations conclude that the ESF is designed with features that will enhance the capability of the waste package to meet the performance objective for controlled releases from the engineered barrier system of 10 CFR 60.113.

The following text outlines in summary fashion the significant observations about the adequacy of Title I Design that were identified in the evaluations about the relevant criteria:

Whereas the Title I design does not address detailed borehole locations and alignments for ESF or surface-based boreholes, this is adequate for Title I.

The shaft locations and design aspects comply conservatively with the requirement to limit impacts on waste isolation.

Comparative evaluations of alternatives for major design features will be required if the features are found to be important to waste isolation. The methodology for this determination is under development, so the lack of these evaluations in the Title I design is judged not to be inadequate.

Statements concerning rock-water chemistry and the use of J-13 water for the ESF may need to be revaluated during the earliest stages of construction, when additional information on the chemistry of UZ pore water is available.

Statements about the benefit gained from separating testing and waste emplacement areas could be reinforced by conducting sensitivity analyses.

Several analyses support the conclusion that the Title I design addresses the need to minimize the potential for deleterious rock movement or fracturing.

The Title I design does not specifically consider excavation techniques for controlling overbreak or limiting disturbance to the rock mass. Although the potential impact on waste isolation is small, controls should be imposed.

Based on the Case and Kelsall (1987) study, it is reasonable to expect that the goal for limiting permeability changes in the wall rock as a result of excavation will be met. This is adequate for Title I design. Experiments to validate the results of Case and Kelsall is planned in the construction phase of ESF testing.

Existing analyses of the behavior of a number of repository openings under thermal loading are considered conservative approximations of the conditions around the ESF openings, and thus are bounding calculations adequate for considering the impact of ESF openings on waste isolation.

Numerical analysis methods for designing underground support systems are generally inconclusive, with no existing standardized methods. The widely accepted empirical rock mass classification approach described for the repository conceptual design (SCP Chapter 6) is therefore considered adequate for the ESF Title I design.

In evaluating the potential performance-related impacts of the underground testing, criteria were developed. Sixteen criteria were considered to have been adequately treated with respect to the Title I design. These included

criteria related to fluids and materials control and their chemical effects, thermal and thermomechanical effects of testing and appropriate location of boreholes. The only criteria related to ESF testing impacts considered to have been inadequately treated is related to the disposal waste water from underground construction, operation, and testing (see discussion under surface utilities). For two of the criteria related to water control during testing, a thorough evaluation of the criteria can only be done after detailed testing procedures are available.

As indicated in the criteria roll-up table (in Appendix I) the criteria related to evaluating the potential performance impacts of performance confirmation tests potentially conducted in the ESF are almost identical to the criteria applied to the planned site characterization tests in the ESF. The only differences were in the application of the criteria related to 60.15(d)(3) and 60.137 to the site characterization and performance confirmation programs, respectively. Since the adequacy of the treatment of the criteria related to the performance impacts of site characterization testing is discussed above, only the concerns relative to the 60.137 requirement are described here. The treatment of performance confirmation concerns is generally considered adequate in the ESF Title I design. This is, in part, based on the availability of sufficient space in the dedicated test area to accommodate additional tests, the construction capacity for developing additional drifts, and the anticipation that essentially the same controls would be applied to all tests (including performance confirmation tests) as appropriate. The evaluation is caveated to indicate that special procedures would be required if tests using radioactive materials were planned in the ESF as part of performance confirmation testing.

The assessment that the ESF Title I design is adequate is partially based on evaluations of the impacts that the design could have on the ability of the site to comply with the performance objectives. These assessments are largely abstracted from section 8.4.3 of the SCP. Many of the data, calculations and analyses supporting the Section 8.4 assessments were also reviewed as part of this TAR. The results of that evaluation bear on the assessment of adequacy of the ESF Title I Design and are summarized in section 2.4.4. Nearly all of the data and analysis reports reviewed for data reasonableness and appropriateness in support of Title I Design were judged to have used appropriate data and methods. Likewise, the treatment of uncertainty was considered appropriate. There were no issues identified by the reviewers that questioned the adequacy of Title I Design. The concerns identified by the reviewers addressed evaluations warranted for Title II Design, and errata to the SCP to be treated in progress reports.

RECOMMENDATIONS AND CORRECTIVE MEASURES

A number of recommendations and possible corrective measures have been identified on the basis of the Design Acceptability Analysis conducted as part of this Technical Assessment Review. The majority address perceived shortcomings in the level of detail or explicitness judged to be present in the Title I Design. These shortcomings are not judged to signify inadequacy in the Title I Design for its intended purpose; in no case was an explicit recommendation made to redo any portion of the Title I Design. The following text outlines in summary fashion the significant observations about

recommendations and proposed corrective measures relative to Title I Design that were identified in the evaluations about the relevant criteria:

Title II design drawings for ESF tests areas should indicate, if practicable, the extent of borings from the U/G area

Implement QA procedures for identifying items important to waste isolation in Title II design. Incorporate comparative evaluations of alternatives for major design features important to waste isolation, into the Title II design, if any such features are identified with respect to the shafts or underground excavations.

Further results of ongoing studies of microbes with respect to waste isolation, should be incorporated into the ESF design and design documentation, to the extent practicable.

Final design should include provisions for inventory of hydrocarbons and solvents used underground, and for minimizing their use.

The design should indicate that the use of J-13 water will be revaluated during the earliest stages of construction, based on available information on UZ pore water chemistry obtained from construction phase hydrochemical studies.

Recommendations of the West (1988) report (relating to minimizing use of water and hydrocarbons underground) should be addressed in further design work. The program to be used for controlling the use of fluids and materials in ESF construction and operation, including inventory of entry and exit of important substances, should be established.

Title II design should specify the blasting method for use in excavating the main pad, and impose other controls including: a Blasting Plan to be submitted 4 hours prior to each blast, and a vibration monitoring program whereby each shot is monitored independently by at least two instruments.

A three-dimensional thermomechanical analysis of the ESF should be performed for Title II design, covering time steps up to 10,000 years or to the duration extent of significant response.

Several recommendations were made relative to the criteria applicable to the testing impacts. These recommendations included integration of MPBH requirements into the ESF Title II SDRD and design, and that Title II design drawings indicate the extent of the holes drilled from the ESF to facilitate evaluations of compliance with the criteria.

Relative to chemical effects of materials, it is recommended that (1) the process for materials control be formalized, (2) future analyses consider the possibility of microcrobial activity and incorporate inventory controls and limitations on the introduction of selected materials into the formation, and (3) a comparison of water chemistry at Yucca Mountain with that of the water planned for use in construction be made.

An examination of test procedures relative to potential performance impacts was also recommended. Further, it was recommended that analyses related to

surface disposal of water (see surface utilities discussion) be conducted early enough in Title II design to allow design modifications to be considered as needed.

Because of the use of essentially the same criteria for performance confirmation testing as for site characterization testing in the ESF, no additional recommendations or corrective actions specific to the performance confirmation testing are made.

REVIEWERS	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Feb 2, 1989
Ernest L. Hardin	EL Hardin	2/2/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.9.7.1 [60.11113(a)(1)(ii)(B)]

1.9.7.1 (UG UTIL) The underground utilities shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction of the underground utilities shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.9.6.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.9.6.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.9.6.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 31, 1989
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.9.8.1 [60.11113(a)(1)(ii)(B)]

1.9.8.1 (UG TST) The underground testing program shall be designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure, and construction and operation of the underground excavation shall be performed in a manner designed to assist or not detract from the capability of the repository to ensure that the release of radionuclides does not exceed a rate of one part in 100,000 per year of the inventory of radionuclides calculated to be present at 1000 years following permanent closure.

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The rationale explaining why the ESF Title I Design is considered to be in compliance with this criterion is contained in the summary evaluation found under criterion 1.9.6.1.

ADEQUACY OF TREATMENT: The adequacy of treatment of this criterion is discussed in the summary evaluation found under criterion 1.9.6.1.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The recommendations and corrective measures for this criterion are discussed in the summary evaluation found under criterion 1.9.6.1.

REVIEWER	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 31, 1987
ORGANIZATION SAIC		

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.1.1 [60.130]

1.10.1.1 (SITE) Pad operation and construction should limit adverse chemical changes by controlling the use of hydrocarbons, solvents and chemicals.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES ____ NO ____ DON'T' KNOW

RATIONALE: The introduction and effects of hydrocarbons, solvents, and chemicals on the site during operation and construction of the pads for the ESF is described in SCP section 8.4, and in a referenced report by West (1988). Compliance with this criterion is addressed indirectly in sections of the Title 1 design report and the ESF Subsystem Design Requirements Document.

The ESF Title I Design Documents comply with this criterion through the following:

1. The main and auxiliary pads are designed with drainage ponds . These ponds are to be lined and the liners are required to have a 25-year life. The liner will restrict the infiltration of fluids including hydrocarbons, solvents and chemicals.

2. Fluid and material usage for the pads will be controlled and the fluids amounts limited. A preliminary fluids and materials evaluation has been completed by West (1988). Based on this evaluation, no restrictions were identified for the surface usage of solvents and hydrocarbons.

3. Water infiltration at the surface is expected to be limited by the high evapotranspiration rates. Volatilities of solvent and many organic compounds are expected to be high. Evaporation processes should therefore decrease their infiltration into the subsurface more than water. Many of the solvent and organic compounds are biodegradable (West, 1988).

4. The effects of microorganisms in the unsaturated zone has not been recognized as a problem for containment of radioactive waste (West, 1988).

5. Hydrocarbons, solvents and chemicals introduced at the surface that penetrate into rock or microorganisms associated with these fluids will move with water. The vertical separation of the surface pads from the waste emplacement drifts indicates that solvent and organic compounds will not be in contact with the radioactive waste elements.

ADEQUACY OF TREATMENT: Adequate for title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.1, 1.10.4.8, 1.10.5.1, 1.10.5.8, 1.10.6.2, 1.10.6.8 [60.130]

1.10.4.1 (ES-1) Shaft operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH, and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4.8 (ES-1) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.5.1 (ES-2) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.5.8 (ES-2) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.6.2 (UG EXC) Underground facility operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.6.8 (UG EXC) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES ____ NO ____ DON'T' KNOW

RATIONALE: These considerations are discussed in the ESF Title 1 design report, the ESF Subsystem Design Requirements Document, the SCP section 8.4, and the West (1988) report.

The ESF Title I Design Documents comply with these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from construction and operation are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the shafts and excavations of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the construction and operation of the ESF. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic reactions are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository levels.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be

filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in ESF construction. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

ADEQUACY OF TREATMENT: Adequate for Title I design. Future design work for the ESF should impose inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon. The results of continuing studies of microbes with respect to radionuclide migration will need to be assessed in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.2, 1.10.5.2, 1.10.6.3 [60.130]

1.10.4.2 (ES-1) The usage of cement, shotcrete, and grout for bolt anchors or other rock mass support for shaft construction and operations should not exceed requirements for proper construction or safety considerations.

1.10.5.2 (ES-2) Same as above

1.10.6.3 (UG EXC) Underground facility construction and operation should limit cement, shotcrete, and grout for bolt anchors or other rock mass support to that required for proper construction.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The use of cement, shotcrete and grout are described in the Title I design documents. The following considerations indicate that this criterion has been addressed:

1. Rock support and other structural anchoring materials shall be compatible with waste isolation and shall neither interfere with radionuclide containment nor enhance radionuclide migration (ESF Subsystem Design Requirements Document 1.2.6.4 Constraint 5 and 1.2.6.5 Constraints 5).

2. The effects of cement and cement-related materials on ground water chemistry have been examined in section 8.4 of the SCP and in the report by Fernandez et al., (1988). The major effects include leaching of alkaline constituents from the concrete with an increase in the pH of the pore fluids. Affected cations and anions are Na,K, OH, and SO4. Increasing hydroxide results in an increase in C03 forming calcium carbonate and decreasing the calcium concentration in solution. Sorption studies have not shown strong effects with increasing pH; increasing pH tends to increase Kd's for most elements (SCP, Chapter 4). Very high pH values may be of concern because of solubility effects for actinides that form OH-complexes. However, high pH values will occur only in the pore waters directly in contact with cement. Increasing amounts of Na and K in solution can lead to competition for cation exchange sites among monovalent waste elements. However, these concerns are not considered to be significant for radionuclide migration because of the combination of the small distance of projected chemical effects from the concrete and the relatively small effects on sorption Kd's.

3. The viewpoint of the design documents for Title I is pervasively conservative with respect to materials used in the ESF. Cement is included as an inventoried material in the report by West (1988). There is no indication in the design documents that excessive amounts of cement, shotcrete, or grouts will be used in construction or operation of the ESF.

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.3, 1.10.5.3, 1.10.6.4 [60.130]

1.10.4.3 (ES-1) The chemistry of any water used in shaft construction, or operation should be compatible with postclosure requirements to isolate and contain waste.

1.10.5.3 (ES-2) Same as above.

1.10.6.4 (UG EXC) The chemistry of any water used in underground excavation construction or operation should be compatible with postclosure requirements to isolate and contain waste.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The nature and origin of water introduced into the ESF is described in the ESF Title I design report, the ESF subsystem design requirements document and the Fluids and Materials and Evaluation report (West, 1988).

The Title I design documents address this criterion through the following:

1. Supply water for the construction and operation of the ESF will be obtained from well J-13 located east of Fortymile Wash outside the exploration block. The water will be transmitted through 4.25 miles of 6-inch reinforced thermal-setting resin pipe to a booster pumping station with a 10,000-gallon storage tank. The water used during operation and construction is metered, controlled, and chemically traced. No chemical changes to the water should be caused by the transport and storage system.

2. The producing aquifer in well J-13 is within the Topopah Spring Member of the Paintbrush Tuff. This water is a sodium bicarbonate water with low dissolved solids. Its chemical composition and Eh-pH characteristics are within the ranges of expected variation for the rock-water buffer system of the site (SCP Chapter 4). No significant chemical changes should be caused by the introduction of water from J-13. A remaining uncertainty however, is the composition of the in situ water of the unsaturated zone. These waters will be analyzed during early construction phases of the ESF. This conclusion will require reevaluation if the composition and chemical characteristics of water of the unsaturated zone proves to be significantly different from the J-13 water.

3. The introduction of water during mining, blasting and dust control operations of the ESF will be limited. These waters will be tagged geochemically. Multipurpose boreholes will be drilled near ES-1 and ES-2. Part of the purpose of these holes will be to monitor fluids in the holes in an attempt to detect chemical changes from the introduction of water in the construction and operation of the ESF.

4. The expected small volume and short distance of infiltration of water penetrating into rock from ESF construction and operation should limit the degree of chemical changes. Any observed effects should be combined to the area immediately surrounding the shafts and drifts.

5. Water composition performance goals have been established from waste package canister studies (SCP). These goals can be met for the ESF in general through use of J-13 water (West, 1988).

ADEQUACY OF TREATMENT: Adequate for Title I design. An evaluation should be included of the water composition of the unsaturated zone during the earliest stages of shaft construction to assess whether unsaturated zone waters differ significantly in composition from J-13 water.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None required.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.4, 1.10.5.4, 1.10.6.5 [60.130]

1.10.4.4 (ES-1) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

1.10.5.4 (ES-2) Same as above.

1.10.6.5 (UG EXC) Fluids and materials planned for use in the underground excavation shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Evaluations of fluids and materials for the ESF construction and operation phases are described in the SCP, Section 8.4, in the published report by West (1988) and in Appendix B of the ESF subsystem requirements design document.

These documents address this criterion through the following:

1. Data on the type, composition and volumes of fluids and materials that will be used in the ESF were compiled in a published report (West, 1988).

2. A decision-tree analysis was used to screen the fluids and materials and to test for interactions among the fluids and materials (West, 1988).

3. No fluids and materials were identified that would have a significant effect on the ability of the site to isolate waste radionuclides from the accessible environment.

ADEQUACY OF TREATMENT: Adequate for Title I.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective actions required. West (1988) made several recommendations based on fluids and material evaluation for the ESF. These recommendations should be considered in further design work. They include: 1) The use of water in the vicinity of site characterization tests should be limited to minimize hydrologic effects and not interfere with site characterization data, and 2) The use of hydrocarbons and solvents should be minimized underground. No formal controls have been established on the use of fluids and materials in construction and operation of the ESF. The recognition of the need for establishing these controls is demonstrated in the design documents, but the process for control has not been formalized.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.5, 1.10.5.5, 1.10.6.6 [60.130]

1.10.4.5 (ES-1) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

1.10.5.5 (ES-2) Same as above.

1.10.6.6 (UG EXC) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: This criterion has been addressed in three documents. The results of a materials inventory described in the report by West (1988) is summarized in section 8.4 of the SCP. The West (1988) report started a Fluids and Materials database for all fluids and materials that will be involved with construction and operation of the ESF. Fluids and materials were cataloged by description, chemical composition, intended use in the ESF, location in the ESF and the quantity or volume of predicted usage. A reference information source was identified with each entry. A major reference for this information is the ESF Subsystem Design Requirements Document, Appendix B. However, no program to formally control materials has been established for the ESF.

ADEQUACY OF TREATMENT: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: A materials control program should be established for the ESF. The program should control the entry and exit of fluids and materials in the ESF for the construction, operation and underground testing aspects of the ESF.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.6, 1.10.5.6 [60.130]

1.10.4.6 (ES-1) The capability to enhance postclosure performance by removing shaft liners shall be retained.

1.10.5.6 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: This criterion is addressed in section 8.4 of the SCP. The SCP states that the shaft liner is designed to be removable. Techniques for removing the liner are described in the referenced report by Fernandez et al. (1988).

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.7, 1.10.5.7, 1.10.6.7 [60.130]

1.10.4.7 (ES-1) The shaft shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

1.10.5.7 (ES-2) Same as above.

1.10.6.7 (UG EXC) The underground excavation shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on a review of volumes 1 and 2 of the ESF Title I design report and the evaluations of the Title I design presented in SCP section 8.4, I conclude that construction controls are planned that will enable flexibility in closure so that seismic (and other) events will be unlikely to compromise the ability to isolate waste. Perhaps the most directly related control is the use of smooth blasting throughout construction of the shafts and the underground excavations. This control will allow the flexibility to implement the postclosure sealing philosophy that provides for redundant components and allows flexibility in selecting (after ESF construction and testing when a much greater amount of information will be known about the site) the exact locations where sealing components will be installed. Additional passive features, such as the sloping of the long lateral drifts away from waste emplacement areas and separation of exploratory boreholes from planned openings, will also contribute to providing assurance that closure can be accomplished effectively.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.1, 1.10.4.8, 1.10.5.1, 1.10.5.8, 1.10.6.2, 1.10.6.8 [60.130]

1.10.4.1 (ES-1) Shaft operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH, and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4.8 (ES-1) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.5.1 (ES-2) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.5.8 (ES-2) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.6.2 (UG EXC) Underground facility operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.6.8 (UG EXC) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES ____ NO ____ DON'T' KNOW

RATIONALE: These considerations are discussed in the ESF Title 1 design report, the ESF Subsystem Design Requirements Document, the SCP section 8.4, and the West (1988) report.

The ESF Title I Design Documents comply with these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from construction and operation are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the shafts and excavations of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the construction and operation of the ESF. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic reactions are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository levels.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be

filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in ESF construction. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

ADEQUACY OF TREATMENT: Adequate for Title I design. Future design work for the ESF should impose inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon. The results of continuing studies of microbes with respect to radionuclide migration will need to be assessed in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.1, 1.10.4.8, 1.10.5.1, 1.10.5.8, 1.10.6.2, 1.10.6.8 [60.130]

1.10.4.1 (ES-1) Shaft operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH, and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4.8 (ES-1) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.5.1 (ES-2) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.5.8 (ES-2) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.6.2 (UG EXC) Underground facility operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.6.8 (UG EXC) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES ____ NO ____ DON'T' KNOW

RATIONALE: These considerations are discussed in the ESF Title 1 design report, the ESF Subsystem Design Requirements Document, the SCP section 8.4, and the West (1988) report.

The ESF Title I Design Documents comply with these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from construction and operation are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the shafts and excavations of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the construction and operation of the ESF. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic reactions are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository levels.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be

filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in ESF construction. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

ADEQUACY OF TREATMENT: Adequate for Title I design. Future design work for the ESF should impose inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon. The results of continuing studies of microbes with respect to radionuclide migration will need to be assessed in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.2, 1.10.5.2, 1.10.6.3 [60.130]

1.10.4.2 (ES-1) The usage of cement, shotcrete, and grout for bolt anchors or other rock mass support for shaft construction and operations should not exceed requirements for proper construction or safety considerations.

1.10.5.2 (ES-2) Same as above

1.10.6.3 (UG EXC) Underground facility construction and operation should limit cement, shotcrete, and grout for bolt anchors or other rock mass support to that required for proper construction.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: The use of cement, shotcrete and grout are described in the Title I design documents. The following considerations indicate that this criterion has been addressed:

1. Rock support and other structural anchoring materials shall be compatible with waste isolation and shall neither interfere with radionuclide containment nor enhance radionuclide migration (ESF Subsystem Design Requirements Document 1.2.6.4 Constraint 5 and 1.2.6.5 Constraints 5).

2. The effects of cement and cement-related materials on ground water chemistry have been examined in section 8.4 of the SCP and in the report by Fernandez et al., (1988). The major effects include leaching of alkaline constituents from the concrete with an increase in the pH of the pore fluids. Affected cations and anions are Na,K, OH, and SO4. Increasing hydroxide results in an increase in CO3 forming calcium carbonate and decreasing the calcium concentration in solution. Sorption studies have not shown strong effects with increasing pH; increasing pH tends to increase Kd's for most elements (SCP, Chapter 4). Very high pH values may be of concern because of solubility effects for actinides that form OH-complexes. However, high pH values will occur only in the pore waters directly in contact with cement. Increasing amounts of Na and K in solution can lead to competition for cation exchange sites among monovalent waste elements. However, these concerns are not considered to be significant for radionuclide migration because of the combination of the small distance of projected chemical effects from the concrete and the relatively small effects on sorption Kd's.

3. The viewpoint of the design documents for Title I is pervasively conservative with respect to materials used in the ESF. Cement is included as an inventoried material in the report by West (1988). There is no indication in the design documents that excessive amounts of cement, shotcrete, or grouts will be used in construction or operation of the ESF.

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

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ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.3, 1.10.5.3, 1.10.6.4 [60.130]

1.10.4.3 (ES-1) The chemistry of any water used in shaft construction, or operation should be compatible with postclosure requirements to isolate and contain waste.

1.10.5.3 (ES-2) Same as above.

1.10.6.4 (UG EXC) The chemistry of any water used in underground excavation construction or operation should be compatible with postclosure requirements to isolate and contain waste.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The nature and origin of water introduced into the ESF is described in the ESF Title I design report, the ESF subsystem design requirements document and the Fluids and Materials and Evaluation report (West, 1988).

The Title I design documents address this criterion through the following:

1. Supply water for the construction and operation of the ESF will be obtained from well J-13 located east of Fortymile Wash outside the exploration block. The water will be transmitted through 4.25 miles of 6-inch reinforced thermal-setting resin pipe to a booster pumping station with a 10,000-gallon storage tank. The water used during operation and construction is metered, controlled, and chemically traced. No chemical changes to the water should be caused by the transport and storage system.

2. The producing aquifer in well J-13 is within the Topopah Spring Member of the Paintbrush Tuff. This water is a sodium bicarbonate water with low dissolved solids. Its chemical composition and Eh-pH characteristics are within the ranges of expected variation for the rock-water buffer system of the site (SCP Chapter 4). No significant chemical changes should be caused by the introduction of water from J-13. A remaining uncertainty however, is the composition of the in situ water of the unsaturated zone. These waters will be analyzed during early construction phases of the ESF. This conclusion will require reevaluation if the composition and chemical characteristics of water of the unsaturated zone proves to be significantly different from the J-13 water.

3. The introduction of water during mining, blasting and dust control operations of the ESF will be limited. These waters will be tagged geochemically. Multipurpose boreholes will be drilled near ES-1 and ES-2. Part of the purpose of these holes will be to monitor fluids in the holes in an attempt to detect chemical changes from the introduction of water in the construction and operation of the ESF.

4. The expected small volume and short distance of infiltration of water penetrating into rock from ESF construction and operation should limit the degree of chemical changes. Any observed effects should be combined to the area immediately surrounding the shafts and drifts.

5. Water composition performance goals have been established from waste package canister studies (SCP). These goals can be met for the ESF in general through use of J-13 water (West, 1988).

ADEQUACY OF TREATMENT: Adequate for Title I design. An evaluation should be included of the water composition of the unsaturated zone during the earliest stages of shaft construction to assess whether unsaturated zone waters differ significantly in composition from J-13 water.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None required.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.4, 1.10.5.4, 1.10.6.5 [60.130]

1.10.4.4 (ES-1) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

1.10.5.4 (ES-2) Same as above.

1.10.6.5 (UG EXC) Fluids and materials planned for use in the underground excavation shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Evaluations of fluids and materials for the ESF construction and operation phases are described in the SCP, Section 8.4, in the published report by West (1988) and in Appendix B of the ESF subsystem requirements design document.

These documents address this criterion through the following:

1. Data on the type, composition and volumes of fluids and materials that will be used in the ESF were compiled in a published report (West, 1988).

2. A decision-tree analysis was used to screen the fluids and materials and to test for interactions among the fluids and materials (West, 1988).

3. No fluids and materials were identified that would have a significant effect on the ability of the site to isolate waste radionuclides from the accessible environment.

ADEQUACY OF TREATMENT: Adequate for Title I.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective actions required. West (1988) made several recommendations based on fluids and material evaluation for the ESF. These recommendations should be considered in further design work. They include: 1) The use of water in the vicinity of site characterization tests should be limited to minimize hydrologic effects and not interfere with site characterization data, and 2) The use of hydrocarbons and solvents should be minimized underground. No formal controls have been established on the use of fluids and materials in construction and operation of the ESF. The recognition of the need for establishing these controls is demonstrated in the design documents, but the process for control has not been formalized.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.5, 1.10.5.5, 1.10.6.6 [60.130]

1.10.4.5 (ES-1) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

1.10.5.5 (ES-2) Same as above.

1.10.6.6 (UG EXC) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: This criterion has been addressed in three documents. The results of a materials inventory described in the report by West (1988) is summarized in section 8.4 of the SCP. The West (1988) report started a Fluids and Materials database for all fluids and materials that will be involved with construction and operation of the ESF. Fluids and materials were cataloged by description, chemical composition, intended use in the ESF, location in the ESF and the quantity or volume of predicted usage. A reference information source was identified with each entry. A major reference for this information is the ESF Subsystem Design Requirements Document, Appendix B. However, no program to formally control materials has been established for the ESF.

ADEQUACY OF TREATMENT: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: A materials control program should be established for the ESF. The program should control the entry and exit of fluids and materials in the ESF for the construction, operation and underground testing aspects of the ESF.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.6, 1.10.5.6 [60.130]

1.10.4.6 (ES-1) The capability to enhance postclosure performance by removing shaft liners shall be retained.

1.10.5.6 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: This criterion is addressed in section 8.4 of the SCP. The SCP states that the shaft liner is designed to be removable. Techniques for removing the liner are described in the referenced report by Fernandez et al. (1988).

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.7, 1.10.5.7, 1.10.6.7 [60.130]

1.10.4.7 (ES-1) The shaft shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

1.10.5.7 (ES-2) Same as above.

1.10.6.7 (UG EXC) The underground excavation shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on a review of volumes 1 and 2 of the ESF Title I design report and the evaluations of the Title I design presented in SCP section 8.4, I conclude that construction controls are planned that will enable flexibility in closure so that seismic (and other) events will be unlikely to compromise the ability to isolate waste. Perhaps the most directly related control is the use of smooth blasting throughout construction of the shafts and the underground excavations. This control will allow the flexibility to implement the postclosure sealing philosophy that provides for redundant components and allows flexibility in selecting (after ESF construction and testing when a much greater amount of information will be known about the site) the exact locations where sealing components will be installed. Additional passive features, such as the sloping of the long lateral drifts away from waste emplacement areas and separation of exploratory boreholes from planned openings, will also contribute to providing assurance that closure can be accomplished effectively.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.1, 1.10.4.8, 1.10.5.1, 1.10.5.8, 1.10.6.2, 1.10.6.8 [60.130]

1.10.4.1 (ES-1) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4.8 (ES-1) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.5.1 (ES-2) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.5.8 (ES-2) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.6.2 (UG EXC) Underground facility operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.6.8 (UG EXC) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T' KNOW

RATIONALE: These considerations are discussed in the ESF Title 1 design report, the ESF Subsystem Design Requirements Document, the SCP section 8.4, and the West (1988) report.

The ESF Title I Design Documents comply with these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from construction and operation are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the shafts and excavations of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the construction and operation of the ESF. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic reactions are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository levels.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be

filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in ESF construction. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

ADEQUACY OF TREATMENT: Adequate for Title I design. Future design work for the ESF should impose inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon. The results of continuing studies of microbes with respect to radionuclide migration will need to be assessed in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None required.

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ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.6.1 [60.130]

1.10.6.1 (UG EXC) The ESF shall be designed with a minimum distance of 75 feet between the centerline of the adjacent ESF and waste emplacement drifts.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES _____ NO _____ DON'T KNOW

RATIONALE: The Title I design documents address this criterion based on the following:

1. The ESF is designed to maintain a minimum separation distance from waste emplacement panels.

2. A minimum separation distance of 30 meters has been described in section 8.4 of the SCP.

3. The 30 meter separation distance is based on analysis of shaft, breakout room and drift mining experiments, heater experiments in G-Tunnel and evaluations of the thermal zone of influence. No displacements or stress-altered regions are expected at the waste emplacement drifts with a 30 meter separation.

4. This separation should prevent the ESF from ever becoming a preferential pathway for transport of radionuclides.

5. The separation prevents water used in underground testing from accessing the waste emplacement drifts.

ADEQUACY OF TREATMENT: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

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ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.1, 1.10.4.8, 1.10.5.1, 1.10.5.8, 1.10.6.2, 1.10.6.8 [60.130]

1.10.4.1 (ES-1) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4.8 (ES-1) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.5.1 (ES-2) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.5.8 (ES-2) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.6.2 (UG EXC) Underground facility operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.6.8 (UG EXC) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES ____ NO ____ DON'T' KNOW

RATIONALE: These considerations are discussed in the ESF Title 1 design report, the ESF Subsystem Design Requirements Document, the SCP section 8.4, and the West (1988) report.

The ESF Title I Design Documents comply with these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from construction and operation are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the shafts and excavations of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the construction and operation of the ESF. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic reactions are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository levels.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be

filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in ESF construction. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

ADEQUACY OF TREATMENT: Adequate for Title I design. Future design work for the ESF should impose inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon. The results of continuing studies of microbes with respect to radionuclide migration will need to be assessed in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None required.

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Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.2, 1.10.5.2, 1.10.6.3 [60.130]

1.10.4.2 (ES-1) The usage of cement, shotcrete, and grout for bolt anchors or other rock mass support for shaft construction and operations should not exceed requirements for proper construction or safety considerations.

1.10.5.2 (ES-2) Same as above

1.10.6.3 (UG EXC) Underground facility construction and operation should limit cement, shotcrete, and grout for bolt anchors or other rock mass support to that required for proper construction.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: The use of cement, shotcrete and grout are described in the Title I design documents. The following considerations indicate that this criterion has been addressed:

1. Rock support and other structural anchoring materials shall be compatible with waste isolation and shall neither interfere with radionuclide containment nor enhance radionuclide migration (ESF Subsystem Design Requirements Document 1.2.6.4 Constraint 5 and 1.2.6.5 Constraints 5).

2. The effects of cement and cement-related materials on ground water chemistry have been examined in section 8.4 of the SCP and in the report by Fernandez et al., (1988). The major effects include leaching of alkaline constituents from the concrete with an increase in the pH of the pore fluids. Affected cations and anions are Na,K, OH, and SO4. Increasing hydroxide results in an increase in C03 forming calcium carbonate and decreasing the calcium concentration in solution. Sorption studies have not shown strong effects with increasing pH; increasing pH tends to increase Kd's for most elements (SCP, Chapter 4). Very high pH values may be of concern because of solubility effects for actinides that form OH-complexes. However, high pH values will occur only in the pore waters directly in contact with cement. Increasing amounts of Na and K in solution can lead to competition for cation exchange sites among monovalent waste elements. However, these concerns are not considered to be significant for radionuclide migration because of the combination of the small distance of projected chemical effects from the concrete and the relatively small effects on sorption Kd's.

3. The viewpoint of the design documents for Title I is pervasively conservative with respect to materials used in the ESF. Cement is included as an inventoried material in the report by West (1988). There is no indication in the design documents that excessive amounts of cement, shotcrete, or grouts will be used in construction or operation of the ESF.

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

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ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.3, 1.10.5.3, 1.10.6.4 [60.130]

1.10.4.3 (ES-1) The chemistry of any water used in shaft construction, or operation should be compatible with postclosure requirements to isolate and contain waste.

1.10.5.3 (ES-2) Same as above.

1.10.6.4 (UG EXC) The chemistry of any water used in underground excavation construction or operation should be compatible with postclosure requirements to isolate and contain waste.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The nature and origin of water introduced into the ESF is described in the ESF Title I design report, the ESF subsystem design requirements document and the Fluids and Materials and Evaluation report (West, 1988).

The Title I design documents address this criterion through the following:

1. Supply water for the construction and operation of the ESF will be obtained from well J-13 located east of Fortymile Wash outside the exploration block. The water will be transmitted through 4.25 miles of 6-inch reinforced thermal-setting resin pipe to a booster pumping station with a 10,000-gallon storage tank. The water used during operation and construction is metered, controlled, and chemically traced. No chemical changes to the water should be caused by the transport and storage system.

2. The producing aquifer in well J-13 is within the Topopah Spring Member of the Paintbrush Tuff. This water is a sodium bicarbonate water with low dissolved solids. Its chemical composition and Eh-pH characteristics are within the ranges of expected variation for the rock-water buffer system of the site (SCP Chapter 4). No significant chemical changes should be caused by the introduction of water from J-13. A remaining uncertainty however, is the composition of the in situ water of the unsaturated zone. These waters will be analyzed during early construction phases of the ESF. This conclusion will require reevaluation if the composition and chemical characteristics of water of the unsaturated zone proves to be significantly different from the J-13 water.

3. The introduction of water during mining, blasting and dust control operations of the ESF will be limited. These waters will be tagged geochemically. Multipurpose boreholes will be drilled near ES-1 and ES-2. Part of the purpose of these holes will be to monitor fluids in the holes in an attempt to detect chemical changes from the introduction of water in the construction and operation of the ESF.

4. The expected small volume and short distance of infiltration of water penetrating into rock from ESF construction and operation should limit the degree of chemical changes. Any observed effects should be combined to the area immediately surrounding the shafts and drifts.

5. Water composition performance goals have been established from waste package canister studies (SCP). These goals can be met for the ESF in general through use of J-13 water (West, 1988).

ADEQUACY OF TREATMENT: Adequate for Title I design. An evaluation should be included of the water composition of the unsaturated zone during the earliest stages of shaft construction to assess whether unsaturated zone waters differ significantly in composition from J-13 water.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None required.

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ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.4, 1.10.5.4, 1.10.6.5 [60.130]

1.10.4.4 (ES-1) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

1.10.5.4 (ES-2) Same as above.

1.10.6.5 (UG EXC) Fluids and materials planned for use in the underground excavation shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Evaluations of fluids and materials for the ESF construction and operation phases are described in the SCP, Section 8.4, in the published report by West (1988) and in Appendix B of the ESF subsystem requirements design document.

These documents address this criterion through the following:

1. Data on the type, composition and volumes of fluids and materials that will be used in the ESF were compiled in a published report (West, 1988).

2. A decision-tree analysis was used to screen the fluids and materials and to test for interactions among the fluids and materials (West, 1988).

3. No fluids and materials were identified that would have a significant effect on the ability of the site to isolate waste radionuclides from the accessible environment.

ADEQUACY OF TREATMENT: Adequate for Title I.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective actions required. West (1988) made several recommendations based on fluids and material evaluation for the ESF. These recommendations should be considered in further design work. They include: 1) The use of water in the vicinity of site characterization tests should be limited to minimize hydrologic effects and not interfere with site characterization data, and 2) The use of hydrocarbons and solvents should be minimized underground. No formal controls have been established on the use of fluids and materials in construction and operation of the ESF. The recognition of the need for establishing these controls is demonstrated in the design documents, but the process for control has not been formalized.

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ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.5, 1.10.5.5, 1.10.6.6 [60.130]

1.10.4.5 (ES-1) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

1.10.5.5 (ES-2) Same as above.

1.10.6.6 (UG EXC) A materials control program should be implemented to enable establishment of limits on the inventory of materials left after decommissioning.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: This criterion has been addressed in three documents. The results of a materials inventory described in the report by West (1988) is summarized in section 8.4 of the SCP. The West (1988) report started a Fluids and Materials database for all fluids and materials that will be involved with construction and operation of the ESF. Fluids and materials were cataloged by description, chemical composition, intended use in the ESF, location in the ESF and the quantity or volume of predicted usage. A reference information source was identified with each entry. A major reference for this information is the ESF Subsystem Design Requirements Document, Appendix B. However, no program to formally control materials has been established for the ESF.

ADEQUACY OF TREATMENT: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: A materials control program should be established for the ESF. The program should control the entry and exit of fluids and materials in the ESF for the construction, operation and underground testing aspects of the ESF.

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ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.7, 1.10.5.7, 1.10.6.7 [60.130]

1.10.4.7 (ES-1) The shaft shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

1.10.5.7 (ES-2) Same as above.

1.10.6.7 (UG EXC) The underground excavation shall be designed with construction controls that enable flexibility in closure, such as the location of seals, so that a seismic event is unlikely to compromise the ability of the facility to isolate wastes.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on a review of volumes 1 and 2 of the ESF Title I design report and the evaluations of the Title I design presented in SCP section 8.4, I conclude that construction controls are planned that will enable flexibility in closure so that seismic (and other) events will be unlikely to compromise the ability to isolate waste. Perhaps the most directly related control is the use of smooth blasting throughout construction of the shafts and the underground excavations. This control will allow the flexibility to implement the postclosure sealing philosophy that provides for redundant components and allows flexibility in selecting (after ESF construction and testing when a much greater amount of information will be known about the site) the exact locations where sealing components will be installed. Additional passive features, such as the sloping of the long lateral drifts away from waste emplacement areas and separation of exploratory boreholes from planned openings, will also contribute to providing assurance that closure can be accomplished effectively.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.4.1, 1.10.4.8, 1.10.5.1, 1.10.5.8, 1.10.6.2, 1.10.6.8 [60.130]

1.10.4.1 (ES-1) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.4.8 (ES-1) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.5.1 (ES-2) Shaft operation and construction should limit adverse chemical changes (type, quantity and location), particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.5.8 (ES-2) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

1.10.6.2 (UG EXC) Underground facility operation and construction should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.6.8 (UG EXC) Construction and operations should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES ____ NO ____ DON'T' KNOW

RATIONALE: These considerations are discussed in the ESF Title 1 design report, the ESF Subsystem Design Requirements Document, the SCP section 8.4, and the West (1988) report.

The ESF Title I Design Documents comply with these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from construction and operation are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the shafts and excavations of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the construction and operation of the ESF. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic reactions are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository levels.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be

filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in ESF construction. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

ADEQUACY OF TREATMENT: Adequate for Title I design. Future design work for the ESF should impose inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon. The results of continuing studies of microbes with respect to radionuclide migration will need to be assessed in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.7.1 [60.130]

1.10.7.1 (UG UTIL) Utility systems, including the water distribution and mine waste-water collection systems, shall be designed so that, in the event of seismic activity, the ability of the facility to isolate waste will not be compromised.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The Title I design documents address this criterion through the following:

1. The primary concern for containment of waste radionuclides is the uncontrolled release of large quantities of water. This water would provide a potential pathway for radionuclide transport.

2. The water distribution system, as described in the Title I Design Report, provides for automatic, excess flow (line break) valves at strategic locations in the piping system. The purpose of these valves are to prevent uncontrolled loss of water. In the event of damage to the water distribution system by seismic activity, the excess flow valves should prevent release of large quantities of water.

3. The performance criteria of the mine wastewater collection system in the ESF subsystem design requirements document include the capacity to handle emergency situations such as water breakage of the wastewater collection system.

4. The expected capacity of wastewater handled in the mine wastewater collection system is sufficiently small that a break in the system would not release significant quantities of water. Should any releases occur the ESF is designed to contain the water in ES-1 (see Diagram FS-GA-0235).

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.8.1 [60.130]

1.10.8.1 (UG TEST) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use for possible effects on the capability of the site to isolate waste, and appropriate controls instituted.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Evaluations of fluids and materials for the underground testing program in the ESF are described in the SCP, Section 8.4, and in the published report by West (1988). West (1988) used information from Appendix B of the ESF Subsystem design requirements document to obtain information on the identity, chemical composition, use and quantities and volume of fluids and materials for the underground testing program.

These documents address this criterion through the following:

1. Data on the fluids and materials that will be used in underground testing in the ESF were compiled (West, 1988).

2. A decision-tree analysis was used to screen the fluids and materials and to test for interactions among the fluids and materials (West, 1988).

3. No fluids and materials were identified that would have a significant effect on the ability of the site to isolate waste radionuclides from the accessible environment.

4. The separation of the test areas for the underground testing program from the waste emplacement drifts insures that fluids and materials from these tests will have no significant impact on the ability of the site to isolate waste.

ADEQUACY OF TREATMENT: Adequate for Title I.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective actions required. West (1988) made several recommendations based on fluids and material evaluation for the ESF. These recommendations should be considered in further design work. They include: 1) The use of water in the vicinity of site characterization tests should be limited to minimize hydrologic effects and not interfere with site characterization data, and 2) The use of hydrocarbons and solvents should be minimized underground. No formal controls have been established on the use of fluids and materials for the underground testing program in the ESF. The recognition of the need for establishing these controls is demonstrated in the design documents, but the process for control has not been formalized.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.8.2, 1.10.8.3 [60.130]

1.10.8.2 (UG TEST) The testing program should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.8.3 (UG TEST) The testing program should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN

__X__ YES ____ NO ____ DON'T' KNOW

RATIONALE: These criteria are discussed in section 8.4 of the SCP, the ESF Title I Design Document and in the ESF subsystem design requirements document.

These design documents address these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from the underground testing program are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the underground testing areas of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the testing program in the ESF. The nature of those effects will depend on the volume and composition of fluids introduced for each test. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic changes are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement

from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository level.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may be beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated zone (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in the underground testing program for the ESF. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

7. Preliminary considerations of the chemical impact of some of the underground testing has been discussed in section 8.4 of the SCP. A nonsorbing tracer will be used in the diffusion test. The expected distance of penetration of this tracer is expected to be very small. Thermal effects of thermo-mechanical testing is expected to extend a maximum distance of 20 meters. The drifts where these tests will be conducted will be bounded by rooms that are ventilated. These will reduce the zone of thermal effects. There will be a 30 meter stand off distance between tests to reduce test interference and mitigate formation of preferential pathways for future migration of radionuclides.

RATIONALE: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required. Future design analysis for the ESF should specifically mention materials inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon in the ESF. The results of future microbial studies with respect to radionuclide migration will need to be evaluated in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.8.2, 1.10.8.3 [60.130]

1.10.8.2 (UG TEST) The testing program should limit adverse chemical changes (type, quantity and location) particularly to pH and organic content of ground water, by controlling the use of hydrocarbons, solvents, and chemicals.

1.10.8.3 (UG TEST) The testing program should be executed in a manner that contributes to or does not detract from isolation capability of the site; for example by limiting organics in drilling fluids, construction materials, and explosive residues from blasting.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN

_X_ YES ____ NO ____ DON'T' KNOW

RATIONALE: These criteria are discussed in section 8.4 of the SCP, the ESF Title I Design Document and in the ESF subsystem design requirements document.

These design documents address these criteria through the following:

1. The major factors mitigating chemical changes that could affect radionuclide migration from the underground testing program are the transitory nature of changes, the small volume of introduced fluids and the considerable separation distances of the waste emplacement drifts from the underground testing areas of the ESF.

2. Hydrologic disturbances of the unsaturated zone will occur from the testing program in the ESF. The nature of those effects will depend on the volume and composition of fluids introduced for each test. Any effect that changes the saturation level of the rocks increases the hydrologic conductivity and potentially increases the rate of transport of waste radionuclides. However a range of considerations indicate that the degree of changes are insignificant. The amount of introduced water will be limited as much as possible by the blasting techniques and the dust control measures. All water will be tagged geochemically. Preliminary estimates suggest that about 10% of the water used in construction will infiltrate the rock walls. This water will cause a transitory increase in the degree of saturation of the rock walls, and these changes will be limited to a zone extending about 10 meters from the openings. The effect of this moisture introduction at the repository horizon will be very small. The only likely mineralogical changes to the rock would be changes in the degree of hydration of zeolite or clay minerals. These changes are reversible and no adverse mineralogic changes are expected (SCP Chapter 4). The conditions of matrix saturation are likely to return to starting conditions within a short period following construction (the amount of time will be dependent on the initial degree of saturation, the matrix permeability and the fracture characteristics of the rocks). Air movement

from ventilation of the ESF should result in drying and the saturation decrease from that drying may exceed the saturation increase from introduced water.

3. A preliminary fluids and materials evaluation of the ESF has been conducted including an inventory of fluids and materials used (West, 1988). The conclusion of the study was that the use of fluids and materials would not have a significant impact on the ability of the site to isolate waste. It was suggested that the use of hydrocarbons and solvents underground should be minimized. Hydrocarbons and solvents generally have a high volatility and may be removed preferentially with the ventilation system. A skimmer will be used with the mine wastewater system to remove petroleum products. Thus the use of these fluids does not appear to be a significant factor for radionuclide migration. Because of the potential for organic complexing with waste elements, particularly the actinides, an inventory or hydrocarbons and solvents used underground should be kept. Their use should be minimized at the repository level.

4. Microbial growth will likely occur in waters introduced in the ESF and will be enhanced by introduction of hydrocarbons and solvents. The effects of microbes on radionuclide migration is not well known. The most important effect may be in promoting reducing conditions which may be beneficial to processes of radionuclide retardation. Bacteria may sorb some radioactive metals from solution. Bacteria in suspension may be filtered from solution by the rock depending on the minimum pore size of the rock. No long-term deleterious effects of microbial action have presently been identified (West, 1988). Continued studies of the effect of microbial action will be required to insure that the effects on radionuclide are not significant.

5. Controlled blasting will introduce gases into the rocks of the unsaturated zone (West, 1988). Most of these products will be removed with the ventilation system. Some will penetrate short distances into the rock. No effects on radionuclide migration have been identified by introduction of these gases.

6. Local chemical changes are expected in pore fluids that interact with cement used in the underground testing program for the ESF. The major chemical changes in these fluids are an increase in the pH, with increased concentration of the alkali cations (Fernandez et al., 1988). These changes are local to the cement materials and are not expected to have significant effects on long term radionuclide migration.

7. Preliminary considerations of the chemical impact of some of the underground testing has been discussed in section 8.4 of the SCP. A nonsorbing tracer will be used in the diffusion test. The expected distance of penetration of this tracer is expected to be very small. Thermal effects of thermo-mechanical testing is expected to extend a maximum distance of 20 meters. The drifts where these tests will be conducted will be bounded by rooms that are ventilated. These will reduce the zone of thermal effects. There will be a 30 meter stand off distance between tests to reduce test interference and mitigate formation of preferential pathways for future migration of radionuclides.

RATIONALE: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required. Future design analysis for the ESF should specifically mention materials inventory controls and limitations on the introduction of hydrocarbons, solvents, and chemicals, particularly near the depths of the repository horizon in the ESF. The results of future microbial studies with respect to radionuclide migration will need to be evaluated in future design documents for the ESF to insure that there are not long term adverse effects from the introduction of growth substrates.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.10.8.4 [60.130]

1.10.8.4 (UG TEST) The chemistry of any water used in the testing program should be compatible with isolation and containment objectives.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The nature and origin of water introduced into the ESF is described in the ESF Title I design report, the ESF subsystem design requirements document and the Fluids and Materials and Evaluation report (West, 1988).

The Title I design documents comply with this criterion through the following:

1. Supply water for the ESF will be obtained from well J-13 located east of Fortymile Wash outside the exploration block. The water will be transmitted through 4.25 miles of 6-inch reinforced thermal-setting resin pipe to a booster pumping station with a 10,000-gallon storage tank. The water is metered, controlled, and chemically traced. No chemical changes to the water should be caused by the transport and storage system.

2. The producing aquifer in well J-13 is within the Topopah Spring Member of the Paintbrush Tuff. This water is a sodium bicarbonate water with low dissolved solids. Its chemical composition and Eh-pH characteristics are within the ranges of expected variation for the rock-water buffer system of the site (SCP Chapter 4). No significant chemical changes should be caused by the introduction of water from J-13. A remaining uncertainty however, is the composition of the in situ water of the unsaturated zone. These waters will be analyzed during early construction phases of the ESF. This conclusion will require reevaluation if the composition and chemical characteristics of water of the unsaturated zone proves to be significantly different from the J-13 water.

3. Multipurpose boreholes will be drilled near ES-1. Part of the purpose of these holes will be to monitor fluids in the holes in an attempt to detect chemical changes from the introduction of water from underground testing in the ESF.

4. The expected small volume and short distance of infiltration of water penetrating into rock from ESF underground testing should limit the degree of chemical changes. Any observed effects should be combined to the area immediately surrounding the experiments and associated boreholes. The required distance of separation of the area for the underground testing from the waste emplacement drifts should limit any effects on radionuclide transport.

5. Water composition performance goals have been established from waste package canister studies (SCP). These goals can be met for the ESF in general through use of J-13 water (West, 1988).

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required. An evaluation should be included of the water composition of the unsaturated zone during the earliest stages of shaft construction to determine if these waters differ chemically from J-13 water. This evaluation should be repeated for the rocks at the depth of the underground testing.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.1, 1.3.5.1 [60.133(A)(1)]; 1.11.4.1, 1.11.5.1 [60.133(a)(1)]

1.3.4.1 (ES-1) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.3.5.1 (ES-2) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.11.4.1 (ES-1) The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

1.11.5.1 The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The exploratory shafts have been specifically designed to not detract from and contribute where possible to the isolation capability of the site. The proposed locations of the shafts are above the pmf, considering debris flows, which should preclude significant quantities of surface water from entering the shaft in post closure time. The proposed construction technique for the shafts is smooth wall blasting. This should limit the extent of fracturing around the shafts and enhance the effectiveness of future sealing. Effects of water entering the shafts are examined in Section 8.4.3 of the SCP. These show that conservative amounts appear to be within the drainage capacity of the shafts without leading to possible flooding of the repository. Sealing of the shafts would inhibit this inflow and provide additional protection to the repository. The shafts are smaller diameter than the other repository shafts and should, accordingly have a smaller mechanical and hydrological effect on the repository. Also, a decision has been made (see SCP section 8.4.2.1.6) not to penetrate the Calico Hills unit until a risk benefit analysis has been completed.

Additionally, as part of this Technical Assessment Review, a comparative evaluation of significant differences in the waste isolation potential of the five alternative exploratory shaft locations identified in the report by Bertram. That evaluation concluded that the presence of a shaft at any of the locations would not be expected to affect significantly the waste isolation capability of the repository, and that the relative differences among the alternative shaft locations are not significant to waste isolation.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: The design aspects individually enable the site to comply with this criteria; taken together they suggest that the design will comply conservatively.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Maintain the capability in the design to support penetration of the Calico Hills and, if possible, prepare risk benefit analysis early in Title II Design. If possible, provide sensitivity or scoping calculations to enable assessment of safety margin in drainage related calculations.

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.3.4.1, 1.3.5.1 [60.133(A)(1)]; 1.11.4.1, 1.11.5.1 [60.133(a)(1)]

1.3.4.1 (ES-1) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.3.5.1 (ES-2) The exploratory shaft locations should be selected, consistent with other goals of site characterization, to limit impacts on isolation

1.11.4.1 (ES-1) The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

1.11.5.1 (ES-2) The shaft configuration (shaft location, shaft diameter, shaft separation, and shaft depth) should contribute to or not detract from the isolation capability of the site

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_✓_ YES ____ NO ____ DON'T KNOW

RATIONALE: The exploratory shafts have been specifically designed to not detract from and contribute where possible to the isolation capability of the site. The proposed locations of the shafts are above the pmf, considering debris flows, which should preclude significant quantities of surface water from entering the shaft in post closure time even if the shafts were not sealed. The proposed construction technique for the shafts is smooth wall blasting. This should limit the extent of fracturing around the shafts and enhance the effectiveness of future sealing. Effects of water entering the shafts are examined in Section 8.4.3 of the SCP. These show that conservative estimates of amounts of water entering the shafts appear to be within the drainage capacity of the shafts without leading to possible flooding of the repository. Sealing of the shafts would inhibit this inflow and provide additional protection to the repository. The shafts are smaller diameter than the other repository shafts and should, accordingly have a smaller mechanical and hydrological effect on the repository. Also, a decision has been made (see SCP section 8.4.2.1.6) not to penetrate the Calico Hills unit until a risk benefit analysis has been completed.

Additionally, as part of this Technical Assessment Review, a comparative evaluation of significant differences in the waste isolation potential of the five alternative exploratory shaft locations identified in the report by Bertram. That evaluation concluded that the presence of a shaft at any of the locations would not be expected to affect significantly the waste isolation capability of the repository, and that the relative differences among the alternative shaft locations are not significant to waste isolation.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: The design aspects individually enable the site to comply with this criteria; taken together they suggest that the design will comply conservatively.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Maintain the capability in the design to support penetration of the Calico Hills and, if possible, prepare risk benefit analysis early in Title II Design. If possible, provide sensitivity or scoping calculations to enable assessment of safety margin in drainage related calculations.

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 30, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.11.6.1 [60.133(a)(1)]

1.11.6.1 (UG EXC) The underground facility configuration (drift location, orientation, geometry, and drift sizes) should contribute to or not detract from the capability of the site to isolate and contain waste.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2, it is concluded that the underground facility configuration is designed to contribute to or not detract from the isolation capability of the site.

Several features of the design of the underground excavations can be cited that contribute to this criteria. First the underground excavations are oriented favorably with respect to the in situ stresses and the expected joint orientations. Second, tests, such as the excavations effects test and the bulk permeability, will be performed early in the initial breakouts to determine if the construction activities are having an affect on the potential ability of the site to contain and isolate waste. Third, there is sufficient flexibility in the design (SCP Section 8.4.2.3.6.4) to re-orient the major drifts and experiment areas in the dedicated test area, if the results from the initial demonstration breakouts show this to be necessary to limit adverse impacts to the site. Fourth, the dedicated test area is separated from the planned repository area by at least two drift diameters and there are only a limited number of connections between the dedicated test area and proposed repository drifts (the connection is required for mining and ventilation of the exploratory drifts. Finally, most of the drifts in the dedicated test area and a substantial portion of the long exploratory drifts are smaller in dimension that the proposed repository drifts in order to limit impact of the drifting on the site.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.11.6.2, 1.11.6.3 [60.133(a)(1)]

1.11.6.2 (UG EXC) Overburden above the potential repository horizon must be > 200m.

1.11.6.3 (UG EXC) If possible, confine Main Test Level facility to TsW2, although TsW1 can be considered.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on an examination of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2, it is concluded that the main test level facility will be limited to the TsW2 formation (including vertical boreholes drilled from the main test level for testing purposes) and that a 200 m overburden will be maintained over the main test level (main test level and repository horizon at the shaft breakout is at approximately 311 m.)

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.11.6.2, 1.11.6.3 [60.133(a)(1)]

1.11.6.2 (UG EXC) Overburden above the potential repository horizon must be > 200m.

1.11.6.3 (UG EXC) If possible, confine Main Test Level facility to TsW2, although TsW1 can be considered.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on an examination of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2, it is concluded that the main test level facility will be limited to the TsW2 formation (including vertical boreholes drilled from the main test level for testing purposes) and that a 200 m overburden will be maintained over the main test level (main test level and repository horizon at the shaft breakout is at approximately 311 m.)

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.11.6.4 [60.133(a)(1)]

1.11.6.4 (UG EXC) Location of underground facility should stay within the conceptual perimeter drift boundary, except as needed to characterize areas outside that boundary, taking into account any potential impacts on the waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on an examination of the ESF-Repository Interface drawing in the SDRD Appendix A (Drawing R07048A) and SCP Section 8.4.2 (including Figure 8.4.2-2) it can be concluded that the location of the underground facility will stay within the the perimeter drift boundary, with the possible exception of exploratory drifts to Drill Hole Wash and the Imbricate Fault, which may penetrate the perimeter drift boundary for the purpose of exploring specific geologic features.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/25/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.2.6.2, 1.11.6.5 [60.15(d)(3)]

1.2.6.2 (UG EXC) For sealing purposes, exploratory boreholes shall be located a minimum distance of 15 m from undeground openings.

1.11.6.5 (UG EXC) The distance of underground facility openings from exploratory boreholes drilled from the surface should be at least 15 m.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the ESF layout in the Title I report, the locations and depths of existing boreholes identified in the Site Atlas, and the locations and depths of the proposed boreholes (Surface-Based Investigations Plan), it is believed that the exploratory boreholes that extend significantly below the repository horizon will not be within 15m of the ESF underground openings. At present, there are 3 holes (USW G-4, USW H-5, and USW WT-2) that are located within the repository underground layout boundary and extend to the water table. The current ESF layout does not show any drifts within 15 m of these holes.

The MPBH holes are within the ESF exclusion (dedicated test) area defined on drawing R07048A of Appendix A of the ESF/SDRD. These holes will not intersect any of the drifting in the ESF dedicated testing area. The MPBHs are not part of the current Title I design; however, if preliminary locations indicated in SCP Figure 8.4.2-19 are selected as the final locations for the MPBHs, they would not meet the 15 m standoff criteria. It is also not clear to this reviewer that they should be expected to meet this criteria since the 15 m standoff criteria is for sealing purposes related to preventing pathways for radionuclide migration to the water table and the MPBHs are not planned to extend significantly, if at all, below the repository horizon. It seems to me a bit illogical to apply this criteria to the MPBHs and thereby enforce a 15 m standoff from two, six-inch or so diameter boreholes while allowing drifts to connect directly with the shafts (14 feet diameter excavations). Prior to the start of Title II design, it is recommended that this criteria be defined with regard to whether or not it applies to the MPBHs. Because of the drainage capacity that exists within the ESF area and the relative isolation of the area from waste emplacement areas, specific interpretation should also be made regarding the need to apply the criteria to separation from USW G-4. Because it seems illogical to apply the criteria to the MPBHs and because the MPBHs were not a part of the Title I design, I consider that the Title I design meets the criteria and expect that the Title II design will consider this matter in detail.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: The SDRD for the ESF Title II design should make clear the intended application for this criteria relative to the MPBHs and USW G-4.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R. Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.11.6.6 [60.133(a)(1)]

1.11.6.6 (UG EXC) The spacing between adjacent ESF drifts shall be a minimum of two drift diameters (using the maximum diameter of either opening, and considering the closest proximity of any part of each opening).

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_✓_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on evaluation of the ESF layout depicted in drwg. FS-GA-0160 in volume 2 of the ESF Title I design report and parts of SCP Section 8.4.2, it is concluded that the Title I design meets the criteria for a two drift diameter standoff except for a few areas. Specific areas that do not meet the criteria are the separation between adjacent drifts in the sequential drift mining area, the standoff between one of the waste package vertical testing drifts and the proposed repository access drift, and for the heated room test (a test under consideration although not a part of the Title I design). Detailed evaluations of the separation between the drifts have been completed for the both the heated room and sequential drift mining experiments that suggest (see the criteria 2/60.133(e)(2)/6/3 evaluation) that the separation is adequate to perform the intended site characterization tests. Also, it is conceivable that tests designed to more heavily load pillars between drifts could provide valuable data for evaluating thermomechanical effects and yet would be prevented by this criteria. It is also very probable, in my opinion, that this criteria is unrealistically stringent as applied to the ESF drifts since numerous calculations of the thermomechanical response of repository drifts indicate that the loadings experienced by the emplacement drifts would be factors of 5-10 greater than those experienced by unheated drifts. It is therefore recommended that this criteria be evaluated in more detail before or during the early stages of Title II design and that the SDRD for Title II design reflect specific wording as to the intended application of this criteria (or perhaps a more appropriately worded one). Analytical evaluations of specific geometries and loadings might be needed to provide the insight to make the criteria consistent with potential application in the repository drifts and the ESF excavations.

ADEQUACY OF TREATMENT: Marginally adequate in the Title I design because of the drift separations that do not meet the criteria. This is not considered to be a major concern relative to the Title I design since increases of a few feet in separation between only a few of the drifts would be needed to be in complete compliance.

RECOMMENDATIONS AND CORRECTIVE MEASURES: As indicated above, it is recomended that the criteria be evaluated and then consistently applied during the Title II design.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERAI (CONTINUED)

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.11.6.7 [60.133(a)(1)]; 1.13.6.2 [60.133(b)]

1.11.6.7 (UG EXC) The number of interconnections between the dedicated test area and the repository should be limited to as few as possible, consistent with access and ventilation needs.

1.13.6.2 (UG EXC) The number of interconnections between the dedicated test area and the repository should be limited to as few as practicable.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Evaluations of selected drawings (FS-GA-0006, -0160, & -0195) indicate that there are two connections between the long lateral drifts and the dedicated test area. For personnel safety reasons related to maintaining the capability for emergency egress from the facility, I consider that this is the minimum number of desirable interconnections. Furthermore, since the elevations of these intersections is above the breakout level for ES-1, the drainage within the dedicated test area would be separate from that of the long lateral drifts.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.6.1 [60.21(c)(11)]; 1.11.6.8 [60.133(a)(1)]; 1.14.4.3, 1.14.5.3, 1.14.6.3 [60.133(d)]

1.4.6.1 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with postclosure sealing concerns.

1.11.6.8 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

1.14.4.3 (ES-1) Same as for 1.11.6.8.

1.14.5.3 (ES-2) Same as for 1.11.6.8.

1.14.6.3 (UG EXC) Same as for 1.11.6.8.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, plans for seal and repository designs (see SCP-CDR, SCP Chapter 6, and SCP section 8.3.3), and the repository interface drawings in the SDRD, I conclude that the drainage plan for the ESF and long exploratory drifts are consistent with planned repository operations and postclosure sealing concerns. As regards the two shafts, my conclusions are related to the fact that the shaft design is consistent with the performance allocation presented in the SCP for sealing. Specifically, the bottoms of the shafts are well below the main test levels (about 50 feet for ES-1 (drwg. FS-GA-0057) and about 100 feet for ES-2 (drwg. FS-GA-0113)) and because the design of the proposed liner is such that it can be removed during decommissioning if necessary to aid in sealing the repository. As regards the underground excavations, my conclusions are related again to the consistency between the ESF Title I design, the repository conceptual design, and the performance allocation presented in the SCP for sealing. Specifically, the proposed exploratory drifts in the ESF are consistent with the planned repository drifts as evidenced by the agreement between the ESF Title I design (drwgs. FS-GA-0195, -0196, -0197, -0198, and -0199) and the ESF-Repository interface drawing (R07048A in Appendix A of the SDRD). This will aid in assuring that the drifts in the repository are graded to allow the slope to be from (rather than toward) emplacement drifts in which waste has been stored. Additionally, the intersections between the long lateral drifts and the dedicated test areas are both above the elevation of the shaft breakouts with the breakout for ES-1

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

representing the lower of the two breakouts (see drwgs. FS-GA-0057, -0113, and -0195). As a result, the drainage in the dedicated test area would generally be toward ES-1 (see drwg. R07048A in ESF SDRD). The only exception to this drainage toward ES-1 in the current design of the dedicated test area is, I believe, the vertical testing drift (about 230 feet long) in the waste package environment test (drwg. FS-GA-0166); the grade of this drift is obviously based on the testing need for instrumentation access.

ADEQUACY OF TREATMENT: Adequate evidence exists tc indicate that the drainage plan for the ESF is consistent with planned repository operations and postclosure sealing concerns and specifically that the drainage in the dedicated test area is generally toward ES-1 and that the slopes of the long drifts are compatible with the repository grades.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R. Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.1.1 [60.133(a)(2)]

1.12.1.1 (SITE) The areas around the shaft collar shall be designed and constructed to prevent water inflow from the probable maximum flood.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIONALE:

The areas around the shaft collar are designed to prevent water influx from probable maximum flooding. As a result there will be virtually no impact on the ability of the repository to isolate waste, and testing in the underground portion of the ESF will not be affected. Section 6.2.3 of the ESF Title I Design Summary Report states: "Drainage channels and ditches are used to control flows in the existing water courses. ...The main pad is protected from the probable maximum flood by deepening and widening the existing wash above the pad. Added protection by way of an earth berm is added on the upper side of the pad to deflect any possible uncontained flood waters." Section 3.2.2.1 of the ESF Title I Design Summary Report states: "There are two 12-foot benches, 30 and 60 feet above the main pad, serving as a catchment for rocks and access for maintenance. At the base of the high wall there is a 10-foot wide drainage channel that diverts runoff from the slope, off the main pad. Surface water encroachment into the shafts will be further limited because the finished collars will be one foot above grade (see SCP page 8.4.2-163 and ESF drawings FS-GA-0026 and FS-GA-0043). Figure 8.4.3-3 in the SCP shows the relationships of the exploratory shafts to probable maximum flooding in the nearby wash. The entrance to ES-1 will be located 16 feet above the maximum height of a probable flood and the entrance to ES-2 will be over 37 feet above the probable maximum flood (this can be seen by comparing the ESF drawings with the height of flooding in figure 8.4.3-3). The surface of the main pad will slope away from the exploratory shafts at about a 2% grade (see ESF Drawing JS-025-ESF-C6). A postclosure aspect of the site that contributes to the ability to prevent water inflow during a maximum probable flood is that the site is located above the flood level in a relatively small wash which has very small erosion rates. Shaft seals and site restoration will further contribute to postclosure water influx prevention.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.2.1 [60.133(a)(2)]

1.12.2.1 (SUR-FAC) Water storage tanks should be located, or protection provided to preclude water inflow to ESF following a possible tank failure.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The ESF design is such that water storage tanks are located away from or downgrade from the entrances to the shafts so that tank ruptures will not result in water entering either shaft. A 150,000 gallon water storage tank will be located about 1500 feet to the west of the ESF pad. Drainage from a rupture in this tank will be to the south and into a wash which will then carry this water away from the ESF pad (see ESF Design Drawings JS-025-ESF-C3 and JS-025-ESF-C42). A 10,000 gallon fresh water tank and booster pump will be located about 0.8 miles to the southeast of the pad at an elevation about 280 feet lower than the pad (see drawings JS-025-ESF-C6 and JS-025-ESF-C16), so there is no potential for a rupture of this tank to flood the shaft entrances.

ADEQUACY OF TRAEATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
KEITH M. KERSCH	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.2.2 [60.133(a)(2)

1.12.2.2 (SUR-FAC) Piping shall be designed to preclude or limit possible water inflow to the ESF following a pipe rupture.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Most fresh water and sewage piping is located away from the openings of the ESF so that a rupture of either of these would not result in water entering either exploratory shaft. The surface of the main pad will slope away from the exploratory shafts at about a 2% grade (see ESF Drawing JS-025-ESF-C6), so any rupture that is away from the shafts will not result in water entering the shafts. Water utilities inside shaft and underground portions of the ESF will be controlled by gate valves, surge protectors, air release valves and blow-off valves, which will reduce the likelihood of a pipe rupture (see section 3.4.2 of the Design Summary Report). These valves can be shut in the event of pipe rupture to limit further influx of water into the facility. Section 3.8.5 of the Design Summary Report states: "For system reliability, automatic, excess flow (line break) valves are utilized at strategic locations in the piping system to limit the amount of water being introduced into the ground structure..." Any water that does enter the facility will flow naturally to a low spot (sump) where it will be collected and pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
KEITH M. KERSCH	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.4.1, 1.12.5.1 [60.133(a)(2)]

1.12.4.1 (ES-1) The exploratory shaft shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facility.

1.12.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report and the design description in SCP section 8.4, I conclude that the exploratory shafts have been designed so that the effects of credible disruptive events such as flooding, fires, and explosions shall be limited from spreading through the facility. One principal preventative method of assuring that flooding will not spread throughout the facility is by locating the entrance to the exploratory shaft significantly above the level of the probable maximum flood so that flood waters will not enter the shaft. This has been indicated in DRWG. JS-025-ESF-C45 and explicitly evaluated in SCP section 8.4.3.3.1.2 based on results presented in SAND85-0598. Examples of other considerations related to this criteria are provided by considering 1) the credible accident list (Title I, table 5-5) that includes flooding, fire, and explosion considerations, 2) the list of applicable codes used in developing the design (Title I, sec. 5.1), 3) the relatively noncombustible materials generally used in the shaft construction, 4) the design feature of extending the shafts to below the main test level and putting in water collection features that allow water to be collected there and pumped to the surface rather than being diverted into the drifts at the test level, 5) numerous valves are designed to be located both at the surface and underground to limit the potential for flooding (see drawings FS-GA-0230, -0235), and 6) monitoring systems (with alarms) have been identified (e.g. drwg. FS-GA-220 and -0222).

ADEQUACY OF TREATMENT: An adequate treatment of the considerations for limiting the spread of credible disruptive events through the facility is evidenced.

RECOMMENDATIONS AND CORRECTIVE MEASURES: NONE

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.4.1, 1.12.5.1 [60.133(a)(2)]

1.12.4.1 (ES-1) The exploratory shaft shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facility.

1.12.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

√ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report and the design description in SCP section 8.4, I conclude that the exploratory shafts have been designed so that the effects of credible disruptive events such as flooding, fires, and explosions shall be limited from spreading through the facility. One principal preventative method of assuring that flooding will not spread throughout the facility is by locating the entrance to the exploratory shaft significantly above the level of the probable maximum flood so that flood waters will not enter the shaft. This has been indicated in DRWG. JS-025-ESF-C45 and explicitly evaluated in SCP section 8.4.3.3.1.2 based on results presented in SAND85-0598. Examples of other considerations related to this criteria are provided by considering 1) the credible accident list (Title I, table 5-5) that includes flooding, fire, and explosion considerations, 2) the list of applicable codes used in developing the design (Title I, sec. 5.1), 3) the relatively noncombustible materials generally used in the shaft construction, 4) the design feature of extending the shafts to below the main test level and putting in water collection features that allow water to be collected there and pumped to the surface rather than being diverted into the drifts at the test level, 5) numerous valves are designed to be located both at the surface and underground to limit the potential for flooding (see drawings FS-GA-0230, -0235), and 6) monitoring systems (with alarms) have been identified (e.g. drwg. FS-GA-220 and -0222).

ADEQUACY OF TREATMENT: An adequate treatment of the considerations for limiting the spread of credible disruptive events through the facility is evidenced.

RECOMMENDATIONS AND CORRECTIVE MEASURES: NONE

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.6.1, 1.12.6.2, 1.12.6.4 [60.133(a)(2)]

1.12.6.1 (UG EXC) The Exploratory Shaft Underground Facility shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facilty.

1.12.6.2 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be designed to ensure that the effects of flooding shall be limited from spreading through the facility.

1.12.6.4 (UG EXC) The underground facility should be designed to limit any spread of fire, which could produce geochemical effects that impact waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, and the repository interface drawings in the SDRD, I conclude that the underground excavations have been designed so that the effects of credible disruptive events during the period of operations such as flooding, fires and explosions shall be limited from spreading through the facility and will therefore be limited such that testing in the ESF is not adversely impacted. First, as regards flooding, it is unlikely that significant quantities of water will enter the underground excavations as a result of floods (see discussions of criteria 1/133(a)(2)/4/1 and 1/133(a)(2)/5/1) because of the location of the shaft entrances relative to flooding and because of the presence of pumps at the bottom of each shaft. It is also unlikely that water will spread through the facility because 1) the dedicated test area is designed so that water will, in general, drain toward ES-1 (see drwg. R07048A/5), 2) skid-mounted pumps are provided during construction near the drift faces and additional pumps are planned as necessary in the dedicated testing area and in drifts near the Ghost Dance Fault, Drill Hole Wash, and the imbricate fault zone (drwg. FS-GA-0235), 3) pumps are provided (drwg. FS-GA-0235) during ESF operations in the shaft bottoms and sump areas for removal of this water (if any is present), and 4) the long lateral drifts are designed so that they are on grades or alignment coincident with planned repository access drifts so that water that might enter such a drift would drain away from repository emplacement drifts in which waste would be stored (Title I rpt. section 3.7.2, and SCP section 8.4.2.3.6.3). Second, as regards spreading of fires or explosions, it is unlikely that they could spread through the facility. Significant evidence exists to indicate that these considerations have been adequately addressed in the Title I design. Examples of the consideration of the need to control and/or prevent such events are provided by 1) the use of applicable codes in developing the design (Title I rpt. sec. 5.1), 2) the safety evaluations completed to date related to the

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

credible accident list (Title I rpt. table 5-5) that includes flooding, fire and explosion considerations, 3) the relatively noncombustible nature of materials generally used in underground excavations (shotcrete, rockbolts, etc.), and 4) the presence of design design features that should contribute to preventing, controlling and responding to such events. These design features include the presence of communications systems, monitoring systems with alarms and shut-off valves, and fire protection systems (including sprinkler systems, portable extinguishers, fire doors in selected areas, and special purpose systems in areas of high potential hazard, such as mine shops or the data system). These features are depicted in drwgs. FS-GA-0220, -0222, -0225, -0227 -0230, and-0235 and in drwgs. JS-025-ESF-W12, -W13, -W14,- W15, and -W16.

ADEQUACY OF TREATMENT: An adequate treatment of the considerations for limiting the spread of credible disruptive events through the underground excavtions is evidenced and the drainage plan for the ESF and the long exploratory drifts is adequately designed to limit flooding.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.6.1, 1.12.6.2, 1.12.6.4 [60.133(a)(2)]

1.12.6.1 (UG EXC) The Exploratory Shaft Underground Facility shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facilty.

1.12.6.2 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be designed to ensure that the effects of flooding shall be limited from spreading through the facility.

1.12.6.4 (UG EXC) The underground facility should be designed to limit any spread of fire, which could produce geochemical effects that impact waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, and the repository interface drawings in the SDRD, I conclude that the underground excavations have been designed so that the effects of credible disruptive events during the period of operations such as flooding, fires and explosions shall be limited from spreading through the facility and will therefore be limited such that testing in the ESF is not adversely impacted. First, as regards flooding, it is unlikely that significant quantities of water will enter the underground excavations as a result of floods (see discussions of criteria 1/133(a)(2)/4/1 and 1/133(a)(2)/5/1) because of the location of the shaft entrances relative to flooding and because of the presence of pumps at the bottom of each shaft. It is also unlikely that water will spread through the facility because 1) the dedicated test area is designed so that water will, in general, drain toward ES-1 (see drwg. R07048A/5), 2) skid-mounted pumps are provided during construction near the drift faces and additional pumps are planned as necessary in the dedicated testing area and in drifts near the Ghost Dance Fault, Drill Hole Wash, and the imbricate fault zone (drwg. FS-GA-0235), 3) pumps are provided (drwg. FS-GA-0235) during ESF operations in the shaft bottoms and sump areas for removal of this water (if any is present), and 4) the long lateral drifts are designed so that they are on grades or alignment coincident with planned repository access drifts so that water that might enter such a drift would drain away from repository emplacement drifts in which waste would be stored (Title I rpt. section 3.7.2, and SCP section 8.4.2.3.6.3). Second, as regards spreading of fires or explosions, it is unlikely that they could spread through the facility. Significant evidence exists to indicate that these considerations have been adequately addressed in the Title I design. Examples of the consideration of the need to control and/or prevent such events are provided by 1) the use of applicable codes in developing the design (Title I rpt. sec. 5.1), 2) the safety evaluations completed to date related to the

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERAI (CONTINUED)

credible accident list (Title I rpt. table 5-5) that includes flooding, fire and explosion considerations, 3) the relatively noncombustible nature of materials generally used in underground excavations (shotcrete, rockbolts, etc.), and 4) the presence of design design features that should contribute to preventing, controlling and responding to such events. These design features include the presence of communications systems, monitoring systems with alarms and shut-off valves, and fire protection systems (including sprinkler systems, portable extinguishers, fire doors in selected areas, and special purpose systems in areas of high potential hazard, such as mine shops or the data system). These features are depicted in drwgs. FS-GA-0220, -0222, -0225, -0227 -0230, and-0235 and in drwgs. JS-025-ESF-W12, -W13, -W14,- W15, and -W16.

ADEQUACY OF TREATMENT: An adequate treatment of the considerations for limiting the spread of credible disruptive events through the underground excavtions is evidenced and the drainage plan for the ESF and the long exploratory drifts is adequately designed to limit flooding.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.6.3 [60.133(a)(2)]

1.12.6.3 (UG EXC) Materials should be selected such that effects of fire do not produce geochemical effects that impact waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The fire protection system for the ESF is described in the ESF Title I Design Report, the ESF Subsystem Design Requirements Document and the SCP, Section 8.4.

The ESF Design Documents address this criterion based on the following:

1. The primary means of limiting the geochemical effects of fire in the ESF is through the separation distance provided for between the underground excavations and the waste emplacement drifts. There is sufficient separation distance that any solid or gaseous byproducts produced by fire should not be in contact with stored radioactive waste.

2. A fire protection system is designed for the ESF. This protection system will limit the extent of any fire through automatic fire suppression system and the presence of one-hour rated fire doors in high fire hazard areas. Limiting the area of fire will limit the extent of potential geochemical effects.

3. The ventilation system of the ESF will control the spread of fire and remove smoke and particulate material produced in a fire.

4. Most of the materials used in ESF construction, including cement, shotcrete and grouts are nonflammable.

5. The primary area of concern from fire would be uncontrolled release of substances that could enhance radionuclide migration. For example, burning of petroleum-base products or fluids could release organic material that could complex with any waste radionuclides present in water. Production of large amounts of soot that penetrated the rock walls could interact with fluids and change the chemistry or pH of the fluids. The distance of penetration of combustion products and interaction with pore fluids, however, is likely to be limited.

6. The combination of separation distance from the waste emplacement drifts, fire suppression and ventilation systems that retard the spread of fire, the nonflammable nature of most construction materials and the limited area of geochemical effects suggest the ability of the site to isolate waste should not be affected by accidental burning of materials in the ESF.

ADEQUACY OF TREATMENT: Adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required. Consideration should be given in future design planning to examining the effects of fire in the underground testing area where the tests might be affected by the fire.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.6.1, 1.12.6.2, 1.12.6.4 [60.133(a)(2)]

1.12.6.1 (UG EXC) The Exploratory Shaft Underground Facility shall be designed so that the effects of credible disruptive events (e.g., flooding, fires, and explosions) shall be limited from spreading through the facilty.

1.12.6.2 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be designed to ensure that the effects of flooding shall be limited from spreading through the facility.

1.12.6.4 (UG EXC) The underground facility should be designed to limit any spread of fire, which could produce geochemical effects that impact waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

√ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, and the repository interface drawings in the SDRD, I conclude that the underground excavations have been designed so that the effects of credible disruptive events during the period of operations such as flooding, fires and explosions shall be limited from spreading through the facility and will therefore be limited such that testing in the ESF is not adversely impacted. First, as regards flooding, it is unlikely that significant quantities of water will enter the underground excavations as a result of floods (see discussions of criteria 1/133(a)(2)/4/1 and 1/133(a)(2)/5/1) because of the location of the shaft entrances relative to flooding and because of the presence of pumps at the bottom of each shaft. It is also unlikely that water will spread through the facility because 1) the dedicated test area is designed so that water will, in general, drain toward ES-1 (see drwg. R07048A/5), 2) skid-mounted pumps are provided during construction near the drift faces and additional pumps are planned as necessary in the dedicated testing area and in drifts near the Ghost Dance Fault, Drill Hole Wash, and the imbricate fault zone (drwg. FS-GA-0235), 3) pumps are provided (drwg. FS-GA-0235) during ESF operations in the shaft bottoms and sump areas for removal of this water (if any is present), and 4) the long lateral drifts are designed so that they are on grades or alignment coincident with planned repository access drifts so that water that might enter such a drift would drain away from repository emplacement drifts in which waste would be stored (Title I rpt. section 3.7.2, and SCP section 8.4.2.3.6.3). Second, as regards spreading of fires or explosions, it is unlikely that they could spread through the facility. Significant evidence exists to indicate that these considerations have been adequately addressed in the Title I design. Examples of the consideration of the need to control and/or prevent such events are provided by 1) the use of applicable codes in developing the design (Title I rpt. sec. 5.1), 2) the safety evaluations completed to date related to the

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

credible accident list (Title I rpt. table 5-5) that includes flooding, fire and explosion considerations, 3) the relatively noncombustible nature of materials generally used in underground excavations (shotcrete, rockbolts, etc.), and 4) the presence of design design features that should contribute to preventing, controlling and responding to such events. These design features include the presence of communications systems, monitoring systems with alarms and shut-off valves, and fire protection systems (including sprinkler systems, portable extinguishers, fire doors in selected areas, and special purpose systems in areas of high potential hazard, such as mine shops or the data system). These features are depicted in drwgs. FS-GA-0220, -0222, -0225, -0227 -0230, and-0235 and in drwgs. JS-025-ESF-W12, -W13, -W14,- W15, and -W16.

ADEQUACY OF TREATMENT: An adequate treatment of the considerations for limiting the spread of credible disruptive events through the underground excavtions is evidenced and the drainage plan for the ESF and the long exploratory drifts is adequately designed to limit flooding.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.6.5 [60.133(a)(2)]

1.12.6.5 (UG EXC) Operational seals shall be provided where necessary to control the spread of water through the facility.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of section 8.4 of the SCP and volumes 1 and 2 of the Title I design report, I conclude that the criteria has been addressed in the design by affording provisions for water control related to inflow from structural features being investigated during site characterization. The partially saturated nature of the Topopah Spring formation significantly limits but does not eliminate the need for some consideration of water inflow control. About the only design features that I think could be construed to be "operational seals" are the devices planned to control water flow if water is encountered in probe holes drilled in selected areas prior to drift construction in that area. While not directly mentioned in the design report, the description of the construction of the main test level and main test level operations area (SCP section 8.4.2.3.4.4) indicates that probe holes will be drilled ahead of each drill face as conditions warrant in areas where faulting or disturbed zones are expected. It is indicated that probe holes will be collared in 2-3 feet and that a "drill-through mechanical packer with full-opening valve will be installed if water is expected." The remainder of the hole will be drilled through the packer and valve assembly such that if water is encountered, the drilling hardware can be removed and the valve shut to contain the water. Since such drilling is considered to be available technology, I would not expect significant detail about specific procedures to be in the Title I design description; however an indication of potential concerns and solutions related to the installation and use of such equipment would have been helpful. It is also recognized that there is substantial uncertainty regarding whether or not sufficient water exists in the underground areas to require the use of such controls. One of the purposes of the planned MPBHs is to provide additional insight into whether or not perched water exists; this information would be factored into contingency planning for ESF development. It is unlikely that the results of the MPBH testing and observations during early parts of ESF construction would eliminate the need for having contingency operations defined for drilling into regions with significant potential for water inflow so I would expect procedures for such activities to be developed as part of the ESF Title II design activities.

ADEQUACY OF TREATMENT: I consider the treatment of the controls planned for use in limiting water inflow to be marginally adequate in the current design description and evaluations.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERAI (CONTINUED)

RECOMMENDATIONS AND CORRECTIVE MEASURES: Treatment of the contingency planning for water flow control should be more extensive in the Title II design description and in the procedures/specifications that accompany the design.

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R. Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.7.1 [60.133(a)(2)]

1.12.7.1 (UG UTIL) Water lines in ESF should be outfitted to limit water inflow to ESF following a possible line rupture.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water lines in the ESF will be outfitted to limit water inflow to ESF following a possible line rupture. Section 3.8.5 of the Design Summary Report states: "For system reliability, automatic, excess flow (line break) valves are utilized at strategic locations in the piping system to limit the amount of water being introduced into the ground structure..." Water utilities inside shaft and underground portions of the ESF will be controlled by gate valves, surge protectors, air release valves and blow-off valves, which will reduce the likelihood of a pipe rupture (see section 3.4.2 of the Design Summary Report). These valves can be shut in the event of pipe rupture to limit further influx of water into the facility. Any water that does enter the facility will flow naturally to a low spot (sump) where it will be collected and pumped to the surface. Section 6.6.6 of the Design Summary Report states: "Vacuum relief devices are utilized for riser pipe protection, and various design methods dampen the effects of water hammer, preventing damage from sudden flow reduction."

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.7.2 [60.133(a)(2)]

1.12.7.2 (UG UTIL) Effective redundant minewater discharge systems should be provided to limit possible impacts on the isolation capability of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The systems for discharge of mine waste water are fully redundant so that there will not be a buildup of water in the ESF sumps. Section 3.8.6 of the Design Summary report states: "The mine waste water system is fully redundant in that each MTL sump pump is duplicated, and each shaft discharge pipe is capable of the 500-gpm design flow compared to the 250-gpm expected flow." Section 6.6.6 of the Design Summary Report says that each of the two main sump pumps is capable of transferring the full design peak flow, as is each shaft riser pipe. Details on line sizes and pump locations are presented in design drawing FS-GA-0235.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M. Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.12.7.3 [60.133(a)(2)]

1.12.7.3 (UG UTIL) Fire suppression agents shall be selected such that they do not produce geochemical effects that adversely impact waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The ESF Title I design documents address these criteria through the following:

1. A design constraint of the ESF Title I design is that fire suppression agents will be approved for use based on their impacts on the in situ site characterization testing program.

2. The primary fire suppression agents will be water, halon and dry chemical units. The water used will be J-13 water. No adverse chemical reactions are expected from the use of J-13 water. West (1988) lists the fire extinguishing chemicals in the ESF as potassium bicarbonate. These chemicals suppress fire through the production of CO_2. Sorption experiments have shown that Kd's for most elements are generally higher with increased partial pressure of CO_2 (SCP, Chapter 4). No long term effects on radionuclide migration are expected from the use of potassium bicarbonate for fire suppression.

ADEQUACY OF TREATMENT: Adequate for Title I Design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: No corrective measures are required.

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.13.6.1 [60.130(b)]

1.13.6.1 (UG EXC) The ESF should be designed so as not to interfere with the flexibility of the repository to accommodate specific site conditions.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The ESF has been designed not to interfere with the flexibility of the repository to accommodate specific site conditions and therefore allow sufficient flexibility to allow adjustments in the repository underground facility to accommodate specific site conditions identified through in situ monitoring, testing or excavation. Specifically, the ESF underground facility has been designed to be within a dedicated area separate from the waste emplacement areas, which would limit the effects of the ESF on repository development. Further, the interconnections between the repository and the test area are limited in number further limiting interference. Finally, the long exploratory drifts are planned to be coincident with repository drifts and would therefore not limit the flexibility of development of the repository drifts.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: Sensitivity calculations about the effectiveness of the separation distances between the waste emplacement area and the dedicated test area would strengthen these arguments.

REVIEWER (PRINT)	SIGNATURE	DATE
Michael D. Voegele	Michael Voegele	Jan 29, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.11.6.7 [60.133(a)(1)]; 1.13.6.2 [60.133(b)]

1.11.6.7 (UG EXC) The number of interconnections between the dedicated test area and the repository should be limited to as few as possible, consistent with access and ventilation needs.

1.13.6.2 (UG EXC) The number of interconnections between the dedicated test area and the repository should be limited to as few as practicable.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Evaluations of selected drawings (FS-GA-0006, -0160, & -0195) indicate that there are two connections between the long lateral drifts and the dedicated test area. For personnel safety reasons related to maintaining the capability for emergency egress from the facility, I consider that this is the minimum number of desirable interconnections. Furthermore, since the elevations of these intersections is above the breakout level for ES-1, the drainage within the dedicated test area would be separate from that of the long lateral drifts.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.13.6.3 [60.133(b)]

1.13.6.3 (UG EXC) The area of the ESF underground excavations shall be limited to that necessary for conducting the needed site characterization and performance confirmation tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: The area of the underground excavations was determined by a combination of testing needs identified in Section 8.3 of the SCP and the operations and access requirements to support those needs. Rationale for the selection of tests is tied in SCP Sections 8.3.2-8.3.5 to providing necessary information about the proposed repository site to resolve issues that address regulatory requirements. The design of the underground excavations provides specifically for that space needed to accomodate planned and anticipated testing needs, accomodation for possible relocation of tests where necessary, sufficient space to accomodate necessary operations shops, staging areas, etc., and allowance to space tests to mitigate against interference caused by other test, construction, or operations activities. Capability is retained to expand excavations should this be found necessary because of site conditions encountered or a need to conduct additional site characterization or performance confirmation tests beyond the current dedicated test area or exploratory drifts, but a functional requirement in the current design (SDRD, Sec. 1.2.6.6, p. 6-1) provides that the test level development will not adversely impact future repository development.

ADEQUACY OF TREATMENT: The design provides for the space presently identified as needed for site characterization and performance confirmation activities.

RECOMMENDATONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.1 [60.133(d)]

1.14.1.1 (SITE) The amount of water used in construction, and operations, of the main pad should be limited so as to limit the effects on the containment and isolation capability of the site

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water used for construction and operation of the main ESF pad will not adversely affect the containment and isolation capability of the site. The site has a very high potential for water evaporation, so most of the water used will be evaporated (see SCP section 8.4.3.2.1.1: Water infiltration from the surface). Section 8.4.3.2.1.3 of the SCP states: "The amount of water that will be used during site characterization activities is small compared with the amount of precipitation that is received annually on the site." Actual water use over 6 years is expected to be 73.8 million gallons which is considerably less than the estimated 230 million gallons of water that falls as precipitation (see page 8.4.3-18 of the SCP).

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M. Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.2 [60.133(d)]

1.14.1.2 (SITE) Water use in pad construction shall not adversely impact goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to 90%.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water used during pad construction will be limited so that saturation levels at the repository level will not be adversely affected. The site has a very high potential for water evaporation, so most of the water used will be evaporated (see SCP section 8.4.3.2.1.1: Water infiltration from the surface). Section 8.4.3.2.1.3 of the SCP states: The amount of water that will be used during site characterization activities is small compared with the amount of precipitation that is received annually on the site." Actual water use over 6 years is expected to be 73.8 million gallons which is considerably less than the estimated 230 million gallons of water that falls as precipitation (see page 8.4.3-18 of the SCP). Pad sizes will be minimized to further reduce the impact of water use on the repository. Construction water that does not evaporate will be imbibed into the alluvium then flow very slowly in the underlying rock matrix so it is unlikely to reach the repository during site characterization. When and if it does reach the repository level it will be spread out and its effect on long term isolation will be insignificant.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M. Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.3 [60.133(d)]

1.14.1.3 (SITE) Construction of the main pad shall be performed in a manner to avoid blockage of natural surface water drainageways and avoid creation of surface water impoundments that could impact post-closure performance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The main pad is constructed to avoid blockage of natural surface water drainageways and avoid creation of surface water impoundments. It will be constructed on the side of a hill out of the major wash drainage path. The pad will have a 2% slope away from the shaft entrances (see ESF Design Drawing JS-025-ESF-C6) so there will be no potential for impoundment of water on the pad. The northwest corner of the pad will be cut below the original contour of the hill and will have drainage ditches to divert any water away from the pad and avoid ponding of the water.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.4, 1.14.8.3 [60.133(d)]

1.14.1.4 (SITE) MPBHs or other surface drilled exploratory boreholes associated with the ESF shall be drilled dry.

1.14.8.3 Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Water will not be used during the drilling of any surface wells in the repository area. SCP section 8.4.2.2.2.2 states: "The unsaturated-zone ...drilling and coring will be performed dry to minimize contamination of samples, and...to reduce disturbance to the in situ hydrologic conditions. ...Each of the proposed MPBH activity boreholes would be drilled to the maximum depth of the respective shaft...Dry drilling and coring are necessary." This section of the SCP further states that the Solitario canyon horizontal borehole will be drilled dry. At the top of page 8.4.2-86 of the SCP, it states that the value of dry drilling has not actually been demonstrated, but will be evaluated during prototype testing at a site away from Yucca Mountain.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M. Kersch	Jan 28, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.5 [60.133(d)]

1.14.1.5 (SITE) MPBHs shall incorporate a standpipe or other measures appropriate and adequate for protection against the effects of maximum credible floods during the period when MPBHs are accessible prior to borehole plugging and sealing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The MPBHs are not likely to be affected by maximum credible floods. These boreholes are planned to be drilled near the exploratory shafts so that drainage and flood control measures for the main pad will provide some protection. In addition, surface casing will be capped when testing is not in progress (see SCP page 8.4.2-75). Standard procedures are to leave a section of casing sticking above the surface and screw a blind flange or bull plug onto the top of the casing when the well is not being used. More detail on shaft location can be found under activity 8.3.1.2.2.4.9 of the SCP. The main pad will be constructed on the side of a hill out of the major wash drainage path. The pad will have a 2% slope away from the shaft entrances (see ESF Design Drawing JS-025-ESF-C6) so there will be no potential for impoundment of water on the pad or around the MPBHs.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M. Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.6 [60.133(d)]

1.14.1.6 (SITE) Construction water shall be limited to that required for dust control and proper equipment operation consistent with performance objectives.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: A small amount of water will be used during construction and operation of the surface facilities which is consistent with performance goals to not adversely affect the containment and isolation capability of the repository. The site has a very high potential for water evaporation, so most of the water used will be evaporated (see SCP section 8.4.3.2.1.1: Water infiltration from the surface). Section 8.4.3.2.1.3 of the SCP states: "The amount of water that will be used during site characterization activities is small compared with the amount of precipitation that is received annually on the site." Section 8.4.2.2.2.3 of the SCP states that 33.2 million gallons of water will be used during construction and testing associated with the ESF. Actual water use for the entire facility over 6 years is expected to be 73.8 million gallons which is considerably less than the estimated 230 million gallons of water that falls as precipitation (see page 8.4.3-18 of the SCP) over the entire surface of the mountain above the repository. The water used on the surface will be less but it will be distributed over about 10 acres. Most of this water will be evaporated. The remaining water will slowly seep into the unsaturated zone and will take a long time to reach the repository level at which time it would be so spread out that its effect would be insignificant.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	11/27/89

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.7 [60.133(d)]

1.14.1.7 Construction procedures shall enable removal of excess water. (SITE)

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Construction water usage will be slight, and the site is to be so constructed that excess water will not accumulate. The site has a very high potential for water evaporation, so most of the water used will be evaporated (see SCP section 8.4.3.2.1.1: Water infiltration from the surface). Section 8.4.3.2.1.3 of the SCP states: "The amount of water that will be used during site characterization activities is small compared with the amount of precipitation that is received annually on the site." Section 8.4.2.2.2.3 of the SCP states that 33.2 million gallons of water will be used during construction and testing associated with the ESF. Most of the water use will be for dust control, and total water use over 6 years is expected to be 73.8 million gallons which is considerably less than the estimated 230 million gallons of water that falls as precipitation (see page 8.4.3-18 of the SCP). The surface of the main pad will slope away from the exploratory shafts at about a 2% grade (see ESF Drawing JS-025-ESF-C6), so excess water would run off into the nearby wash.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.8 [60.133(d)]

1.14.1.8 (SITE) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Utility water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance calculations. Other water is unlikely to enter the ESF. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited."

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.2.1 [60.133(d)]

1.14.2.1 (SITE) Fluids recovered from sanitary uses or during construction operations should be disposed of in such a way as to avoid potential for performance impacts, for example in lined ponds.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES ____ NO ____ DON'T KNOW

BASIS FOR CONCLUSION: Disposal of fluids recovered during construction, operations, and testing are provided for by two systems in the Title I design. Drawings JS-025-ESF-C3 and -C41 depict a sewage system and a mine waste water system. Based on my knowledge of results from hydrologic calculations related to the Yucca Mountain site, I believe it is unlikely that postclosure performance impacts will result from these facilities because they are located a substantial distance (more than 2000 feet) beyond the repository block boundary. As indicated in the design discussions in SCP section 8.4.2.3.3.2, it is planned that additional analysis will be performed to ensure that this system will not impact site characterization; because these analyses have not yet been performed, it is indicated that the ability to meet this criteria is, at present, inadequately treated. Furthermore, because it would be possible to line the waste water pond or to increase the separation distance from the repository if the analyses indicated a significant concern, the lack of a completed analysis is not considered significant relative to the adequacy of the Title I design.

Provisions for collecting the water and pumping it to the waste water disposal area are described under criteria 1/133(d)/4/5, 1/133(d)/5/4, 1/133(d)/6/6, and 1/133(d)/7/1.

ADEQUACY OF TREATMENT: As indicated above, the evidence does not exist in the design or supporting evaluations to directly indicate that the criteria has been adequately addressed. Treatment is at this time considered inadequate relative to this criteria and it is recommended that the planned analyses be completed.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Analyses planned for Title II design should be completed during the Title II design to document evaluation of the separation distance of water disposal areas from the repository boundary as regards potential for postclosure performance implications. These analyses should be done early enough in Title II design to allow a decision to be made regarding whether or not it is necessary to move the pond and sewer system or to line the pond. No corrective measures are necessary, at this time, for the

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

design but consideration should be given during Title II design to the potential modifications mentioned above if the analyses indicate they are needed.

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.1 [60.133(d)]

1.14.4.1 (ES-1) The amount of water used in construction and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Water used in construction and operations of the shafts and underground will be limited in order to limit the effects on the containment and isolation capability of the site. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface." Minimum amounts of water may be used for dust control after blasting. This water most likely will be removed with the rubble.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

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ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.2 [60.133(d)]

1.14.4.2 (ES-1) Water use in shaft construction should be generally consistent with repository design goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to <90% in waste emplacement areas.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water use in testing and construction of the exploratory shafts and underground facilities will be consistent with the repository design goal to limit the average saturation at the repository horizon and in waste emplacement areas. Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during drilling may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

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Keith M. Kersch	Keith M Kersch	1/27/89

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.6.1 [60.21(c)(11)]; 1.11.6.8 [60.133(a)(1)]; 1.14.4.3, 1.14.5.3, 1.14.6.3 [60.133(d)]

1.4.6.1 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with postclosure sealing concerns.

1.11.6.8 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

1.14.4.3 (ES-1) Same as for 1.11.6.8.

1.14.5.3 (ES-2) Same as for 1.11.6.8.

1.14.6.3 (UG EXC) Same as for 1.11.6.8.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, plans for seal and repository designs (see SCP-CDR, SCP Chapter 6, and SCP section 8.3.3), and the repository interface drawings in the SDRD, I conclude that the drainage plan for the ESF and long exploratory drifts are consistent with planned repository operations and postclosure sealing concerns. As regards the two shafts, my conclusions are related to the fact that the shaft design is consistent with the performance allocation presented in the SCP for sealing. Specifically, the bottoms of the shafts are well below the main test levels (about 50 feet for ES-1 (drwg. FS-GA-0057) and about 100 feet for ES-2 (drwg. FS-GA-0113)) and because the design of the proposed liner is such that it can be removed during decommissioning if necessary to aid in sealing the repository. As regards the underground excavations, my conclusions are related again to the consistency between the ESF Title I design, the repository conceptual design, and the performance allocation presented in the SCP for sealing. Specifically, the proposed exploratory drifts in the ESF are consistent with the planned repository drifts as evidenced by the agreement between the ESF Title I design (drwgs. FS-GA-0195, -0196, -0197, -0198, and -0199) and the ESF-Repository interface drawing (R07048A in Appendix A of the SDRD). This will aid in assuring that the drifts in the repository are graded to allow the slope to be from (rather than toward) emplacement drifts in which waste has been stored. Additionally, the intersections between the long lateral drifts and the dedicated test areas are both above the elevation of the shaft breakouts with the breakout for ES-1

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

representing the lower of the two breakouts (see drwgs. FS-GA-0057, -0113, and -0195). As a result, the drainage in the dedicated test area would generally be toward ES-1 (see drwg. R07048A in ESF SDRD). The only exception to this drainage toward ES-1 in the current design of the dedicated test area is, I believe, the vertical testing drift (about 230 feet long) in the waste package environment test (drwg. FS-GA-0166); the grade of this drift is obviously based on the testing need for instrumentation access.

ADEQUACY OF TREATMENT: Adequate evidence exists to indicate that the drainage plan for the ESF is consistent with planned repository operations and postclosure sealing concerns and specifically that the drainage in the dedicated test area is generally toward ES-1 and that the slopes of the long drifts are compatible with the repository grades.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.4 [60.133(d)]

1.14.4.4 (ES-1) The shafts should be separted to maintain reasonable distances for power and instrument cabling and water piping as well as to provide for redundancy in mine water discharge.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the 300 feet separation between ES-1 and ES-2 identified in the Title I design and upon the designs of the mine water and waste water systems, I conclude that the shafts are separated a reasonable distance to preclude a significant potential for postclosure performance impacts resulting from the water systems. While the power and instrument cabling could be related to data quality, I don't believe that a significant concern is warranted about them relative to postclosure implications. The concerns related to the water systems (drwgs. FS-GA-0230 and -0235) are most likely relatively minor considerations relative to shaft separation; nevertheless, the distance between shafts should, if consistent with other constraints, be limited to preclude having long distances underground with pipes that contain fluids under high pressure. Furthermore, while it is possible to limit even further such distances by concentrating the piping in and near a single shaft, I believe that the designers were prudent in providing redundancy in these systems and that the 300 feet separation distance is a reasonable one.

ADEQUACY OF TREATMENT: Adequate treatment of this criteria is provided for by the ESF Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.5, 1.14.5.4, 1.14.6.6, 1.14.7.1 [60.133(d)]

1.14.4.5 (ES-2) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.5.4 (ES-2) Same as above.

1.14.6.6 (UG EXC) Same as above.

1.14.7.1 (UG UTIL) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on an evaluation of selected sections of the Title I design report (particularly drwg. FS-GA-0235 and associated text) it is obvious that appropriate gravity drainage and pumping systems have been incorporated into the Title I design to allow drainage of waste water or naturally occurring water from construction and testing areas, collection of the water, and pumping to the surface. The drawing appropriately identifies an interface with the surface mine waste water collection system (see discussion of criteria 1/133(d)/2/1). For water removal during the construction of the shaft, it is indicated that waste water and spills during construction are removed by the shaft sinking bucket (Title I rpt. section 3.7). After construction, the mine waste water collection system design (drwg FS-GA-0235) indicates that redundant pumps are planned in the bottom of each shaft (below the main test level horizon. Where possible, mine waste water flows by gravity to the main test level sump. Provisions are made in the design for collecting water that might come in near the shaft collar, from taps installed related to perched water testing, or from the upper demonstration breakout room. At the main test level, a sump is shown near ES-1 and three redundant pumps are planned. During construction of the drifts, plans are identified to use pumps as required near the drift face, to collect the water in skid-mounted tanks, and to pump the water to the sump near ES-1 for discharge to the surface. Typical sump arrangements that might be needed in exploratory drifts, in the waste package test or other test alcoves, and in shops areas such as the fueling/wash area are also depicted.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

The ESF Title I design also includes the capability to collect water from the muck pile area and discharge it to the mine waste water system (see drwgs. JS-025-ESF-C38 and -C39; see also text in Section 3.2.2.2.5 of ESF Title I design summary report). To facilitate the recovery of the water from this area, the muck storage pad will be lined and sloped so that water can be collected in a lined collection basin at the east end of the pad. From this collection basin, the water can be pumped to the mine waste water disposal system.

ADEQUACY OF TREATMENT: Sufficient evidence exists to indicate that there is adequate treatment of the drainage and/or pumping systems in the current designs of the shafts, underground excavations, and underground utilities for draining water away from testing and other working areas for collection and/or disposal.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.6 [60.133(d)]

1.14.4.6 (ES-1) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Operating procedures to ensure water entering the ESF is managed properly is primarily a Title II Design concern and will be addressed in more detail in those documents. Utility water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance. Other water is unlikely to enter the ESF. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited."

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.7 [60.133(d)]

1.14.4.7 (ES-1) Construction water shall be limited to that required for dust control and proper equipment operation consistent with performance goals.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Construction and operating water will be limited to that required for dust control and proper equipment operation and will be consistent with performance objectives. Water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance calculations. under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "... uncontrolled use of water underground will be prohibited." Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during shaft construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during drilling may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

[illegible] SIGNATURE

[illegible] Kersch Keith M Kersch Jan 31, 1989

[illegible] ION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.8 [60.133(d)]

1.14.4.8 Construction procedures shall enable removal of excess water. (ES-1)

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Construction procedures will enable the removal of excess water. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

DEFICIENCIES: none

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.9 [60.133(d)]

1.14.4.9 (ES-1) Operational seals shall be provided where necessary to control the intrusion of water into the facility.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Operational seals are mostly a postclosure, Title II Design feature and as such are to be considered in detail under that design document. After closure, seals will be placed in the exploratory shafts so that shaft fill will not act as a pathway for water. SCP section 8.4.1.3 states: "Excavations will be backfilled during repository closure with material that has properties such that under expected conditions it will also be unsaturated. This backfill and other seal components will be designed to limit vapor flow and flow of surface water that might have access to these excavations. As a result of these designs, water entering the backfill would be expected to be imbibed into the rock matrix." Under SCP Section 8.4.2.3.6.3 it states that drainage in long exploratory drifts will be away from areas where waste will be stored. This feature when combined with seals will help to prevent the spread of water through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.5.1 [60.133(d)]

1.14.5.1 (ES-2) The amount of water used in construction and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water used in construction and operations of the shafts and underground will be limited in order to limit the effects on the containment and isolation capability of the site. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface." Minimum amounts of water may be used for dust control after blasting. This water most likely will be removed with the rubble.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.5.2 [60.133(d)]

1.14.5.2 (ES-2) Water use in shaft construction should be generally consistent with repository design goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to <90% in waste emplacement areas.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water use in testing and construction of the exploratory shafts and underground facilities will be consistent with the repository design goal to limit the average saturation at the repository horizon and in waste emplacement areas. Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during drilling may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.6.1 [60.21(c)(11)]; 1.11.6.8 [60.133(a)(1)]; 1.14.4.3, 1.14.5.3, 1.14.6.3 [60.133(d)]

1.4.6.1 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with postclosure sealing concerns.

1.11.6.8 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

1.14.4.3 (ES-1) Same as for 1.11.6.8.

1.14.5.3 (ES-2) Same as for 1.11.6.8.

1.14.6.3 (UG EXC) Same as for 1.11.6.8.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, plans for seal and repository designs (see SCP-CDR, SCP Chapter 6, and SCP section 8.3.3), and the repository interface drawings in the SDRD, I conclude that the drainage plan for the ESF and long exploratory drifts are consistent with planned repository operations and postclosure sealing concerns. As regards the two shafts, my conclusions are related to the fact that the shaft design is consistent with the performance allocation presented in the SCP for sealing. Specifically, the bottoms of the shafts are well below the main test levels (about 50 feet for ES-1 (drwg. FS-GA-0057) and about 100 feet for ES-2 (drwg. FS-GA-0113)) and because the design of the proposed liner is such that it can be removed during decommissioning if necessary to aid in sealing the repository. As regards the underground excavations, my conclusions are related again to the consistency between the ESF Title I design, the repository conceptual design, and the performance allocation presented in the SCP for sealing. Specifically, the proposed exploratory drifts in the ESF are consistent with the planned repository drifts as evidenced by the agreement between the ESF Title I design (drwgs. FS-GA-0195, -0196, -0197, -0198, and -0199) and the ESF-Repository interface drawing (R07048A in Appendix A of the SDRD). This will aid in assuring that the drifts in the repository are graded to allow the slope to be from (rather than toward) emplacement drifts in which waste has been stored. Additionally, the intersections between the long lateral drifts and the dedicated test areas are both above the elevation of the shaft breakouts with the breakout for ES-1

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

representing the lower of the two breakouts (see drwgs. FS-GA-0057, -0113, and -0195). As a result, the drainage in the dedicated test area would generally be toward ES-1 (see drwg. R07048A in ESF SDRD). The only exception to this drainage toward ES-1 in the current design of the dedicated test area is, I believe, the vertical testing drift (about 230 feet long) in the waste package environment test (drwg. FS-GA-0166); the grade of this drift is obviously based on the testing need for instrumentation access.

ADEQUACY OF TREATMENT: Adequate evidence exists to indicate that the drainage plan for the ESF is consistent with planned repository operations and postclosure sealing concerns and specifically that the drainage in the dedicated test area is generally toward ES-1 and that the slopes of the long drifts are compatible with the repository grades.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.5, 1.14.5.4, 1.14.6.6, 1.14.7.1 [60.133(d)]

1.14.4.5 (ES-2) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.5.4 (ES-2) Same as above.

1.14.6.6 (UG EXC) Same as above.

1.14.7.1 (UG UTIL) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on an evaluation of selected sections of the Title I design report (particularly drwg. FS-GA-0235 and associated text) it is obvious that appropriate gravity drainage and pumping systems have been incorporated into the Title I design to allow drainage of waste water or naturally occurring water from construction and testing areas, collection of the water, and pumping to the surface. The drawing appropriately identifies an interface with the surface mine waste water collection system (see discussion of criteria 1/133(d)/2/1). For water removal during the construction of the shaft, it is indicated that waste water and spills during construction are removed by the shaft sinking bucket (Title I rpt. section 3.7). After construction, the mine waste water collection system design (drwg FS-GA-0235) indicates that redundant pumps are planned in the bottom of each shaft (below the main test level horizon. Where possible, mine waste water flows by gravity to the main test level sump. Provisions are made in the design for collecting water that might come in near the shaft collar, from taps installed related to perched water testing, or from the upper demonstration breakout room. At the main test level, a sump is shown near ES-1 and three redundant pumps are planned. During construction of the drifts, plans are identified to use pumps as required near the drift face, to collect the water in skid-mounted tanks, and to pump the water to the sump near ES-1 for discharge to the surface. Typical sump arrangements that might be needed in exploratory drifts, in the waste package test or other test alcoves, and in shops areas such as the [illegible]ling/wash area are a[illegible]

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

The ESF Title I design also includes the capability to collect water from the muck pile area and discharge it to the mine waste water system (see drwgs. JS-025-ESF-C38 and -C39; see also text in Section 3.2.2.2.5 of ESF Title I design summary report). To facilitate the recovery of the water from this area, the muck storage pad will be lined and sloped so that water can be collected in a lined collection basin at the east end of the pad. From this collection basin, the water can be pumped to the mine waste water disposal system.

ADEQUACY OF TREATMENT: Sufficient evidence exists to indicate that there is adequate treatment of the drainage and/or pumping systems in the current designs of the shafts, underground excavations, and underground utilities for draining water away from testing and other working areas for collection and/or disposal.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.5.5 [60.133(d)]

1.14.5.5 (ES-2) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Operating procedures to ensure water entering the ESF is managed properly is primarily a Title II Design concern and will be addressed in more detail in those documents. Utility water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance. Other water is unlikely to enter the ESF. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited."

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.5.6 [60.133(d)]

1.14.5.6 (ES-2) Construction water shall be limited to that required for dust control and proper equipment operation consistent with performance goals.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Construction and operating water will be limited to that required for dust control and proper equipment operation and will be consistent with performance objectives. Water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance calculations. under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "... uncontrolled use of water underground will be prohibited." Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during shaft construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during drilling may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

[illegible] (PRINT)	[illegible]ATURE	[illegible]
Keith M. Kersc	Keith M Kersch	Jan 31, 1989

ORGANIZATION: [illegible]

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.5.7 [60.133(d)]

1.14.5.7 Construction procedures shall enable removal of excess water. (ES-2)

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Construction procedures will enable the removal of excess water. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

DEFICIENCIES: none

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.5.8 [60.133(d)]

1.14.5.8 (ES-2) Operational seals shall be provided where necessary to control the intrusion of water into the facility.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Operational seals are mostly a postclosure, Title II Design feature and as such are to be considered in detail under that design document. After closure, seals will be placed in the exploratory shafts so that shaft fill will not act as a pathway for water. SCP section 8.4.1.3 states: "Excavations will be backfilled during repository closure with material that has properties such that under expected conditions it will also be unsaturated. This backfill and other seal components will be designed to limit vapor flow and flow of surface water that might have access to these excavations. As a result of these designs, water entering the backfill would be expected to be imbibed into the rock matrix." Under SCP Section 8.4.2.3.6.3 it states that drainage in long exploratory drifts will be away from areas where waste will be stored. This feature when combined with seals will help to prevent the spread of water through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.6.1 [60.133(d)]

1.14.6.1 (UG EXC) The amount of water used in construction and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Water used in construction and operations of the shafts and underground will be limited in order to limit the effects on the containment and isolation capability of the site. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface." Minimum amounts of water may be used for dust control after blasting. This water most likely will be removed with the rubble.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.6.2 [60.133(d)]

1.14.6.2 (UG EXC) Water used in construction and operations should not adversely impact the repository design goals to limit the average saturation of the repository horizon to <75% and limit local saturation to <90% in areas of waste emplacement.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water use in testing and construction of the exploratory shafts and underground facilities will be consistent with the repository design goal to limit the average saturation at the repository horizon and in waste emplacement areas. Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during drilling may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.6.1 [60.21(c)(11)]; 1.11.6.8 [60.133(a)(1)]; 1.14.4.3, 1.14.5.3, 1.14.6.3 [60.133(d)]

1.4.6.1 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with postclosure sealing concerns.

1.11.6.8 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be consistent with repository operations and postclosure sealing concerns. Specifically, drainage in the dedicated test area should be toward ES-1 and drainage in long drifts should be compatible with repository grades.

1.14.4.3 (ES-1) Same as for 1.11.6.8.

1.14.5.3 (ES-2) Same as for 1.11.6.8.

1.14.6.3 (UG EXC) Same as for 1.11.6.8.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, plans for seal and repository designs (see SCP-CDR, SCP Chapter 6, and SCP section 8.3.3), and the repository interface drawings in the SDRD, I conclude that the drainage plan for the ESF and long exploratory drifts are consistent with planned repository operations and postclosure sealing concerns. As regards the two shafts, my conclusions are related to the fact that the shaft design is consistent with the performance allocation presented in the SCP for sealing. Specifically, the bottoms of the shafts are well below the main test levels (about 50 feet for ES-1 (drwg. FS-GA-0057) and about 100 feet for ES-2 (drwg. FS-GA-0113)) and because the design of the proposed liner is such that it can be removed during decommissioning if necessary to aid in sealing the repository. As regards the underground excavations, my conclusions are related again to the consistency between the ESF Title I design, the repository conceptual design, and the performance allocation presented in the SCP for sealing. Specifically, the proposed exploratory drifts in the ESF are consistent with the planned repository drifts as evidenced by the agreement between the ESF Title I design (drwgs. FS-GA-0195, -0196, -0197, -0198, and -0199) and the ESF-Repository interface drawing (R07048A in Appendix A of the SDRD). This will aid in assuring that the drifts in the repository are graded to allow the slope to be from (rather than toward) emplacement drifts in which waste has been stored. Additionally, the intersections between the long lateral drifts and the dedicated test areas are both above the elevation of the shaft breakouts with the breakout for ES-1

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

representing the lower of the two breakouts (see drwgs. FS-GA-0057, -0113, and -0195). As a result, the drainage in the dedicated test area would generally be toward ES-1 (see drwg. R07048A in ESF SDRD). The only exception to this drainage toward ES-1 in the current design of the dedicated test area is, I believe, the vertical testing drift (about 230 feet long) in the waste package environment test (drwg. FS-GA-0166); the grade of this drift is obviously based on the testing need for instrumentation access.

ADEQUACY OF TREATMENT: Adequate evidence exists to indicate that the drainage plan for the ESF is consistent with planned repository operations and postclosure sealing concerns and specifically that the drainage in the dedicated test area is generally toward ES-1 and that the slopes of the long drifts are compatible with the repository grades.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.6.4 [60.133(d)]

1.14.6.4 (UG EXC) Construction and operating water shall be limited to that required for dust control and proper equipment operation consistent with performance goals.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Construction and operating water will be limited to that required for dust control and proper equipment operation and will be consistent with performance objectives. Water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance calculations. under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "... uncontrolled use of water underground will be prohibited." Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during shaft construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during drilling may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

NAME (PRINT)	SIGNATURE	DATE
[illegible]	Keith M Kerch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.6.5 [60.133(d)]

1.14.6.5 Construction procedures shall enable removal of excess water. (UG EXC)

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Construction procedures will enable the removal of excess water. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

DEFICIENCIES: none

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.5, 1.14.5.4, 1.14.6.6, 1.14.7.1 [60.133(d)]

1.14.4.5 (ES-2) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.5.4 (ES-2) Same as above.

1.14.6.6 (UG EXC) Same as above.

1.14.7.1 (UG UTIL) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on an evaluation of selected sections of the Title I design report (particularly drwg. FS-GA-0235 and associated text) it is obvious that appropriate gravity drainage and pumping systems have been incorporated into the Title I design to allow drainage of waste water or naturally occurring water from construction and testing areas, collection of the water, and pumping to the surface. The drawing appropriately identifies an interface with the surface mine waste water collection system (see discussion of criteria 1/133(d)/2/1). For water removal during the construction of the shaft, it is indicated that waste water and spills during construction are removed by the shaft sinking bucket (Title I rpt. section 3.7). After construction, the mine waste water collection system design (drwg FS-GA-0235) indicates that redundant pumps are planned in the bottom of each shaft (below the main test level horizon. Where possible, mine waste water flows by gravity to the main test level sump. Provisions are made in the design for collecting water that might come in near the shaft collar, from taps installed related to perched water testing, or from the upper demonstration breakout room. At the main test level, a sump is shown near ES-1 and three redundant pumps are planned. During construction of the drifts, plans are identified to use pumps as required near the drift face, to collect the water in skid-mounted tanks, and to pump the water to the sump near ES-1 for discharge to the surface. Typical sump arrangements that might be needed in exploratory drifts, in the waste package test or other test alcoves, and in shops areas such as the fueling/was[illegible] also depicted.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

The ESF Title I design also includes the capability to collect water from the muck pile area and discharge it to the mine waste water system (see drwgs. JS-025-ESF-C38 and -C39; see also text in Section 3.2.2.2.5 of ESF Title I design summary report). To facilitate the recovery of the water from this area, the muck storage pad will be lined and sloped so that water can be collected in a lined collection basin at the east end of the pad. From this collection basin, the water can be pumped to the mine waste water disposal system.

ADEQUACY OF TREATMENT: Sufficient evidence exists to indicate that there is adequate treatment of the drainage and/or pumping systems in the current designs of the shafts, underground excavations, and underground utilities for draining water away from testing and other working areas for collection and/or disposal.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.6.7 [60.133(d)]

1.14.6.7 (UG EXC) Operating procedures shall be developed to ensure water entering the ESF is managed appropriately, including quantity, location, and water balance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Operating procedures to ensure water entering the ESF is managed properly is primarily a Title II Design concern and will be addressed in more detail in those documents. Utility water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance. Other water is unlikely to enter the ESF. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited."

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.6.8 [60.133(d)]

1.14.6.8 (UG EXC) Operational seals shall be provided where necessary to control the intrusion of water into the facility.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Operational seals are mostly a postclosure, Title II Design feature and as such are to be considered in detail under that design document. After closure, seals will be placed in the exploratory shafts so that shaft fill will not act as a pathway for water. SCP section 8.4.1.3 states: "Excavations will be backfilled during repository closure with material that has properties such that under expected conditions it will also be unsaturated. This backfill and other seal components will be designed to limit vapor flow and flow of surface water that might have access to these excavations. As a result of these designs, water entering the backfill would be expected to be imbibed into the rock matrix." Under SCP Section 8.4.2.3.6.3 it states that drainage in long exploratory drifts will be away from areas where waste will be stored. This feature when combined with seals will help to prevent the spread of water through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.4.5, 1.14.5.4, 1.14.6.6, 1.14.7.1 [60.133(d)]

1.14.4.5 (ES-2) Appropriate gravity drainage and/or pumping systems shall be incorporated into the shaft and underground facilities for draining water away from testing and other working areas to suitable collections point(s) for further treatment and/or disposal.

1.14.5.4 (ES-2) Same as above.

1.14.6.6 (UG EXC) Same as above.

1.14.7.1 (UG UTIL) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on an evaluation of selected sections of the Title I design report (particularly drwg. FS-GA-0235 and associated text) it is obvious that appropriate gravity drainage and pumping systems have been incorporated into the Title I design to allow drainage of waste water or naturally occurring water from construction and testing areas, collection of the water, and pumping to the surface. The drawing appropriately identifies an interface with the surface mine waste water collection system (see discussion of criteria 1/133(d)/2/1). For water removal during the construction of the shaft, it is indicated that waste water and spills during construction are removed by the shaft sinking bucket (Title I rpt. section 3.7). After construction, the mine waste water collection system design (drwg FS-GA-0235) indicates that redundant pumps are planned in the bottom of each shaft (below the main test level horizon. Where possible, mine waste water flows by gravity to the main test level sump. Provisions are made in the design for collecting water that might come in near the shaft collar, from taps installed related to perched water testing, or from the upper demonstration breakout room. At the main test level, a sump is shown near ES-1 and three redundant pumps are planned. During construction of the drifts, plans are identified to use pumps as required near the drift face, to collect the water in skid-mounted tanks, and to pump the water to the sump near ES-1 for discharge to the surface. Typical sump arrangements that might be needed in exploratory drifts, in the waste package test or other test alcoves, and in shops areas such as the fueling/wash [illegible]

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

The ESF Title I design also includes the capability to collect water from the muck pile area and discharge it to the mine waste water system (see drwgs. JS-025-ESF-C38 and -C39; see also text in Section 3.2.2.2.5 of ESF Title I design summary report). To facilitate the recovery of the water from this area, the muck storage pad will be lined and sloped so that water can be collected in a lined collection basin at the east end of the pad. From this collection basin, the water can be pumped to the mine waste water disposal system.

ADEQUACY OF TREATMENT: Sufficient evidence exists to indicate that there is adequate treatment of the drainage and/or pumping systems in the current designs of the shafts, underground excavations, and underground utilities for draining water away from testing and other working areas for collection and/or disposal.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.7.2 [60.133(d)]

1.14.7.2 (UG UTIL) The groundwater collection and control system shall be designed to include possible inflow from penetrations of fault structures during geologic drifting or from perched water horizons during shaft sinking and facility development, in addition to expected inflows.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The groundwater collection and control system will be designed to include possible inflow from penetrations of fault structures during geologic drifting and from perched water horizons during shaft sinking and facility development, in addition to expected inflows. Inflow into the top of the shaft is unlikely, but if water should enter the top of the shaft it will probably flow down the side of the collar to a collection ring located at the bottom of the collar (see Design Drawing FS-GA-0026). Any water that flows past this ring will collect in the sump at the bottom of the shaft. Any water thus collected will be pumped to the surface. On page 8.4.2-191, Section 8.4.2.3.4.4, of the SCP it says: "If a seep or perched-water zone is encountered...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.7.3 [60.133(d)]

1.14.7.3 (UG UTIL) The storage and pumping system shall be designed to provide the capacity to handle emergency situations such as unexpected inflow of water or water line breakage at a peak rate of 250 GPM, or a steady flow of 20 GPM.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The storage and pumping system is designed to provide the capacity to handle emergency situations such as unexpected inflow of water or water line breakage at a peak rate of 250 GPM, or a steady flow of 20 GPM. The sumps will have two pumps in the bottom of each exploratory shaft with each pump rated at 250 GPM and 110 feet discharge head (see section 3.6.6 of the Summary design report or Design Drawing FS-GA-0235).

ADEQUACY OF DESIGN: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.8.1 [60.133(d)]

1.14.8.1 (UG TEST) The amount of water used in testing and operations, should be limited so as to limit the effects on the containment and isolation capability of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

____ YES ____ NO _X_ DON'T KNOW

RATIONALE: Water used in testing and operations will probably be limited in order to limit the effects on the containment and isolation capability of the site. Not all test plans have been developed so the impact of these tests is uncertain. The goal, however is to limit water use so that other tests and repository operations are not adversely affected. Many tests will use small amounts of water but the impact on the repository's capability to isolate waste is expected to be insignificant. The greatest water use is likely to be during shaft construction. Page 8.4.2-105 of the SCP states: "...construction water is estimated to penetrate, in general, less than 10 m into the formation." Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface."

ADEQUACY OF TREATMENT: All testing procedures have not been written at this time, so a thorough evaluation of this criteria is not possible at this time.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: Examine the detailed procedures as they are written to determine possible impacts.

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.8.2 [60.133(d)]

1.14.8.2 (UG EXC) Water use in testing should be generally consistent with repository design goals to limit the average saturation of the repository horizon to <75% and limit the local saturation to <90% in waste emplacement areas.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water use in testing and construction of the exploratory shafts and underground facilities will be consistent with the repository design goal to limit the average saturation at the repository horizon and in waste emplacement areas. Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during drilling may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.1.4, 1.14.8.3 [60.133(d)]

1.14.1.4 (SITE) MPBHs or other surface drilled exploratory boreholes associated with the ESF shall be drilled dry.

1.14.8.3 Same as above

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Water will not be used during the drilling of any surface wells in the repository area. SCP section 8.4.2.2.2.2 states: "The unsaturated-zone ...drilling and coring will be performed dry to minimize contamination of samples, and...to reduce disturbance to the in situ hydrologic conditions. ...Each of the proposed MPBH activity boreholes would be drilled to the maximum depth of the respective shaft...Dry drilling and coring are necessary." This section of the SCP further states that the Solitario canyon horizontal borehole will be drilled dry. At the top of page 8.4.2-86 of the SCP, it states that the value of dry drilling has not actually been demonstrated, but will be evaluated during prototype testing at a site away from Yucca Mountain.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 28, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.8.4 [60.133(d)]

1.14.8.4 (UG TEST) Testing water should be limited to that required for dust control and proper test operation consistent with performance goals.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Testing and operating water will be limited to that required for dust control and proper equipment operation and will be consistent with performance objectives. Water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance calculations. under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "... uncontrolled use of water underground will be prohibited." Section 8.4.3.2.1.3 of the SCP discusses the impacts of water used in construction. On page 8.4.3-18, it states that an estimated 10 percent of the water introduced during shaft construction will not be recovered and is assumed to remain in the unsaturated zone. It was estimated that the saturation change at the proposed repository horizon is only 0.0017 (less than one fifth of a percent), which is consistent with the design goals. The SCP further states: "...the volume of water to be introduced to the site during site characterization is comparable to the volume of water from annual precipitation. Global redistribution of water that will be retained in the rock from mining the shafts is not expected to significantly change the initial matrix saturation profile, either near the surface or at depth. The farther the water moves from the shaft wall, the smaller the change in the matrix saturation profile." Section 8.4.3.2.1.4 of the SCP goes on to state that the water introduced during construction may actually be removed by evaporation caused by forced circulation of air through the facility.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

PREPARED BY	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.8.5 [60.133(d)]

1.14.8.5 Testing procedures shall require the removal of excess water.
(UG TEST)

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Testing procedures will enable the removal of excess water. Water use will be controlled so that the need for removal of excess water is slight. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
KEITH M. KERSCH	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.8.6 [60.133(d)]

1.14.8.6 (UG TEST) Any cleaning of ESF walls to facilitate photogrammetry, mapping, or other testing shall be done using compressed air/mist using control procedures.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Cleaning of ESF walls for photogrammetry, mapping and other testing will be done using compressed air/mist to minimize the impact on the capability of the repository to isolate waste. For more information see Activity 8.3.1.4.2.2.4 which is the primary activity concerned with lithologic and fracture mapping. On page 8.4.2-107 of the SCP it states: "Included in this activity are cleaning the shaft or drift wall areas using minimal amounts of water (i.e., less than that used for dust control)..." It further states that there will be no significant perturbation of the natural conditions.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: none

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.8.7 [60.133(d)]

1.14.8.7 (UG TEST) Test procedures must be developed to ensure that water entering the ESF is managed appropriately, including quantity, location, and water balance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Not all testing procedures have been developed at this time. The goal is to have testing procedures be developed to ensure water entering the ESF is managed properly. Utility water entering the ESF will be carefully monitored, which includes measurement of quantity, location, and water balance. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited."

ADEQUACY OF TREATMENT: Not all testing procedures have been developed at this time, so it is impossible to determine the impact of future testing on the capability of the repository to isolate waste until those procedures are written.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: Review testing procedures as they are written to determine their impact on the capability of the repository to isolate waste.

REVIEWER (PRINT)	SIGNATURE	DATE
KEITH M. KERSCH	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.14.8.8 [60.133(d)]

1.14.8.8 (UG TEST) Gaseous products used in characterization should not produce geochemical effects that impact waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The impact of the underground testing program is described in the ESF Title I Design document, in section 8.4 of the SCP, and in the ESF Subsystem Design Requirements Document. Individual characterization tests are described briefly in section 8.4 and in Appendix B Test and Integrated Data System (IDS) Requirements of the ESF Subsystem Design Requirements Document. The following information from these documents indicate that this criterion has been addressed for Title I design:

1. The spacing of individual underground tests and the separation distance from the waste emplacement drifts indicate that gaseous products used in the characterization studies should not affect waste containment.

2. The ESF ventilation system should remove the major volume of gaseous products that are released in the underground testing areas. The penetration distance of unremoved gases into the rocks is not expected to be significant.

3. Boreholes drilled in the characterization studies will be sealed. The anticipated air conductivity of the sealed boreholes will be sufficiently low to not provide preferential pathways for gaseous products.

4. The volume of gaseous products used in underground testing is expected to be limited. Two tests, the excavation effects test and the diffusion test, anticipate using nitrogen. Nitrogen will be used to measure air permeability in the former and nitrogen will be used to pressure packers in the latter. No harmful geochemical effects are anticipated from the use of gaseous nitrogen.

5. Gaseous products expected to be used in the ESF have been inventoried in the report by West (1988). With the exception of nitrogen, the only gaseous products required in the underground testing areas are for construction and operation of the ESF. Acetylene and oxygen will be used for metal welding and cutting for experiments, oxygen will be available for first aid and as part of safety systems, a variety of gaseous products will be used for fire suppression including halon (fluorinated hydrocarbon) and carbon dioxide. Acetylene and halon are of concern because their release will provide a source of organics that could provide substrates for microbes or could complex chemically with the actinides and affect retardation. The small volume and limited expected dispersal of these gaseous materials suggest they are not of concern for radionuclide migration.

ADEQUACY OF TREATMENT: Adequate for Title I. Additional evaluations of the geochemical effects of gaseous products will be required when detailed test plans and procedures are developed for the underground testing program. It is recommended that the use of gaseous products in underground testing be carefully controlled and inventoried.

RECOMMENDATIONS AND CORRECTIVE MEASURES:

REVIEWER (PRINT)	SIGNATURE	DATE
Bruce M. Crowe	Bruce M. Crowe	1-30-89

ORGANIZATION: LOS ALAMOS

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.4.1, 1.15.5.1 [60.133(e)(2)]

1.15.4.1 (ES-1) The shaft shall be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I Design addresses the need to provide shaft stability and reduce the potential for deleterious rock movement or fracturing is based on several references. The ESF Title I Design Summary Report references 60.133(e)(2) and states that the underground openings of the ESF that become part of the repository are designed to the same criteria that govern the design of the repository drifts in terms of the control of potential deleterious rock movement or fracturing for 100 years (Volume 1, Section 7.2). Postclosure concerns are addressed under 60.113 where the document states that the ESF will be designed so it will not create a potential pathway for ground water to contact the waste packages or for radionuclide migration through existing pathways. The decision to adapt one of the controlled blasting techniques for constructing the shaft (smooth blasting) was influenced by 10 CFR Part 60 requirements to minimize the effects of excavation on the rock (Volume 1, Section 6.4.1).

The ESF Title I Design specifies that the shafts will be constructed using the drill and blast method. Other methods are available that would likely result in less fracturing of the intact rock as a result of construction, such as shaft drilling. The decision to use conventional methods is based on the conclusions reached by the Ad Hoc Committee Evaluation of the Construction Technique Alternatives for the Exploratory Shaft (Vieth to M. Gates, "Decision on Method for Constructing the Exploratory Shaft at Yucca Mountain," 1982). The committee considered two construction methods for the exploratory shafts: drilling, and conventional sinking (drill and blast method). The Figure of Merit technique was used for comparing the two alternatives. A number of objectives and criteria were used for decision making including the need to minimize the introduction of fluids into the rock that may alter the hydrologic and geochemical conditions. Some significant fluid losses had been recorded during the drilling of 4 inch diameter boreholes at the site. Based on the objectives considered, the committee recommended the drill and blast method for constructing the exploratory shafts. This recommendation was subsequently approved by the NNWSI Project.

Excavation-induced effects on permeability of the rock surrounding the shafts is discussed in Section 8.4.3.2 of the SCP and is based on analyses by Case and Kelsall (1987). The model developed is based upon analyses which consider

modification in the rock mass permeability around the shaft resulting from stress redistribution and blast damage. The constitutive relationships for permeability changes from stress redistribution are based on theoretical considerations and laboratory data. The effects of blast damage are estimated from case histories. These permeability modifications are used in Fernandez et al. (1988) where it is concluded that the changes to not significantly enhance radionuclide release for several extreme disruptive scenarios.

ADEQUACY OF TREATMENT: The ESF Title I Design explicitly recognizes the 60.133(e)(2) requirement. The construction method in the shaft design was chosen to minimize the disturbance to the rock surrounding the shaft while minimizing the introduction of fluids.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.4.2, 1.15.5.2 [60.133(e)(2)]

1.15.4.2 (ES-1) An adequate distance between shafts should be provided to reduce potential mechanical interference between the two shafts.

1.15.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I design addresses the need to provide adequate distance between shafts to reduce the mechanical interference between them and subsequent deleterious rock movement or fracturing is based on the results of analyses performed by Costin and Bauer (1988).

ADEQUACY OF TREATMENT: Linear elastic models, summarized in Section 8.4.3.2 of the SCP, indicate that the extent of the stress redistribution zone (i.e., greater than 1% change from in situ conditions) is approximately 5 shaft diameters. ES-1 and ES-2 are located approximately 20 shaft diameters apart making mechanical interference between the shafts unlikely.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.4.1, 1.15.5.1 [60.133(e)(2)]

1.15.4.1 (ES-1) The shaft shall be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I Design addresses the need to provide shaft stability and reduce the potential for deleterious rock movement or fracturing is based on several references. The ESF Title I Design Summary Report references 60.133(e)(2) and states that the underground openings of the ESF that become part of the repository are designed to the same criteria that govern the design of the repository drifts in terms of the control of potential deleterious rock movement or fracturing for 100 years (Volume 1, Section 7.2). Postclosure concerns are addressed under 60.113 where the document states that the ESF will be designed so it will not create a potential pathway for ground water to contact the waste packages or for radionuclide migration through existing pathways. The decision to adapt one of the controlled blasting techniques for constructing the shaft (smooth blasting) was influenced by 10 CFR Part 60 requirements to minimize the effects of excavation on the rock (Volume 1, Section 6.4.1).

The ESF Title I Design specifies that the shafts will be constructed using the drill and blast method. Other methods are available that would likely result in less fracturing of the intact rock as a result of construction, such as shaft drilling. The decision to use conventional methods is based on the conclusions reached by the Ad Hoc Committee Evaluation of the Construction Technique Alternatives for the Exploratory Shaft (Vieth to M. Gates, "Decision on Method for Constructing the Exploratory Shaft at Yucca Mountain," 1982). The committee considered two construction methods for the exploratory shafts: drilling, and conventional sinking (drill and blast method). The Figure of Merit technique was used for comparing the two alternatives. A number of objectives and criteria were used for decision making including the need to minimize the introduction of fluids into the rock that may alter the hydrologic and geochemical conditions. Some significant fluid losses had been recorded during the drilling of 4 inch diameter boreholes at the site. Based on the objectives considered, the committee recommended the drill and blast method for constructing the exploratory shafts. This recommendation was subsequently approved by the NNWSI Project.

Excavation-induced effects on permeability of the rock surrounding the shafts is discussed in Section 8.4.3.2 of the SCP and is based on analyses by Case and Kelsall (1987). The model developed is based upon analyses which consider

modification in the rock mass permeability around the shaft resulting from stress redistribution and blast damage. The constitutive relationships for permeability changes from stress redistribution are based on theoretical considerations and laboratory data. The effects of blast damage are estimated from case histories. These permeability modifications are used in Fernandez et al. (1988) where it is concluded that the changes to not significantly enhance radionuclide release for several extreme disruptive scenarios.

ADEQUACY OF TREATMENT: The ESF Title I Design explicitly recognizes the 60.133(e)(2) requirement. The construction method in the shaft design was chosen to minimize the disturbance to the rock surrounding the shaft while minimizing the introduction of fluids.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.4.2, 1.15.5.2 [60.133(e)(2)]

1.15.4.2 (ES-1) An adequate distance between shafts should be provided to reduce potential mechanical interference between the two shafts.

1.15.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I design addresses the need to provide adequate distance between shafts to reduce the mechanical interference between them and subsequent deleterious rock movement or fracturing is based on the results of analyses performed by Costin and Bauer (1988).

ADEQUACY OF TREATMENT: Linear elastic models, summarized in Section 8.4.3.2 of the SCP, indicate that the extent of the stress redistribution zone (i.e., greater than 1% change from in situ conditions) is approximately 5 shaft diameters. ES-1 and ES-2 are located approximately 20 shaft diameters apart making mechanical interference between the shafts unlikely.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	1/31/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.6.1, 1.15.6.2 [60.133]

1.15.6.1 (UG EXC) The underground excavation should be designed to provide stability and to minimize the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.6.2 (UG EXC) The design of underground openings and their supports shall utilize pillar and opening geometries that limit stress concentration to acceptable levels, so as to minimize the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I addresses the need to minimize the potential for deleterious rock movement or fracturing that could create pathways for radionuclide migration is based on a number of analyses that were performed of the ESF. The related requirements in 10 CFR Part 60.113 and 60.133 are recognized in Title I Design (Volume 1, Section 7.2) and influenced the decision to adapt one of the controlled blasting techniques for constructing the underground openings.

ADEQUACY OF TREATMENT: A number of analyses were performed to evaluate the structural stability of openings in tuff. The ESF main test level design was analyzed by Hill (1985) using a two-dimensional finite element model. The analyses employed a nonlinear, jointed, rock constitutive law to evaluate the influence of pillar size on the stress field between parallel drifts. Differences between the current ESF design and that at the time of the analyses include the assumed ESF depth (approximately 100 m greater in the analyses) and several of the material property values (80% higher deformation modulus and 40% lower Poison's ratio values). The 0.2 horizontal-to-vertical stress ratio assumed in the analyses is at the low end of the range contained in Version 3.0 of the RIB (i.e., the highest deviatoric stress). Overall, the results of the analyses are likely to be conservative compared to results if average RIB values were used. Comparison of the redistributed stresses with the intact strength indicated a factor of safety of 4 around the openings. The regions of stress redistribution were localized.

St. John (1987) performed a series of analyses to evaluate the influence dimension and shape of an emplacement drift has on the deformation and stress around the drift immediately after excavation. Several different horizontal-to-vertical stress ratios were considered and the parameter values used are very similar to those contained in Version 3.0 of the RIB. The drift dimensions analyzed varied from 22 x 16 ft to a 13 x 20 ft openings. Based on the results of the analyses, St. John concluded that stable openings of the dimensions investigated could be constructed within a tuff rock mass with the assumed properties. Stability problems could be encountered if the in situ

horizontal stress is very low (i.e., below the current estimate of the lower bound).

In summary, the analyses performed indicate the ESF openings will be stable with only localized regions of rock failure expected.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Hill, J., 1985. "Structural Analysis of the NNWSI Exploratory Shaft," SAND84-2354, Sandia National Laboratories, Albuquerque, NM.

St. John, C., 1987. "Investigative Study of the Underground Excavations for a Nuclear Waste Repository in Tuff," SAND83-7451, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. V	2/1/88

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.6.1, 1.15.6.2 [60.133]

1.15.6.1 (UG EXC) The underground excavation should be designed to provide stability and to minimize the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

1.15.6.2 (UG EXC) The design of underground openings and their supports shall utilize pillar and opening geometries that limit stress concentration to acceptable levels, so as to minimize the potential for deleterious rock movement or fracturing that may create a pathway for radionuclide migration.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I addresses the need to minimize the potential for deleterious rock movement or fracturing that could create pathways for radionuclide migration is based on a number of analyses that were performed of the ESF. The related requirements in 10 CFR Part 60.113 and 60.133 are recognized in Title I Design (Volume 1, Section 7.2) and influenced the decision to adapt one of the controlled blasting techniques for constructing the underground openings.

ADEQUACY OF TREATMENT: A number of analyses were performed to evaluate the structural stability of openings in tuff. The ESF main test level design was analyzed by Hill (1985) using a two-dimensional finite element model. The analyses employed a nonlinear, jointed, rock constitutive law to evaluate the influence of pillar size on the stress field between parallel drifts. Differences between the current ESF design and that at the time of the analyses include the assumed ESF depth (approximately 100 m greater in the analyses) and several of the material property values (80% higher deformation modulus and 40% lower Poison's ratio values). The 0.2 horizontal-to-vertical stress ratio assumed in the analyses is at the low end of the range contained in Version 3.0 of the RIB (i.e., the highest deviatoric stress). Overall, the results of the analyses are likely to be conservative compared to results if average RIB values were used. Comparison of the redistributed stresses with the intact strength indicated a factor of safety of 4 around the openings. The regions of stress redistribution were localized.

St. John (1987) performed a series of analyses to evaluate the influence dimension and shape of an emplacement drift has on the deformation and stress around the drift immediately after excavation. Several different horizontal-to-vertical stress ratios were considered and the parameter values used are very similar to those contained in Version 3.0 of the RIB. The drift dimensions analyzed varied from 22 x 16 ft to a 13 x 20 ft openings. Based on the results of the analyses, St. John concluded that stable openings of the dimensions investigated could be constructed within a tuff rock mass with the assumed properties. Stability problems could be encountered if the in situ

horizontal stress is very low (i.e., below the current estimate of the lower bound).

In summary, the analyses performed indicate the ESF openings will be stable with only localized regions of rock failure expected.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Hill, J., 1985. "Structural Analysis of the NNWSI Exploratory Shaft," SAND84-2354, Sandia National Laboratories, Albuquerque, NM.

St. John, C., 1987. "Investigative Study of the Underground Excavations for a Nuclear Waste Repository in Tuff," SAND83-7451, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.6.3 [60.133(e)(2)]

1.15.6.3 (UG EXC) The spacing between adjacent ESF drifts shall be a minimum of two drift diameters (using the maximum diameter of either opening, and considering the closest proximity of any part of each opening).

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

____ YES X NO ____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I design does not address the need to maintain a minimum of two-drift diameters between adjacent ESF drifts is based on my review of the layout diagrams in Volume 2 of the ESF Title I Design Report.

ADEQUACY OF TREATMENT: Figure 160 indicates that the distances between several of the drifts is less than the minimum separation distance in the criterion. The distance between the Sequential Drift Mining drifts appear to be less than the two diameter criterion as are the Vertical Waste Package and the adjacent repository access drifts. There also appears to be an incorrect statement in Section 8.4.2 of the SCP (page 8.4.2-217) concerning the standoff distance of the ESF drifts from the repository drifts:

> "A minimum of two-drift-diameter standoff from repository drifts is also maintained to isolate the dedicated test area and reduce the probability that testing activities would interfere with or alter any part of the repository area."

RECOMMENDATIONS AND CORRECTIVE MEASURES: The ESF layout should be changed in the Title II Design to comply with the criterion for minimum standoff distance.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.15.6.4 [60.133(e)(2)]

1.15.6.4 (UG EXC) The ESF shall be designed to be consistent with the repository design goal to limit the extraction ratio to less than 30%.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: In general, the ESF Title I Design appears to address the criterion for the design to be consistent with the repository design goal to limit the extraction ratio to 30%. Section 6.5.2.3 in Volume I of the Design Summary Report says that the overall areal extraction ration is 27 percent, whereas the local extraction ratios range from 25 to 32 percent for the four areas of activity considered in these analyses.

ADEQUACY OF TREATMENT: Local extraction ratios for various sections of the ESF analyzed range from 25% to 32%. The two percent in excess of the goal is considered insignificant.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.1.1 [60.133(f)]

1.16.1.1 (SITE) Excavation techniques used for pad construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

____ YES X NO ____ DON'T KNOW

RATIONALE: Major ESF facilities are housed on the 5-1/2 acre main pad. The pad slopes away from the shafts at a 2 percent grade. The cut side of the pad to the northwest is blasted out of rock to a maximum height of 80 feet at a 1:4 horizontal to vertical slope. In addition to the main pad there are several auxiliary pads that require a minimal amount of excavation. The pads are shown in drawings JS-025-ESF-C3, -C4, -C6, -C37, C-38, as well as in other site and grading plans.

Excavation techniques are covered in the following H&N specifications:

Section	Title
02110	Site Clearing
02202	Rock Removal
02211	Rough Grading
02222	Excavation
02223	Backfilling
02225	Trenching

The above specifications represent standard civil engineering practice. There are no special provisions for controlling overbreak or limiting damage to the adjoining rock mass. Conventional blasting methods are unlikely to cause damage of the rock mass beyond 2 m from the walls and base of the pad excavation (see Table 3 of Case and Kelsall, 1987, included in discussion of Criteria 1.16.4.2, and note that in many of the case histories blast damage was not distinguished from stress relief effects). The damage zone is small enough and far enough away from the test areas that pad construction will not interfere with the site characterization tests in the shafts or the main test level. While controlled drilling and blasting of rock for pad construction is not necessary to maintain the waste isolation capability of the site, careful blasting is necessary to avoid very large or deep blasts which might cause fracturing of the rock, especially in the vicinity of the shafts. Consequently some controls are required to specifically eliminate the possibility of the contractor drilling deep blast holes or detonating very large blasts.

ADEQUACY OF TREATMENT: The Title 1 Design does not specifically consider excavation techniques for controlling overbreak or limiting disturbance to the adjoining rock mass during pad construction. Although, in practice, the

potential impact of this on the waste isolation capability of the site is low, it would be prudent to impose some controls, such as specifying the maximum diameter and length of blast holes, and the types of explosives which may be used.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Impose controls on excavation techniques for pad construction as part of Title II design. In particular, specify the maximum diameter and length of blast holes, and the types of explosives which may be used. Also, require a Blasting Plan to be submitted for approval by the Contracting Officer at least 4 hours prior to each blast, and implement a vibration monitoring program.

REFERENCE:

Case, J.B. and P.C. Kelsall, 1987. "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.1, 1.16.5.1 [60.133(f)]

1.16.4.1 (ES-1) The exploratory shaft construction method should be selected, consistent with other goals of site characterization, to limit impacts on isolation.

1.16.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The two alternatives for shaft construction using available technology are shaft drilling, using a large-diameter boring machine, and conventional mining, using a drill-blast-muck sequence of excavation.

In 1982 the pros and cons of the two alternatives were carefully weighed, and a decision was made to proceed with conventional mining. The rationale for this decision is documented in an Action Memorandum to Mahlon E. Gates from Donald L. Vieth dated 9/8/82 entitled "Decision on Method for Constructing the Exploratory Shaft at Yucca Mountain"; the memorandum includes 12 attachments. This decision was supported by the Ad Hoc Technical Overview Contractor Committee, which was convened to evaluate alternative construction methods and to screen potential sites (Bertram, 1984).

The decision to use conventional shaft construction technology was one of the performance criteria included in the SDRD (e.g., p. 4-2 items 14 & 16, p. 5-2 items 16 & 17). The sinking sequence using conventional mining is shown in drawings FS-GA-0054, -0055, -0056.

With regard to the long-term waste isolation capability of the site, there is a concern for each of the two alternatives. For conventional mining (drill-blast-muck), the concern is that blasting may cause a zone of higher permeability rock to exist around the shaft, which may eventually become a preferential pathway; this concern is further addressed in the discussion of Criteria 1.16.4.2, 1.16.4.3 and 1.16.4.4.

For shaft drilling the concern is that a potential exists for losing relatively large amounts of drilling fluid, additives, and lost circulation material, and that these might alter conditions in the unsaturated zone (e.g., changes in saturation, geochemical effects) that could also allow a preferential pathway to develop.

The previous decision to construct the exploratory shafts by conventional mining (drill-blast-muck sequence) still appears to be valid. There is no recent evidence to suggest that this method poses any more of a concern to long-term waste isolation than the only other reasonable alternative, shaft drilling. In addition, there appears to be more control and less uncertainty

with conventional mining, especially when this construction method incorporates controlled drilling and blasting procedures as planned in the ESF, than with shaft drilling and its attendant problems of fluid control. Consequently it should be easier to predict performance with the conventional mining method, and to design and execute remedial measures for eventual sealing of the shafts.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCE:

Bertram, S.G., 1984 "NNWSI Exploratory Shaft Site and Construction Method Recommendation Report," SAND 84-1003, Sandia National Laboratories, Albuquerque, NM.

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.2, 1.16.5.2, 1.16.6.1 [60.133(f)]

1.16.4.2 (ES-1) Excavation techniques used for shaft and station construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

1.16.5.2 (ES-2) Same as above.

1.16.6.1 (UG-EXC) Excavation techniques used for ESF construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Controlled drilling and blasting methods will be used to excavate the shafts, stations, and underground openings. Of the four principal techniques of controlled blasting (namely cushion blasting, line drilling, presplitting, and smooth wall blasting), smooth wall blasting has been chosen as the preferred technique for the ESF because:

1. Rock damage outside the excavation perimeter can be confined to reasonable limits.

2. Conventional underground equipment can be used.

3. Reasonable round depths (6 to 12 ft) can be maintained.

4. No unusual safety hazards will be introduced.

Although smooth wall blasting generally will be used while excavating the shafts, shaft stations and drifts, line drilling will be used in initiating shaft openings or other excavations where precise opening dimensions are required.

The choice of smooth wall blasting is discussed in the ESF Title I Design Summary Report (p. 6-3) and in the SCP (p. 8.4.2-187). The technical specification for "Controlled Drilling and Blasting" (No FS-SP-0205) is included in the Title I package.

Providing the smooth wall blasting pattern is carefully designed and executed it should limit any overbreak to a few centimeters. Much depends on the characteristics of the rock encountered. In some rock types, smooth wall blasting, when successfully executed, will leave a pattern of half-hole casts around the perimeter of the opening; in these situations the amount of overbreak (i.e., excavation beyond the planned opening contour) will be a function of the accuracy of the drilling rather than a function of the

blasting. In less competent rocks, it may not be possible to achieve a pattern of half-hole casts around the perimeter of the opening; in these circumstances the amount of overbreak will be a function of the type and amounts of explosives used, loading and firing pattern, as well as on the accuracy of drilling.

In the ESF, specification FS-SP-0204 (Excavation for Stations, Drifts, and Alcoves) requires the wall and roof surfaces to be within a radial tolerance of +6 inches, -0 inches of the lines, grades and levels shown on the Contract Drawings. Specification FS-SP-0205 (Controlled Drilling and Blasting) requires the Contractor to conduct test blasting programs in various locations to accommodate changing rock conditions in which the shafts, stations, and underground drifts will be excavated. The test blasting programs are required to demonstrate, amongst other things, that overbreak be held to a maximum of 15 cm (~6 inches).

The procedures employed to control overbreak also help to limit disturbance to the adjoining rock mass. Because smooth wall blasting uses lightly-loaded charges in closely-spaced perimeter holes which are detonated after the main blast, a relatively small shock wave is created in the radial direction of the surrounding rock mass. Case and Kelsall (1987, p. 56) estimated that the use of controlled blasting in welded tuff causes rock damage, expressed as an increase in fracture frequency, to be contained within 0.5 m of the wall of the excavation. In their upper bound case (using lower bound rock strength and upper bound in situ stresses), rock damage is estimated to be contained within 1 m of the excavation wall. This is consistent with other case histories of blast damage measured in tunnels (see the attached Table 3 from Case and Kelsall, 1987).

A vibration monitoring program, using a calibrated seismograph system, will provide data on peak particle velocities and the frequency of vibration at a minimum of two locations for each blast. The present intent is to limit peak particle velocities to 5 in/sec in the shafts and 10 in/sec in the drifts. The seismograph records will provide one of the permanent records of each test blast. If deemed appropriate the vibration monitoring program could be extended to more blasts, or even to all blasts, to help ensure that the intent of this criterion is met.

The conclusion is that the procedures and the controlled blasting techniques planned for the construction of the shafts, stations, and underground drifts will control overbreak and limit disturbance to the surrounding rock mass, and that these will limit the potential for creating preferential pathways for ground water.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Case, J.B. and P.C. Kelsall, 1987. "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

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TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Colorado School of Mines (Edgar Mine) Colorado	Biotite gneiss	Smoothwall	5m x 3m	0.5m	Borehole logging, cross-hole permeability (packer tests), borehole deformation	Depth of blast damage not well documented but in agreement with theoretical calculations	Montazer and Hustrulid, 1983
Stripa Mine Sweden	Granite	Smoothwall	4m x 4m	0.3m	Boreholes	Fracture lengths ranged from 0.1-1.0m, with an average length of 0.3m; permeability of blast damaged zone not measured	Anderson and Halen, 1978
Rainier Mesa Nevada Test Site	Zeolitized tuff	Conventional	3m	<1.7m (?)	Air permeability	Blast damage not well distinguished from stress effects	Miller et al., 1974
Rolla Experimental Mine	Dolomite	Various	2.5 x 2.2m	0.3-2.5m	Seismic refraction	Depth of damage varies according to method of blasting used; blast damage not distinguished from stress relief	Worsey, 1985
Test Drift	Basalt	Conventional	5m	~2m	Cross-hole seismic	Blast damage seen most clearly in vertical travel direction in drift wall, effects of stress relief seen in horizontal direction	King et al., 1984

TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS (Continued)

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Ontario, Canada	Limestone	Presplit	~8m	~1m	TV camera in boreholes in crown	Separate zones of moderate cracking and hairline cracks; depth of damage varies with charge weight	Lukajic, 1982
Saimogo, Japan	Sandstone/ shale	Conventional	5.1m	up to 1.3m	Seismic refraction	Comparison of blasting with excavation by TBM; difficult to separate blast damage from stress relief	Nishida et al., 1982
Crestmore Mine	Marble	Conventional	30-70ft	4-5ft	Seismic refraction, borehole jack, borehole logging	The borehole jacking method was used to determine the rock mass deformation modulus	Heuze and Goodman, 1974
Churchill Falls, Canada	Gneiss	Controlled perimeter	2.1 x 2.4m	<1m	Plate load test	Most damage within 0.3m	Benson et al., 1970
Straight Creek, Colorado	Granite/ gneiss/ schist	Conventional	4m	"few ft"	Seismic refraction	Blast damage depth estimated within overall low velocity layer extending 1-5m	Scott et al., 1968
Belledonne, France	Granite	Conventional	5.9m	~1m	Seismic refraction	Blasting and stress relief effects not specifically distinguished	Plichon, 1980

TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS (Continued)

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Mine	Shale	Conventional	?	0.5-1m	Seismic refraction	Blasting and stress relief effects not specifically distinguished	Brizzolari 1981
Rama Tunnel, Yugoslavia	Dolomite	Conventional	5m	<1m	Cross-hole seismic	Blasting and stress relief effects not specifically distinguished	Kujundic, et al., 1970
Turlough Hill, Ireland	Granite	Conventional	2.5m	0.5-2.5m	Cross-hole seismic	Blasting and stress relief effects not specifically distinguished	O'Donoghue and O'Flaherty, 1974

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.3, 1.16.5.3, 1.16.6.2 [60.133(f)]

1.16.4.3 (ES-1) Drill and blast specifications should include controls related to types and amounts of explosives, shot patterns, and hole depth in order to limit the magnitude and extent of blast-induced permeability.

1.16.5.3 (ES-2) Same as above.

1.16.6.2 (UG-EXC) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: As discussed in Criteria 1.16.4.1 and 1.16.4.2 the ESF excavations will be constructed using controlled drilling and blasting methods, in particular smooth wall blasting.

Title I Design includes a specification entitled "Controlled Drilling and Blasting"(No FS-SP-0205), which covers drilling and blasting operations for rock excavation in vertical shafts, shaft stations and drifts.

With regard to controls relating to the types and amounts of explosives, FS-SP-0205 prohibits the use of free running explosives in the shaft. It requires production holes to be charged with water gel explosive or emulsion with equivalent blasting strength, and requires perimeter holes to be string loaded with small-diameter cartridges of a low density water gel explosive or emulsion with equivalent blasting strength. The specification also applies controls to the types of detonators and stemming material which may be used, and the procedures to be used for drilling, hole charging, stemming, and timing each round.

The maximum depth of drillholes is specified in FS-SP-0205 as being 10 feet in the shaft and 12 feet in drifts. These depths will be reduced if the Contractor fails to break 85% of the drilled depth in 8 out of 10 blast rounds in the test blasting program that will be carried out in appropriate locations of the ESF.

Initial drill patterns to be employed in the ESF shafts and drifts will be included in the Contract Drawings (this level of detail is beyond the scope of Title I). The maximum diameter of drillholes is specified as 1-7/8 inches in FS-SP-0205. Maximum allowable drillhole deviation is 1/2 inch per foot, and drillholes will be inspected for alignment by Mining Inspectors prior to charging.

The Contractor is also required by FS-SP-0205 to submit a Drilling and Blasting Plan to the Contracting Officer for approval. This plan will contain, amongst other things, the following information with regard to the shot pattern: drillhole pattern, hole depth and diameter; types of explosives, size of cartridges, powder factor; hole loading configurations; delay type, arrangement and timing; decking and stemming arrangements; and details of the blasting circuit. In addition, a plan for each individual blast will be submitted to the Contracting Officer at least 4 hours prior to each blast. These plans will include details of the drilling and charging pattern, time delays, firing sequence, and planned time of blast. If changing rock conditions during drilling dictate a change in the individual shot blasting plan, such changes must be approved by the Contracting Officer before operations are allowed to proceed. In addition, a vibration monitoring program will be implemented.

In conclusion, the drill and blast specifications included in FS-SP-0204 and FS-SP-0205 provide sufficient controls for Title I design relating to explosives, hole depths and shot patterns to limit blast-induced damage. Controls on blast-induced damage directly limit the extent of blast-induced permeability. The relationship between blast-induced damage and permeability is further considered in the discussion of Criteria 1.16.4.4.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.4, 1.16.5.4 [60.133(f)]

1.16.4.4 (ES-1) The excavation methods should be compatible with repository design goals to limit permeability changes beyond 3 m from the walls of the excavation to less than one order of magnitude.

1.16.5.4 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: The construction method, excavation techniques, and drill and blast specifications (considered in the discussions of Criteria 1.16.4.1, 1.16.4.2 and 1.16.4.3) are all designed to limit the magnitude and extent of blast-induced damage around excavations. One of the main reasons for limiting blast-induced damage is to limit permeability changes in the surrounding rock mass, particularly at seal locations, and to minimize the likelihood of creating a preferential pathway for ground water to enter the repository or radionuclides to migrate to the accessible environment via the ESF.

Permeability changes in the rock mass surrounding an excavation result from stress redistribution due to the creation of a void in a stressed rock mass and damage induced by the method of excavation (e.g., drill-blast). Both processes are capable of causing new fractures to develop or old fractures to open up. The extent to which fracturing is increased depends upon the nature and strength of the rock mass, the in situ stress field, and the care taken during excavation. Increases in permeability are directly related to the degree of fracturing in the rock mass. Close to the wall of an excavation, additional fracturing due to stress relief and blasting will be at a maximum, and will decrease to zero as the radial distance from the opening increases.

Case and Kelsall (1987) have investigated the modification of rock mass permeability in the zone surrounding a shaft in fractured, welded tuff. They developed a model of permeability changes as a function of radial distance from a shaft wall. They assumed that controlled blasting creates new fractures so that the fracture frequency increases by a factor of three in the blast-damaged zone. They also assumed that the new fractures would have similar characteristics to the preexisting fractures, and that a similar relationship would hold for changes in permeability due to changes in stress. Consequently the permeability in the blast-damaged zone can be expected to increase by a factor of three over that which occurs due to stress relief.

Figure 24 of Case and Kelsall (1987), which is attached, shows the relationship between relative rock mass permeability and distance from the shaft wall, due to blasting and stress induced changes for expected conditions at 310 m depth in the Topopah Spring welded tuff. For the annulus within 0.5 m of the shaft wall the permeability of the rock mass is expected to increase by a

factor of 60 over the undisturbed value. At distances of 1 m and 3 m of the shaft wall, the factors for enhanced permeability due to stress relief (since no blast damage is anticipated) are 6.5 and 2 respectively. This latter factor of 2 at 3 m is much less than the factor of 10 quoted as a goal for this criteria (1.16.4.4).

Based on the Case and Kelsall (1987) study, it is reasonable to expect that the goal will be met for limiting permeability changes induced by shaft construction to less than one order of magnitude at points in the rock mass beyond 3 m from the shaft walls. This is adequate for Title I Design.

Testing to validate the results of Case and Kelsall (1987) is incorporated into the site characterization program. In the Excavation Effects Test (drwg FS-GA-0164) small diameter vertical holes will be drilled at selected distances from the unexcavated shaft wall. Stress changes will be measured in the near-field wall rock as the shaft is mined and lined, and air-permeability changes will be measured that result from stress distribution (and blast damage if this latter process is more extensive than currently envisioned). In the Radial Borehole Tests (drwg FS-GA-0058) near-field excavation effects on hydrologic properties will be measured from two radially drilled boreholes at each of eight shaft depths. Nitrogen injection tests in packed-off intervals will be conducted to obtain gas permeabilities at various distances from the shaft wall. The results of both these tests will be incorporated into the design of the shaft seals and used in performance assessment evaluations.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Case, J.B. and P.C. Kelsall, 1987, "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

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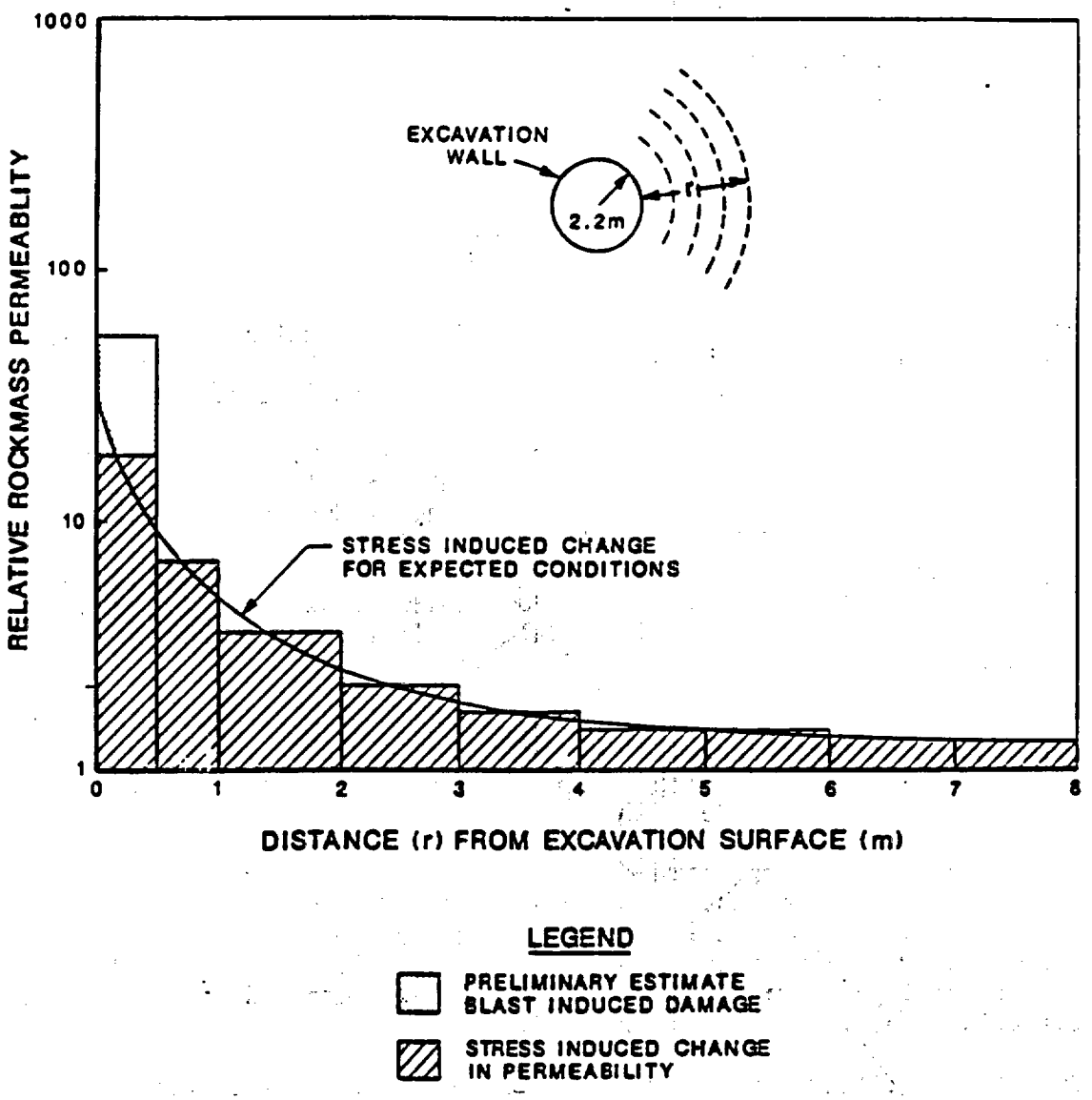

FIGURE 24. MODIFIED PERMEABILITY ZONE MODEL FOR TOPOPAH SPRING WELDED TUFF FOR EXPECTED CONDITIONS AT 310 m DEPTH

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.1, 1.16.5.1 [60.133(f)]

1.16.4.1 (ES-1) The exploratory shaft construction method should be selected, consistent with other goals of site characterization, to limit impacts on isolation.

1.16.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The two alternatives for shaft construction using available technology are shaft drilling, using a large-diameter boring machine, and conventional mining, using a drill-blast-muck sequence of excavation.

In 1982 the pros and cons of the two alternatives were carefully weighed, and a decision was made to proceed with conventional mining. The rationale for this decision is documented in an Action Memorandum to Mahlon E. Gates from Donald L. Vieth dated 9/8/82 entitled "Decision on Method for Constructing the Exploratory Shaft at Yucca Mountain"; the memorandum includes 12 attachments. This decision was supported by the Ad Hoc Technical Overview Contractor Committee, which was convened to evaluate alternative construction methods and to screen potential sites (Bertram, 1984).

The decision to use conventional shaft construction technology was one of the performance criteria included in the SDRD (e.g., p. 4-2 items 14 & 16, p. 5-2 items 16 & 17). The sinking sequence using conventional mining is shown in drawings FS-GA-0054, -0055, -0056.

With regard to the long-term waste isolation capability of the site, there is a concern for each of the two alternatives. For conventional mining (drill-blast-muck), the concern is that blasting may cause a zone of higher permeability rock to exist around the shaft, which may eventually become a preferential pathway; this concern is further addressed in the discussion of Criteria 1.16.4.2, 1.16.4.3 and 1.16.4.4.

For shaft drilling the concern is that a potential exists for losing relatively large amounts of drilling fluid, additives, and lost circulation material, and that these might alter conditions in the unsaturated zone (e.g., changes in saturation, geochemical effects) that could also allow a preferential pathway to develop.

The previous decision to construct the exploratory shafts by conventional mining (drill-blast-muck sequence) still appears to be valid. There is no recent evidence to suggest that this method poses any more of a concern to long-term waste isolation than the only other reasonable alternative, shaft drilling. In addition, there appears to be more control and less uncertainty

with conventional mining, especially when this construction method incorporates controlled drilling and blasting procedures as planned in the ESF, than with shaft drilling and its attendant problems of fluid control. Consequently it should be easier to predict performance with the conventional mining method, and to design and execute remedial measures for eventual sealing of the shafts.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCE:

Bertram, S.G., 1984 "NNWSI Exploratory Shaft Site and Construction Method Recommendation Report," SAND 84-1003, Sandia National Laboratories, Albuquerque, NM.

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.2, 1.16.5.2, 1.16.6.1 [60.133(f)]

1.16.4.2 (ES-1) Excavation techniques used for shaft and station construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

1.16.5.2 (ES-2) Same as above.

1.16.6.1 (UG-EXC) Excavation techniques used for ESF construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Controlled drilling and blasting methods will be used to excavate the shafts, stations, and underground openings. Of the four principal techniques of controlled blasting (namely cushion blasting, line drilling, presplitting, and smooth wall blasting), smooth wall blasting has been chosen as the preferred technique for the ESF because:

1. Rock damage outside the excavation perimeter can be confined to reasonable limits.

2. Conventional underground equipment can be used.

3. Reasonable round depths (6 to 12 ft) can be maintained.

4. No unusual safety hazards will be introduced.

Although smooth wall blasting generally will be used while excavating the shafts, shaft stations and drifts, line drilling will be used in initiating shaft openings or other excavations where precise opening dimensions are required.

The choice of smooth wall blasting is discussed in the ESF Title I Design Summary Report (p. 6-3) and in the SCP (p. 8.4.2-187). The technical specification for "Controlled Drilling and Blasting" (No FS-SP-0205) is included in the Title I package.

Providing the smooth wall blasting pattern is carefully designed and executed it should limit any overbreak to a few centimeters. Much depends on the characteristics of the rock encountered. In some rock types, smooth wall blasting, when successfully executed, will leave a pattern of half-hole casts around the perimeter of the opening; in these situations the amount of overbreak (i.e., excavation beyond the planned opening contour) will be a function of the accuracy of the drilling rather than a function of the

blasting. In less competent rocks, it may not be possible to achieve a pattern of half-hole casts around the perimeter of the opening; in these circumstances the amount of overbreak will be a function of the type and amounts of explosives used, loading and firing pattern, as well as on the accuracy of drilling.

In the ESF, specification FS-SP-0204 (Excavation for Stations, Drifts, and Alcoves) requires the wall and roof surfaces to be within a radial tolerance of +6 inches, -0 inches of the lines, grades and levels shown on the Contract Drawings. Specification FS-SP-0205 (Controlled Drilling and Blasting) requires the Contractor to conduct test blasting programs in various locations to accommodate changing rock conditions in which the shafts, stations, and underground drifts will be excavated. The test blasting programs are required to demonstrate, amongst other things, that overbreak be held to a maximum of 15 cm (~6 inches).

The procedures employed to control overbreak also help to limit disturbance to the adjoining rock mass. Because smooth wall blasting uses lightly-loaded charges in closely-spaced perimeter holes which are detonated after the main blast, a relatively small shock wave is created in the radial direction of the surrounding rock mass. Case and Kelsall (1987, p. 56) estimated that the use of controlled blasting in welded tuff causes rock damage, expressed as an increase in fracture frequency, to be contained within 0.5 m of the wall of the excavation. In their upper bound case (using lower bound rock strength and upper bound in situ stresses), rock damage is estimated to be contained within 1 m of the excavation wall. This is consistent with other case histories of blast damage measured in tunnels (see the attached Table 3 from Case and Kelsall, 1987).

A vibration monitoring program, using a calibrated seismograph system, will provide data on peak particle velocities and the frequency of vibration at a minimum of two locations for each blast. The present intent is to limit peak particle velocities to 5 in/sec in the shafts and 10 in/sec in the drifts. The seismograph records will provide one of the permanent records of each test blast. If deemed appropriate the vibration monitoring program could be extended to more blasts, or even to all blasts, to help ensure that the intent of this criterion is met.

The conclusion is that the procedures and the controlled blasting techniques planned for the construction of the shafts, stations, and underground drifts will control overbreak and limit disturbance to the surrounding rock mass, and that these will limit the potential for creating preferential pathways for ground water.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Case, J.B. and P.C. Kelsall, 1987. "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

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TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Colorado School of Mines (Edgar Mine) Colorado	Biotite gneiss	Smoothwall	5m x 3m	0.5m	Borehole logging, cross-hole permeability (packer tests), borehole deformation	Depth of blast damage not well documented but in agreement with theoretical calculations	Montazer and Hustrulid, 1983
Stripa Mine Sweden	Granite	Smoothwall	4m x 4m	0.3m	Boreholes	Fracture lengths ranged from 0.1-1.0m, with an average length of 0.3m; permeability of blast damaged zone not measured	Anderson and Halen, 1978
Rainier Mesa Nevada Test Site	Zeolitized tuff	Conventional	3m	<1.7m (?)	Air permeability	Blast damage not well distinguished from stress effects	Miller et al., 1974
Rolla Experimental Mine	Dolomite	Various	2.5 x 2.2m	0.3-2.5m	Seismic refraction	Depth of damage varies according to method of blasting used; blast damage not distinguished from stress relief	Worsey, 1985
Test Drift	Basalt	Conventional	5m	~2m	Cross-hole seismic	Blast damage seen most clearly in vertical travel direction in drift wall, effects of stress relief seen in horizontal direction	King et al., 1984

TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS (Continued)

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Ontario, Canada	Limestone	Presplit	~8m	~1m	TV camera in bore-holes in crown	Separate zones of moderate cracking and hairline cracks; depth of damage varies with charge weight	Lukajic, 1982
Saimogo, Japan	Sandstone/ shale	Conventional	5.1m	up to 1.3m	Seismic refraction	Comparison of blasting with excavation by TBM; difficult to separate blast damage from stress relief	Nishida et al., 1982
Crestmore Mine	Marble	Conventional	30-70ft	4-5ft	Seismic refraction, borehole jack, borehole logging	The borehole jacking method was used to determine the rock mass deformation modulus	Heuze and Goodman, 1974
Churchill Falls, Canada	Gneiss	Controlled perimeter	2.1 x 2.4m	<1m	Plate load test	Most damage within 0.3m	Benson et al., 1970
Straight Creek, Colorado	Granite/ gneiss/ schist	Conventional	4m	"few ft"	Seismic refraction	Blast damage depth estimated within overall low velocity layer extending 1-5m	Scott et al., 1968
Belledonne, France	Granite	Conventional	5.9m	~1m	Seismic refraction	Blasting and stress relief effects not specifically distinguished	Plichon, 1980

TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS (Continued)

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Mine	Shale	Conventional	?	0.5-1m	Seismic refraction	Blasting and stress relief effects not specifically distinguished	Brizzolari 1981
Rama Tunnel, Yugoslavia	Dolomite	Conventional	5m	<1m	Cross-hole seismic	Blasting and stress relief effects not specifically distinguished	Kujundic, et al., 1970
Turlough Hill, Ireland	Granite	Conventional	2.5m	0.5-2.5m	Cross-hole seismic	Blasting and stress relief effects not specifically distinguished	O'Donoghue and O'Flaherty, 1974

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.3, 1.16.5.3, 1.16.6.2 [60.133(f)]

1.16.4.3 (ES-1) Drill and blast specifications should include controls related to types and amounts of explosives, shot patterns, and hole depth in order to limit the magnitude and extent of blast-induced permeability.

1.16.5.3 (ES-2) Same as above.

1.16.6.2 (UG-EXC) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: As discussed in Criteria 1.16.4.1 and 1.16.4.2 the ESF excavations will be constructed using controlled drilling and blasting methods, in particular smooth wall blasting.

Title I Design includes a specification entitled "Controlled Drilling and Blasting"(No FS-SP-0205), which covers drilling and blasting operations for rock excavation in vertical shafts, shaft stations and drifts.

With regard to controls relating to the types and amounts of explosives, FS-SP-0205 prohibits the use of free running explosives in the shaft. It requires production holes to be charged with water gel explosive or emulsion with equivalent blasting strength, and requires perimeter holes to be string loaded with small-diameter cartridges of a low density water gel explosive or emulsion with equivalent blasting strength. The specification also applies controls to the types of detonators and stemming material which may be used, and the procedures to be used for drilling, hole charging, stemming, and timing each round.

The maximum depth of drillholes is specified in FS-SP-0205 as being 10 feet in the shaft and 12 feet in drifts. These depths will be reduced if the Contractor fails to break 85% of the drilled depth in 8 out of 10 blast rounds in the test blasting program that will be carried out in appropriate locations of the ESF.

Initial drill patterns to be employed in the ESF shafts and drifts will be included in the Contract Drawings (this level of detail is beyond the scope of Title I). The maximum diameter of drillholes is specified as 1-7/8 inches in FS-SP-0205. Maximum allowable drillhole deviation is 1/2 inch per foot, and drillholes will be inspected for alignment by Mining Inspectors prior to charging.

The Contractor is also required by FS-SP-0205 to submit a Drilling and Blasting Plan to the Contracting Officer for approval. This plan will contain, amongst other things, the following information with regard to the shot pattern: drillhole pattern, hole depth and diameter; types of explosives, size of cartridges, powder factor; hole loading configurations; delay type, arrangement and timing; decking and stemming arrangements; and details of the blasting circuit. In addition, a plan for each individual blast will be submitted to the Contracting Officer at least 4 hours prior to each blast. These plans will include details of the drilling and charging pattern, time delays, firing sequence, and planned time of blast. If changing rock conditions during drilling dictate a change in the individual shot blasting plan, such changes must be approved by the Contracting Officer before operations are allowed to proceed. In addition, a vibration monitoring program will be implemented.

In conclusion, the drill and blast specifications included in FS-SP-0204 and FS-SP-0205 provide sufficient controls for Title I design relating to explosives, hole depths and shot patterns to limit blast-induced damage. Controls on blast-induced damage directly limit the extent of blast-induced permeability. The relationship between blast-induced damage and permeability is further considered in the discussion of Criteria 1.16.4.4.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.4, 1.16.5.4 [60.133(f)]

1.16.4.4 (ES-1) The excavation methods should be compatible with repository design goals to limit permeability changes beyond 3 m from the walls of the excavation to less than one order of magnitude.

1.16.5.4 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The construction method, excavation techniques, and drill and blast specifications (considered in the discussions of Criteria 1.16.4.1, 1.16.4.2 and 1.16.4.3) are all designed to limit the magnitude and extent of blast-induced damage around excavations. One of the main reasons for limiting blast-induced damage is to limit permeability changes in the surrounding rock mass, particularly at seal locations, and to minimize the likelihood of creating a preferential pathway for ground water to enter the repository or radionuclides to migrate to the accessible environment via the ESF.

Permeability changes in the rock mass surrounding an excavation result from stress redistribution due to the creation of a void in a stressed rock mass and damage induced by the method of excavation (e.g., drill-blast). Both processes are capable of causing new fractures to develop or old fractures to open up. The extent to which fracturing is increased depends upon the nature and strength of the rock mass, the in situ stress field, and the care taken during excavation. Increases in permeability are directly related to the degree of fracturing in the rock mass. Close to the wall of an excavation, additional fracturing due to stress relief and blasting will be at a maximum, and will decrease to zero as the radial distance from the opening increases.

Case and Kelsall (1987) have investigated the modification of rock mass permeability in the zone surrounding a shaft in fractured, welded tuff. They developed a model of permeability changes as a function of radial distance from a shaft wall. They assumed that controlled blasting creates new fractures so that the fracture frequency increases by a factor of three in the blast-damaged zone. They also assumed that the new fractures would have similar characteristics to the preexisting fractures, and that a similar relationship would hold for changes in permeability due to changes in stress. Consequently the permeability in the blast-damaged zone can be expected to increase by a factor of three over that which occurs due to stress relief.

Figure 24 of Case and Kelsall (1987), which is attached, shows the relationship between relative rock mass permeability and distance from the shaft wall, due to blasting and stress induced changes for expected conditions at 310 m depth in the Topopah Spring welded tuff. For the annulus within 0.5 m of the shaft wall the permeability of the rock mass is expected to increase by a

factor of 60 over the undisturbed value. At distances of 1 m and 3 m of the shaft wall, the factors for enhanced permeability due to stress relief (since no blast damage is anticipated) are 6.5 and 2 respectively. This latter factor of 2 at 3 m is much less than the factor of 10 quoted as a goal for this criteria (1.16.4.4).

Based on the Case and Kelsall (1987) study, it is reasonable to expect that the goal will be met for limiting permeability changes induced by shaft construction to less than one order of magnitude at points in the rock mass beyond 3 m from the shaft walls. This is adequate for Title I Design.

Testing to validate the results of Case and Kelsall (1987) is incorporated into the site characterization program. In the Excavation Effects Test (drwg FS-GA-0164) small diameter vertical holes will be drilled at selected distances from the unexcavated shaft wall. Stress changes will be measured in the near-field wall rock as the shaft is mined and lined, and air-permeability changes will be measured that result from stress distribution (and blast damage if this latter process is more extensive than currently envisioned). In the Radial Borehole Tests (drwg FS-GA-0058) near-field excavation effects on hydrologic properties will be measured from two radially drilled boreholes at each of eight shaft depths. Nitrogen injection tests in packed-off intervals will be conducted to obtain gas permeabilities at various distances from the shaft wall. The results of both these tests will be incorporated into the design of the shaft seals and used in performance assessment evaluations.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Case, J.B. and P.C. Kelsall, 1987, "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

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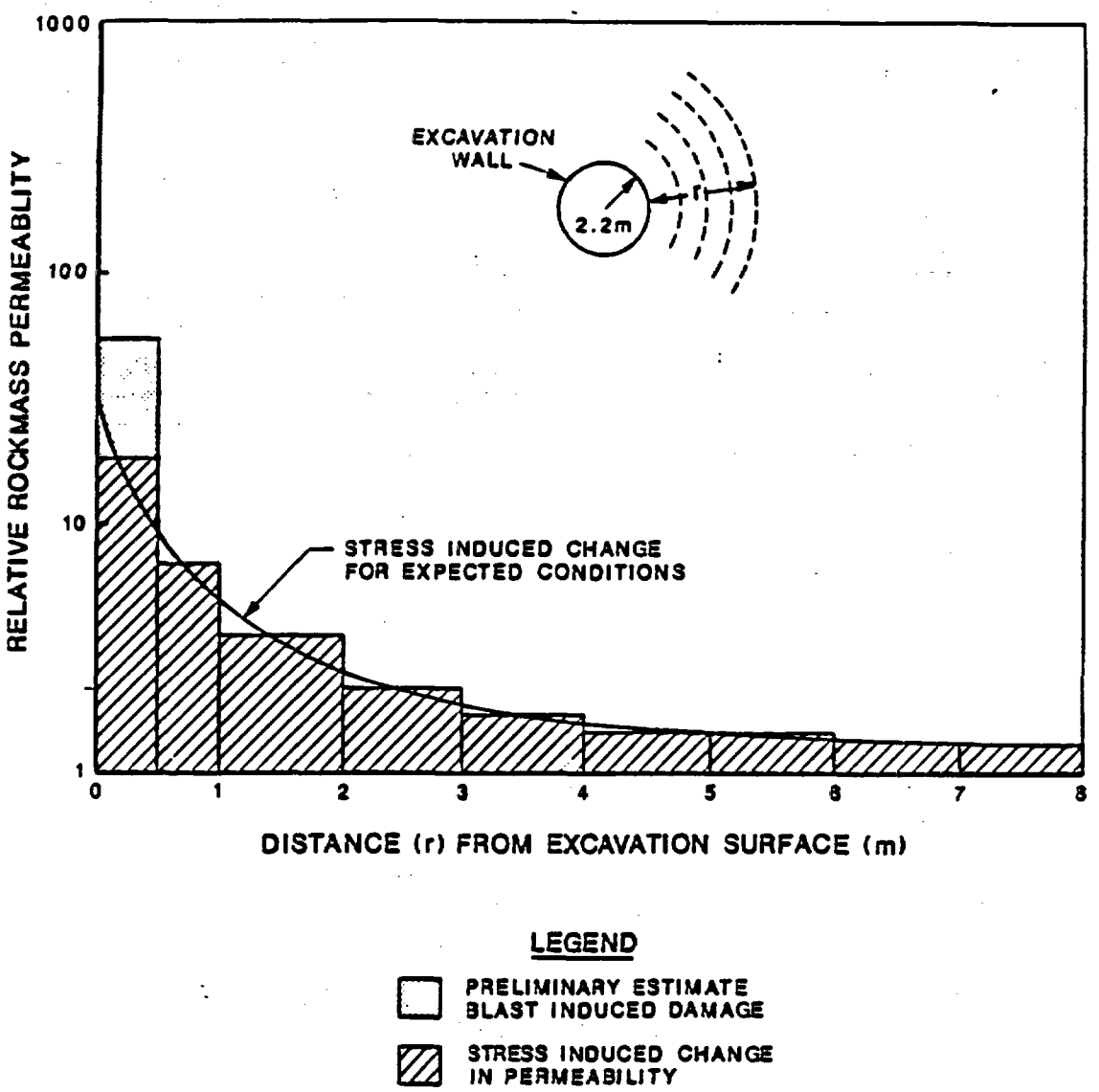

FIGURE 24. MODIFIED PERMEABILITY ZONE MODEL FOR TOPOPAH SPRING WELDED TUFF FOR EXPECTED CONDITIONS AT 310 m DEPTH

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.2, 1.16.5.2, 1.16.6.1 [60.133(f)]

1.16.4.2 (ES-1) Excavation techniques used for shaft and station construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

1.16.5.2 (ES-2) Same as above.

1.16.6.1 (UG-EXC) Excavation techniques used for ESF construction shall control overbreak of rock and limit disturbance to the integrity of the adjoining rock mass.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Controlled drilling and blasting methods will be used to excavate the shafts, stations, and underground openings. Of the four principal techniques of controlled blasting (namely cushion blasting, line drilling, presplitting, and smooth wall blasting), smooth wall blasting has been chosen as the preferred technique for the ESF because:

1. Rock damage outside the excavation perimeter can be confined to reasonable limits.

2. Conventional underground equipment can be used.

3. Reasonable round depths (6 to 12 ft) can be maintained.

4. No unusual safety hazards will be introduced.

Although smooth wall blasting generally will be used while excavating the shafts, shaft stations and drifts, line drilling will be used in initiating shaft openings or other excavations where precise opening dimensions are required.

The choice of smooth wall blasting is discussed in the ESF Title I Design Summary Report (p. 6-3) and in the SCP (p. 8.4.2-187). The technical specification for "Controlled Drilling and Blasting" (No FS-SP-0205) is included in the Title I package.

Providing the smooth wall blasting pattern is carefully designed and executed it should limit any overbreak to a few centimeters. Much depends on the characteristics of the rock encountered. In some rock types, smooth wall blasting, when successfully executed, will leave a pattern of half-hole casts around the perimeter of the opening; in these situations the amount of overbreak (i.e., excavation beyond the planned opening contour) will be a function of the accuracy of the drilling rather than a function of the

blasting. In less competent rocks, it may not be possible to achieve a pattern of half-hole casts around the perimeter of the opening; in these circumstances the amount of overbreak will be a function of the type and amounts of explosives used, loading and firing pattern, as well as on the accuracy of drilling.

In the ESF, specification FS-SP-0204 (Excavation for Stations, Drifts, and Alcoves) requires the wall and roof surfaces to be within a radial tolerance of +6 inches, -0 inches of the lines, grades and levels shown on the Contract Drawings. Specification FS-SP-0205 (Controlled Drilling and Blasting) requires the Contractor to conduct test blasting programs in various locations to accommodate changing rock conditions in which the shafts, stations, and underground drifts will be excavated. The test blasting programs are required to demonstrate, amongst other things, that overbreak be held to a maximum of 15 cm (~6 inches).

The procedures employed to control overbreak also help to limit disturbance to the adjoining rock mass. Because smooth wall blasting uses lightly-loaded charges in closely-spaced perimeter holes which are detonated after the main blast, a relatively small shock wave is created in the radial direction of the surrounding rock mass. Case and Kelsall (1987, p. 56) estimated that the use of controlled blasting in welded tuff causes rock damage, expressed as an increase in fracture frequency, to be contained within 0.5 m of the wall of the excavation. In their upper bound case (using lower bound rock strength and upper bound in situ stresses), rock damage is estimated to be contained within 1 m of the excavation wall. This is consistent with other case histories of blast damage measured in tunnels (see the attached Table 3 from Case and Kelsall, 1987).

A vibration monitoring program, using a calibrated seismograph system, will provide data on peak particle velocities and the frequency of vibration at a minimum of two locations for each blast. The present intent is to limit peak particle velocities to 5 in/sec in the shafts and 10 in/sec in the drifts. The seismograph records will provide one of the permanent records of each test blast. If deemed appropriate the vibration monitoring program could be extended to more blasts, or even to all blasts, to help ensure that the intent of this criterion is met.

The conclusion is that the procedures and the controlled blasting techniques planned for the construction of the shafts, stations, and underground drifts will control overbreak and limit disturbance to the surrounding rock mass, and that these will limit the potential for creating preferential pathways for ground water.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Case, J.B. and P.C. Kelsall, 1987. "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

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TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Colorado School of Mines (Edgar Mine) Colorado	Biotite gneiss	Smoothwall	5m x 3m	0.5m	Borehole logging, cross-hole permeability (packer tests), borehole deformation	Depth of blast damage not well documented but in agreement with theoretical calculations	Montazer and Hustrulid, 1983
Stripa Mine Sweden	Granite	Smoothwall	4m x 4m	0.3m	Boreholes	Fracture lengths ranged from 0.1-1.0m, with an average length of 0.3m; permeability of blast damaged zone not measured	Anderson and Halen, 1978
Rainier Mesa Nevada Test Site	Zeolitized tuff	Conventional	3m	<1.7m (?)	Air permeability	Blast damage not well distinguished from stress effects	Miller et al., 1974
Rolla Experimental Mine	Dolomite	Various	2.5 x 2.2m	0.3-2.5m	Seismic refraction	Depth of damage varies according to method of blasting used; blast damage not distinguished from stress relief	Worsey, 1985
Test Drift	Basalt	Conventional	5m	~2m	Cross-hole seismic	Blast damage seen most clearly in vertical travel direction in drift wall, effects of stress relief seen in horizontal direction	King et al., 1984

TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS (Continued)

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Ontario, Canada	Limestone	Presplit	~8m	~1m	TV camera in bore-holes in crown	Separate zones of moderate cracking and hairline cracks; depth of damage varies with charge weight	Lukajic, 1982
Saimogo, Japan	Sandstone/ shale	Conventional	5.1m	up to 1.3m	Seismic refraction	Comparison of blasting with excavation by TBM; difficult to separate blast damage from stress relief	Nishida et al., 1982
Crestmore Mine	Marble	Conventional	30-70ft	4-5ft	Seismic refraction, borehole jack, borehole logging	The borehole jacking method was used to determine the rock mass deformation modulus	Heuze and Goodman, 1974
Churchill Falls, Canada	Gneiss	Controlled perimeter	2.1 x 2.4m	<1m	Plate load test	Most damage within 0.3m	Benson et al., 1970
Straight Creek, Colorado	Granite/ gneiss/ schist	Conventional	4m	"few ft"	Seismic refraction	Blast damage depth estimated within overall low velocity layer extending 1-5m	Scott et al., 1968
Belledonne, France	Granite	Conventional	5.9m	~1m	Seismic refraction	Blasting and stress relief effects not specifically distinguished	Plichon, 1980

TABLE 3

CASE HISTORIES OF BLAST DAMAGE MEASURED IN TUNNELS (Continued)

SITE	ROCK TYPE	BLASTING METHOD	TUNNEL DIMENSIONS	DEPTH OF DAMAGE	MEASUREMENT METHOD	COMMENTS	REFERENCES
Mine	Shale	Conventional	?	0.5-1m	Seismic refraction	Blasting and stress relief effects not specifically distinguished	Brizzolari 1981
Rama Tunnel, Yugoslavia	Dolomite	Conventional	5m	<1m	Cross-hole seismic	Blasting and stress relief effects not specifically distinguished	Kujundic, et al., 1970
Turlough Hill, Ireland	Granite	Conventional	2.5m	0.5-2.5m	Cross-hole seismic	Blasting and stress relief effects not specifically distinguished	O'Donoghue and O'Flaherty, 1974

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.16.4.3, 1.16.5.3, 1.16.6.2 [60.133(f)]

1.16.4.3 (ES-1) Drill and blast specifications should include controls related to types and amounts of explosives, shot patterns, and hole depth in order to limit the magnitude and extent of blast-induced permeability.

1.16.5.3 (ES-2) Same as above.

1.16.6.2 (UG-EXC) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: As discussed in Criteria 1.16.4.1 and 1.16.4.2 the ESF excavations will be constructed using controlled drilling and blasting methods, in particular smooth wall blasting.

Title I Design includes a specification entitled "Controlled Drilling and Blasting"(No FS-SP-0205), which covers drilling and blasting operations for rock excavation in vertical shafts, shaft stations and drifts.

With regard to controls relating to the types and amounts of explosives, FS-SP-0205 prohibits the use of free running explosives in the shaft. It requires production holes to be charged with water gel explosive or emulsion with equivalent blasting strength, and requires perimeter holes to be string loaded with small-diameter cartridges of a low density water gel explosive or emulsion with equivalent blasting strength. The specification also applies controls to the types of detonators and stemming material which may be used, and the procedures to be used for drilling, hole charging, stemming, and timing each round.

The maximum depth of drillholes is specified in FS-SP-0205 as being 10 feet in the shaft and 12 feet in drifts. These depths will be reduced if the Contractor fails to break 85% of the drilled depth in 8 out of 10 blast rounds in the test blasting program that will be carried out in appropriate locations of the ESF.

Initial drill patterns to be employed in the ESF shafts and drifts will be included in the Contract Drawings (this level of detail is beyond the scope of Title I). The maximum diameter of drillholes is specified as 1-7/8 inches in FS-SP-0205. Maximum allowable drillhole deviation is 1/2 inch per foot, and drillholes will be inspected for alignment by Mining Inspectors prior to charging.

The Contractor is also required by FS-SP-0205 to submit a Drilling and Blasting Plan to the Contracting Officer for approval. This plan will contain, amongst other things, the following information with regard to the shot pattern: drillhole pattern, hole depth and diameter; types of explosives, size of cartridges, powder factor; hole loading configurations; delay type, arrangement and timing; decking and stemming arrangements; and details of the blasting circuit. In addition, a plan for each individual blast will be submitted to the Contracting Officer at least 4 hours prior to each blast. These plans will include details of the drilling and charging pattern, time delays, firing sequence, and planned time of blast. If changing rock conditions during drilling dictate a change in the individual shot blasting plan, such changes must be approved by the Contracting Officer before operations are allowed to proceed. In addition, a vibration monitoring program will be implemented.

In conclusion, the drill and blast specifications included in FS-SP-0204 and FS-SP-0205 provide sufficient controls for Title I design relating to explosives, hole depths and shot patterns to limit blast-induced damage. Controls on blast-induced damage directly limit the extent of blast-induced permeability. The relationship between blast-induced damage and permeability is further considered in the discussion of Criteria 1.16.4.4.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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D. M. Ross-Brown	D M Ross-Brown	1/31/89

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.17.4.1 [60.133(h)]

1.17.4.1 (ES-1) Engineered barriers in the shafts shall assist the geologic setting in limiting the release of radionuclides to the accessible environment.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The engineered barriers in the shafts will assist the geologic setting in limiting the release of radionuclides to the accessible environment. The exact sealing designs have not been developed at this time. The shafts will be sealed to limit the potential for them to serve as preferential pathways for flooding, increased percolation, transport of radionuclides, or gas-phase transport (see page 8.4.3-35 of the SCP). The seals will be designed to impede flow in the backfill, tending to restrict flow to the rock mass where it involves the rock matrix. The slow travel times in the matrix will contribute to waste isolation. Since the facility is designed to drain into ES-1 it is unlikely that the backfilled shafts will adversely affect waste isolation.

ADEQUACY OF TREATMENT: The design of shaft plugs and seals is not provided in the Title I Design, which is appropriate because additional site-specific information from characterization activities is needed. The Title I ESF Design addresses shaft plugging and sealing through the requirements for: (1) controlled blasting to minimize damage to the rock mass, (2) liner removability, and (3) limiting the use of water in the shafts for construction, testing, and operations. This is adequate for preliminary design, and is probably adequate for detailed design also because it represents the extent of practicable measures. Note that assessments with respect to other criteria discuss review of procedures for the following activities, with respect to waste isolation: (1) controlling testing; (2) controlling water use in construction, testing, and operations; and (3) controlling water inflow.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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Keith M. Kersch	Keith M Kersch	Feb 3, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.17.5.1 [60.133(h)]

1.17.5.1 (ES-2) Engineered barriers in the shafts shall assist the geologic setting in limiting the release of radionuclides to the accessible environment.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: The engineered barriers in the shafts will assist the geologic setting in limiting the release of radionuclides to the accessible environment. The exact sealing designs have not been developed at this time. The shafts will be sealed to limit the potential for them to serve as preferential pathways for flooding, increased percolation, transport of radionuclides, or gas-phase transport (see page 8.4.3-35 of the SCP). The seals will be designed to impede flow in the backfill, tending to restrict flow to the rock mass where it involves the rock matrix. The slow travel times in the matrix will contribute to waste isolation. Since the facility is designed to drain into ES-1 it is unlikely that the backfilled shafts will adversely affect waste isolation.

ADEQUACY OF TREATMENT: The design of shaft plugs and seals is not provided in the Title I Design, which is appropriate because additional site-specific information from characterization activities is needed. The Title I ESF Design addresses shaft plugging and sealing through the requirements for: (1) controlled blasting to minimize damage to the rock mass, (2) liner removability, and (3) limiting the use of water in the shafts for construction, testing, and operations. This is adequate for preliminary design, and is probably adequate for detailed design also because it represents the extent of practicable measures. Note that assessments with respect to other criteria discuss review of procedures for the following activities, with respect to waste isolation: (1) controlling testing; (2) controlling water use in construction, testing, and operations; and (3) controlling water inflow.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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Keith M. Kersch	Keith M Kersch	Feb 3, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.17.6.1 [60.133(h)]

1.17.6.1 (UG EXC) The engineered barriers in the underground excavation must be designed such that other systems, structures, and components of the ESF and the candidate repository do not eventually become ground-water flow paths and do not promote the release of radionuclides to the accessible environment.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The engineered barriers in the underground excavation are designed such that other systems and components of the ESF and the candidate repository will not become ground-water flow paths and will not promote the release of radionuclides to the accessible environment. The ESF is designed to drain water used in construction and testing toward ES-1 which inhibits water moving from the ESF into waste emplacement panels (see page 8.4.3-34 of the SCP. Similarly water from the waste emplacement areas will not drain into the ESF or test areas. The waste package will be surrounded by an air gap which will inhibit water from contacting and corroding the waste container (see page 8.4.3-35 of the SCP).

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.17.6.2 [60.133(h)]

1.17.6.2 The engineered barriers in the underground excavation shall not preclude the repository from creating a waste package environment that favorably controls chemical reactions affecting waste package performance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The engineered barriers in the underground excavation will preclude the repository form creating a waste package environment that favorably controls chemical reactions affecting waste package performance. The waste package will be surrounded by an air gap which will inhibit water from contacting and corroding the waste container (see page 8.4.3-35 of the SCP). Controlled blasting will be used throughout in the construction of the repository which will limit the permeability changes in surrounding rock to me consistent with shaft sealing and performance allocation; reduce uncertainties in predicting seal performance; and reduce limitations in emplacing sealing components.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

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Keith M. Kersch	Keith M Kersch	1/27/89

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.4.9.1 [60.21(c)(11)]; 1.17.9.1 [60.133(h)]

1.4.9.1 (DECOM) The first shaft, second shaft, all underground excavations, and all boreholes shall be constructed to allow backfilling and sealing as necessary to limit the release of radioactive material to the environment.

1.17.9.1 (DECOM) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES ____ NO ____ DON'T KNOW

RATIONALE: Numerous features provided in and criteria met by the ESF Title I design give adequate evidence that the shafts, underground excavations, and ESF-related exploratory boreholes are designed to be constructed to allow adequate backfilling and sealing. Examples of this assurance are provided by the criteria related to maintaining usable openings for 100 years (1/60.15(d)(3)/4/1 & 5/1), provisions for liner removal, removable fixtures in the shafts, and removable non-permanent items (1/60.21(c)(11)/4/1, 5/1, 4/3, 5/3, and 6/2), lateral separation between drifts and shafts to preclude mechanical interference, drainage considerations, and location of the entrances to the shafts above the elevations of flow from the probable maximum floods.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.4.1, 1.18.5.1 [60.133(i)]

1.18.4.1 (ES-1) The shaft liner shall withstand pressures exerted along its length and around the entire perimeter under anticipated conditions, including reaction to thermally induced stresses resulting from thermal loads.

1.18.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES _____ NO __X__ DON'T KNOW

RATIONALE: An assessment of whether the ESF Title I design addresses the criterion that the shaft liner be able to withstand pressures under anticipated conditions could not be made based on the documentation available. Several analyses have been performed that provide information concerning the ES liner design but do not specifically address the need to consider thermal loads as specified in this criterion.

ADEQUACY OF TREATMENT: St. John (1987) analyzed repository access shafts which have a larger shaft diameter (6.5 m vs 4.3 m) than the ESF shafts and a thicker concrete liner (0.5 m vs 0.3 m). The elastic analyses considered two shaft locations; one located in the center of the repository within a 200 m pillar and the other, 100 m from the edge of the repository. Thermal loading conditions up to 100 years were modeled. In both cases, no failure was predicted for the rock surrounding the shafts. Tensile stresses of approximately 4.5 MPa were predicted in the liner which may create horizontal tensile cracks in the nonreinforced concrete. St. John concluded that it is unlikely the cracks would affect the stability of the liner.

Appendix B.2 in Volume 4B of the ESF Title I Design Summary Report contains a three-dimensional thermomechanical analysis to evaluate the temperatures and stresses in the ESF over a 10,000 year time span. The stresses and strains calculated are due only to thermal loads; excavation induced stresses were not considered. Unfortunately, the stress data was not post processed to determine the expected stresses in the liner.

Finally, Appendix B.3 contains the results of a sensitivity study that provides estimates of the expected values and variations of temperature, stress, and strain in the vicinity of ES-1 during the first 100 years of repository operation. Ranges of the independent variables were expressed as a percent variation of the mean value. The associated temperatures, stresses and strains in the ES-1 liner were not computed in the study. This could be accomplished by post processing the data similar to the St. John (1987) analyses.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The majority of the analytical effort has been completed and is summarized in Appendices B.2 and B.3. The remaining calculations to evaluate the repository thermal loads on the ES liners should be relatively straight forward. These analyses should be included in the Title II Design, prior to construction of the exploratory shafts.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.4.1, 1.18.5.1 [60.133(i)]

1.18.4.1 (ES-1) The shaft liner shall withstand pressures exerted along its length and around the entire perimeter under anticipated conditions, including reaction to thermally induced stresses resulting from thermal loads.

1.18.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES _____ NO __X__ DON'T KNOW

RATIONALE: An assessment of whether the ESF Title I design addresses the criterion that the shaft liner be able to withstand pressures under anticipated conditions could not be made based on the documentation available. Several analyses have been performed that provide information concerning the ES liner design but do not specifically address the need to consider thermal loads as specified in this criterion.

ADEQUACY OF TREATMENT: St. John (1987) analyzed repository access shafts which have a larger shaft diameter (6.5 m vs 4.3 m) than the ESF shafts and a thicker concrete liner (0.5 m vs 0.3 m). The elastic analyses considered two shaft locations; one located in the center of the repository within a 200 m pillar and the other, 100 m from the edge of the repository. Thermal loading conditions up to 100 years were modeled. In both cases, no failure was predicted for the rock surrounding the shafts. Tensile stresses of approximately 4.5 MPa were predicted in the liner which may create horizontal tensile cracks in the nonreinforced concrete. St. John concluded that it is unlikely the cracks would affect the stability of the liner.

Appendix B.2 in Volume 4B of the ESF Title I Design Summary Report contains a three-dimensional thermomechanical analysis to evaluate the temperatures and stresses in the ESF over a 10,000 year time span. The stresses and strains calculated are due only to thermal loads; excavation induced stresses were not considered. Unfortunately, the stress data was not post processed to determine the expected stresses in the liner.

Finally, Appendix B.3 contains the results of a sensitivity study that provides estimates of the expected values and variations of temperature, stress, and strain in the vicinity of ES-1 during the first 100 years of repository operation. Ranges of the independent variables were expressed as a percent variation of the mean value. The associated temperatures, stresses and strains in the ES-1 liner were not computed in the study. This could be accomplished by post processing the data similar to the St. John (1987) analyses.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The majority of the analytical effort has been completed and is summarized in Appendices B.2 and B.3. The remaining calculations to evaluate the repository thermal loads on the ES liners should be relatively straight forward. These analyses should be included in the Title II Design, prior to construction of the exploratory shafts.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.6.1 [60.133(i)]

1.18.6.1 (UG EXC) The ESF shall be designed, taking into account the predicted thermal and thermomechanical response of the host rock and surrounding strata so that the performance objectives of the repository can be met.

HAS THE CRITERIA BEEN ADDRESSED ON THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The conclusion that the criterion has been addressed in the design is based on several analyses referenced in the ESF Title I Design Summary Report (Table 2-1, Appendix A, Vol. 4B). The analyses consider the behavior of a number of repository openings including repository emplacement and access drifts. The types of loads considered include stress redistribution around openings and the thermomechanical loads from heat generated by the emplaced waste. In several of the analyses, the resulting stress conditions were analyzed to determine the extent of the rock damage around the openings. While none of the analyses considered the specific conditions for the ESF openings (i.e., distance from waste panel, layout configuration, etc.) they are considered conservative approximations of the thermomechanical conditions around the ESF openings and, therefore, bounding calculations of the ESF opening impact on performance.

ADEQUACY OF TREATMENT: The supporting analyses are considered adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: A three-dimensional thermomechanical analysis of the ESF should be performed for Title II Design. The analysis should cover time-steps up to 10,000 years after waste emplacement. One objective of the analysis should be to evaluate the extent and nature of changes in the hydrologic conditions around the ESF resulting from the thermal and thermomechanical effects of the repository.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.6.2, 1.18.8.1 [60.133(i)]

1.18.6.2 (UG EXC) The ESF shall be designed such that the thermal and thermomechanical effects of ESF operations and testing do not produce failure of intact rock, nor gross rock mass failure, along potential pathways from the repository to the accessible environment.

1.18.8.1 (UG TEST) The ESF shall be designed such that the thermal and thermomechanical effects of ESF testing do not produce failure of intact rock, nor gross rock mass failure, along potential pathways from the repository to the accessible environment.

HAS THE CRITERIA BEEN ADDRESSED ON THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The conclusion that the criterion has been addressed in the design is based on a number of analyses referenced in the ESF Title I Design Summary Report (Table 2-1, Appendix A, Vol. 4B) and Section 8.4 of the SCP. The analyses referenced in the Design Summary consider the behavior of various repository openings including repository emplacement and access drifts. The types of loads considered include stress redistribution around openings and the thermomechanical loads from heat generated by emplaced waste. In several of the analyses, the resulting stress conditions are analyzed to determine the extent of the rock damage around the openings. While the applied thermomechanical loads considered in these analyses differ considerably from those expected from the ESF tests, the results can be considered conservative approximations or bounding estimates of the impact the ESF has on performance.

Bauer et al. (1988) performed thermomechanical analyses of the heated room test, the canister scale heater test, and the thermal stress test. The results of the analyses have been used to estimate the zones of influence of the test. The analyses indicate that the thermal and thermomechanical effects of the tests are expected to be relatively localized (i.e., within a few opening diameters of the experiments. Since massive fracturing of the regions near heaters were not predicted and the effects of the experiments were relatively localized, it can be concluded that the ESF has been designed such that the effects of ESF testing would not produce significant amounts of failure of the intact rock nor gross rock mass failure along potential pathways to the accessible environment.

ADEQUACY OF TREATMENT: The supporting analyses are considered adequate to indicate that the Title I design meets the criteria.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.6.3, 1.18.8.2 [60.133(i)]

1.18.6.3 (UG EXC) The ESF shall be designed so that the thermal and thermomechanical effects of ESF operations and testing on the groundwater system, do not significantly increase the saturation of the host rock in the waste emplacement area.

1.18.8.2 (UG TEST) The ESF shall be designed so that the thermal and thermomechanical effects of ESF testing on the groundwater system, do not significantly increase the saturation of the host rock in the waste emplacement area.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: The conclusion that the design addresses the criterion that the ESF tests should not significantly increase the saturation of the host rock in the emplacement area is based on analyses discussed in Section 8.4 of the SCP. The possibility that thermomechanical disturbances from the testing activities may affect site performance due to redistribution of the moisture is discussed in Section 8.4.3.2.5.5. Bauer et al., 1988 performed analyses of the canister scale heater experiment, the heated room experiment and the thermal stress test. The zone of thermally disturbed rock, defined as the extent of rock having temperatures greater than 5 degrees C above ambient, is assumed to represent the extent of possible hydrologic alteration. This zone is confined to within 30 m of the planned tests. Furthermore, the presence of the repository access drifts adjacent to the ESF is expected to retard the thermal disturbance.

The extent of the thermomechanical influence from the tests is generally localized (i.e., limited to within about a couple of opening diameters from the tests) and the design is intended to provide standoff from waste emplacement areas. Hence because the effects are laterally separated from waste emplacement areas, it is unlikely that the saturation in waste emplacement areas could be modified by ESF-related thermal and thermomechanical effects.

ADEQUACY OF TREATMENT: The analyses performed to support Title I Design are considered adequate.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.6.4 [60.133(i)]

1.18.6.4 (UG EXC) The underground excavation support system shall be designed to withstand pressures under anticipated conditions, including reaction to thermally induced stresses resulting from thermal loads.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: The adequacy of the support system in the ESF to withstand the anticipated conditions is based on the thermomechanical analyses referenced in Appendix A of the ESF Title I Design Summary Report (Vol. 4B). Several of the analyses evaluate the stability of a variety of repository drifts (e.g., emplacement, access, etc.) under in situ and thermal loads expected during repository operation. The results of the analyses indicate that the extent of the disturbed zone around the drifts is limited to a few drift diameters around the opening (depending on the orientation of the joint sets). The models used in these analyses, with the exception of St. John (1987), did not include support systems. It follows that, if the designed openings in the conceptual repository met the performance objectives without the benefit of a support system, then the ESF openings, subjected to comparable loads, would behave similarly and it's support system is capable of withstanding the anticipated conditions.

ADEQUACY OF TREATMENT: The ground support system design for the ESF is based on rock mass classification systems (Section 6.5.2.4) which were developed from case history studies. These empirical support design methods are generally considered conservative as they are based on successfully supported openings. The question of whether the supports will be sufficient to withstand the additional thermal loads from waste emplacement will be evaluated during site characterization (e.g., the heated room test). The success of numerical analyses for designing underground support systems is inconclusive with no standardized design methods being widely accepted. Based on these considerations, the current design is considered adequate.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

St. John, C., 1987. "Investigative Study of the Underground Excavations for a Nuclear Waste Repository in Tuff," SAND83-7451, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/92

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.6.2, 1.18.8.1 [60.133(i)]

1.18.6.2 (UG EXC) The ESF shall be designed such that the thermal and thermomechanical effects of ESF operations and testing do not produce failure of intact rock, nor gross rock mass failure, along potential pathways from the repository to the accessible environment.

1.18.8.1 (UG TEST) The ESF shall be designed such that the thermal and thermomechanical effects of ESF testing do not produce failure of intact rock, nor gross rock mass failure, along potential pathways from the repository to the accessible environment.

HAS THE CRITERIA BEEN ADDRESSED ON THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The conclusion that the criterion has been addressed in the design is based on a number of analyses referenced in the ESF Title I Design Summary Report (Table 2-1, Appendix A, Vol. 4B) and Section 8.4 of the SCP. The analyses referenced in the Design Summary consider the behavior of various repository openings including repository emplacement and access drifts. The types of loads considered include stress redistribution around openings and the thermomechanical loads from heat generated by emplaced waste. In several of the analyses, the resulting stress conditions are analyzed to determine the extent of the rock damage around the openings. While the applied thermomechanical loads considered in these analyses differ considerably from those expected from the ESF tests, the results can be considered conservative approximations or bounding estimates of the impact the ESF has on performance.

Bauer et al. (1988) performed thermomechanical analyses of the heated room test, the canister scale heater test, and the thermal stress test. The results of the analyses have been used to estimate the zones of influence of the test. The analyses indicate that the thermal and thermomechanical effects of the tests are expected to be relatively localized (i.e., within a few opening diameters of the experiments. Since massive fracturing of the regions near heaters were not predicted and the effects of the experiments were relatively localized, it can be concluded that the ESF has been designed such that the effects of ESF testing would not produce significant amounts of failure of the intact rock nor gross rock mass failure along potential pathways to the accessible environment.

ADEQUACY OF TREATMENT: The supporting analyses are considered adequate to indicate that the Title I design meets the criteria.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.6.3, 1.18.8.2 [60.133(i)]

1.18.6.3 (UG EXC) The ESF shall be designed so that the thermal and thermomechanical effects of ESF operations and testing on the groundwater system, do not significantly increase the saturation of the host rock in the waste emplacement area.

1.18.8.2 (UG TEST) The ESF shall be designed so that the thermal and thermomechanical effects of ESF testing on the groundwater system, do not significantly increase the saturation of the host rock in the waste emplacement area.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: The conclusion that the design addresses the criterion that the ESF tests should not significantly increase the saturation of the host rock in the emplacement area is based on analyses discussed in Section 8.4 of the SCP. The possibility that thermomechanical disturbances from the testing activities may affect site performance due to redistribution of the moisture is discussed in Section 8.4.3.2.5.5. Bauer et al., 1988 performed analyses of the canister scale heater experiment, the heated room experiment and the thermal stress test. The zone of thermally disturbed rock, defined as the extent of rock having temperatures greater than 5 degrees C above ambient, is assumed to represent the extent of possible hydrologic alteration. This zone is confined to within 30 m of the planned tests. Furthermore, the presence of the repository access drifts adjacent to the ESF is expected to retard the thermal disturbance.

The extent of the thermomechanical influence from the tests is generally localized (i.e., limited to within about a couple of opening diameters from the tests) and the design is intended to provide standoff from waste emplacement areas. Hence because the effects are laterally separated from waste emplacement areas, it is unlikely that the saturation in waste emplacement areas could be modified by ESF-related thermal and thermomechanical effects.

ADEQUACY OF TREATMENT: The analyses performed to support Title I Design are considered adequate.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.18.8.3 [60.133(i)]

1.18.8.3 (UG TEST) The ESF shall be designed so that the thermal effects of ESF testing do not result in temperatures in excess of 115°C in either the TsW3 or CHn units.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on the discussion of thermal zones of influence presented in SCP Section 8.4.2.3.1 for each of the thermal tests and the evaluations of those zones with regard to the potential for test-to-test interference presented in SCP Section 8.4.2.3.6.1, it can be concluded that the thermal zones (within which the temperature is expected to exceed 5°C above ambient temperature) from the testing in the dedicated test area will not extend into either the TsW3 or the the CHn units. Therefore, the temperature will not exceed 115°C in those units.

SCP Figure 8.4.2-39 shows a plan view of the thermal zones from the testing in the dedicated test area. The maximum lateral extent of these zones is less than 30 m. The vertical extent is not shown but because of the arrangement of the heaters for these tests it can be expected that the vertical extent will not exceed that shown for the lateral extent. The Reference Information Base (RIB) Version 3.001 shows that the top of the TsW3 is approximately 100 m below the main test level. Thus, it was concluded that neither the TsW3 nor the CHn units would be affected by the thermal zones from tests conducted in the dedicated test area.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.19.6.1, 1.19.8.1 [60.137]

1.19.6.1 (UG EXC) The underground excavations shall be designed to accommodate the performance confirmation tests required by 60.141 and 60.142, and taking into account any potentially adverse impacts these excavations could have on the waste isolation capabilities of the site.

1.19.8.1 (UG TEST) The testing program shall accommodate the performance confirmation tests required by 60.141 and 60.142, and taking into account any potentially adverse impacts these tests could have on the waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests (including performance confirmation testing) in the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or post-closure performance impacts.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to allow reasonable expansion for additional testing if needed. It should be noted that upon completion of their review of the CD-SCP, the NRC did not recommend any additional tests be performed, with the exception of tests related to sealing concepts, which are being addressed in SCP Sections 8.3 and 8.4. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate reasonable expansion of the testing program. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

If the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required. It would also be expected that, for any future testing, potential impacts on the site would be provided in a manner similar to those completed for the planned tests.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 1.19.6.1, 1.19.8.1 [60.137]

1.19.6.1 (UG EXC) The underground excavations shall be designed to accommodate the performance confirmation tests required by 60.141 and 60.142, and taking into account any potentially adverse impacts these excavations could have on the waste isolation capabilities of the site.

1.19.8.1 (UG TEST) The testing program shall accommodate the performance confirmation tests required by 60.141 and 60.142, and taking into account any potentially adverse impacts these tests could have on the waste isolation capabilities of the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests (including performance confirmation testing) in the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or post-closure performance impacts.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to allow reasonable expansion for additional testing if needed. It should be noted that upon completion of their review of the CD-SCP, the NRC did not recommend any additional tests be performed, with the exception of tests related to sealing concepts, which are being addressed in SCP Sections 8.3 and 8.4. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate reasonable expansion of the testing program. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

If the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required. It would also be expected that, for any future testing, potential impacts on the site would be provided in a manner similar to those completed for the planned tests.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 1.20.8.1 [60.140(d)(1)]

1.20.8.1 (UG TST) The design of the performance confirmation testing program shall incorporate aspects specifically directed at limiting the potential for adverse impacts on the long term performance of the repository, and implementation of the performance confirmation testing program and operation of the facility shall be performed in a manner that limits the potential for adverse impacts on the long term performance of the repository

HAS THE CRITERION BEEN ADDRESSED IN THE ESF TITLE I DESIGN

✓ YES _____NO _____DON'T KNOW

RATIONALE:

10 CFR 60.140(d)(1) requires that investigations to obtain the required performance confirmation information be conducted in such a manner as to limit adverse effects on the long term performance of the geologic repository to the extent practicable. The approach taken in this TAR to evaluate the adequacy of the ESF Title I Design was to consider 10 CFR 60.140(d)(1) as an upper level requirement and assess the adequacy of the design on the basis of whether or not it was considered adequate with respect to a hierarchy of lower level criteria. Specifically, this approach involves considering the criteria developed for the Design Criteria of 10 CFR 60 in the evaluation of the impact on the ability of the site to comply with the performance objectives. A table was prepared that shows how the lower level requirements are considered in the evaluations of the higher level requirements of 10 CFR 60.140(d)(1). This table (see Figure 2.3-1) indicates that in order to show compliance with 60.140(d)(1) one must demonstrate that the performance confirmation program results in no less acceptable impacts than other facets of the site characterization program on the ability of the site to comply with the post closure performance objectives in 60.112, 60.113(a)(1)(ii)(A), and 60.113(a)(1)(ii)(B), as evaluated under 10 CFR 60.15(d)(1).

During discussions about the the development of the specific criteria to address the regulation a general philosophy of the manner by which the evaluations about the criteria would be used to address NRC concern #1 evolved within the subcommittee. Generally, this approach involves recognition that the two most basic requirements related to NRC concern #1 are (1) that site characterization be conducted to limit adverse effects on long term performance of the geologic repository to the extent practical [60.15(d)(1)] and (2) that the performance characterization program be implemented so that

it will not adversely affect the ability of the natural and engineered elements of the geologic repository to meet the performance objectives [60.140(d)(1)]. To show compliance with these two basic requirements, it is necessary to evaluate the ESF activities (construction, operation, and testing) to demonstrate that there are minimal and acceptable impacts on the ability of the site to comply with the postclosure performance objectives in 60.112, 60.113(a)(1)(ii)(A), and 60.113(a)(1)(ii)(B). The philosophy used in evaluating each of the ESF-related postclosure performance objectives was to (1) directly evaluate whether the site characterization activities associated with the ESF can be expected to impact significantly the ability of the site and engineered features to meet the postclosure performance objectives, and (2) evaluate whether or not the ESF activities would impact the ability to meet numerous additional related criteria in 10 CFR Part 60 that, if satisfied, will likely contribute to meeting the performance objectives. A table (Figure 2.3-1) was prepared to illustrate this philosophy. This table shows how the lower level requirements related to the ESF roll up into the higher requirements of 10 CFR 60.112, 60.113(a)(1)(ii)(A), and 60.113(a)(1)(ii)(B) then to 60.15(d)(1) and 60.140(d)(1).

It is considered that this "roll up" approach is consistent with the intent of the requirements in 10 CFR Part 60. The additional Design Criteria of 10 CFR Part 60, as originally proposed, required the design of the repository to accommodate potential interaction of the waste, the underground facility and the site, as well as specifying requirements related to the method of construction. The notice of the proposed rule (Fed. Reg., Vol. 46, No. 130, July 8, 1981) noted that the Commission believed that such requirements were necessary to assure that the ability of the repository to contain and isolate the wastes would not be compromised by the construction of the repository. The proposed criteria were thought to represent a common practice based on experience which has shown that such items need to be regulated. Additionally, in response to comments on the proposed rule (NUREG 0084) the Commission defended the inclusion of specific requirements and noted they consider it appropriate to include reasonable generic requirements that if satisfied will ordinarily contribute to meeting the release standards.

It should be noted that a design that incorporates the features identified in the related design criteria of 10 CFR Part 60 is not automatically assured of either being in compliance with the performance objectives of 10 CFR part 60 or not impacting the ability of the site to comply with the performance objectives. However, the design criteria of 10 CFR Part 60 encompass virtually all options open to a designer to ensure that a design does not impact the ability of the site to meet the performance objectives and, where possible, enhances the ability of the site to meet the performance objectives.

As indicated for paragraph 60.112 in the roll-up table (Figure 2.3-1), the criteria used for considering the potential impacts of performance confirmation testing are similar to the criteria applied to site characterization testing. The only differences identified are in the application of 60.15(d)(3) and 60.137 to site characterization and performance confirmation, respectively. No specific distinction between the performance confirmation testing requirements from construction and operations criteria was considered necessary at this time since no construction and activities related only to performance confirmation are identified that are not part of ESF construction. The conclusion is reached in the TAR that the treatment of

performance confirmation concerns is generally considered adequate in the ESF Title I design, based on the following: availability of space in the ESF dedicated test area for future testing; flexibility to develop additional excavations; the assumption that future testing will be similar to planned testing with respect to potential impacts on waste isolation; controls at least as stringent as those for site characterization testing will be maintained; and, potential impacts on performance will be evaluated prior to conducting any tests for which impact has not already been evaluated.

ADEQUACY OF TREATMENT:

The reviewers generally sought to determine if the Title I design consciously incorporates design features and controls on the site characterization and performance confirmation activities specifically intended either to assist the site in complying with the performance objectives and the related specific criteria or to limit potential changes to the site physical properties that could result in an impact on the ability of the site to comply with the performance objectives. The reviewers also sought to recognize appropriate components of the repository system to be relied on for performance. These components were then considered in the evaluation of the impacts of site characterization and performance confirmation testing on the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet the performance objectives. These features in the ESF Title I design comprise both physical items, including aspects of the configuration, and the control of activities. The evaluations of the impacts that the design could have on the ability of the site to comply with the performance objectives are largely abstracted from Section 8.4.3 of the SCP. In these assessments the issue resolution strategies presented in the SCP are used to identify the system elements and performance measures relied upon to achieve and demonstrate that the performance objectives have been met. The potential impacts of the site characterization and performance confirmation activities on the performance measures of the system elements were evaluated. Many of the data, calculations and analyses supporting the assessments in SCP Section 8.4 were also reviewed as part of this TAR. The results of that evaluation bear on the assessment of adequacy of the ESF Title I Design and are summarized in Section 2.4.4 of the TAR.

Evaluations of the Title I Design of the ESF indicate a number of design features and activity controls were specifically embodied in the design to assist the site in complying with the performance objectives and to limit impacts to the site properties and conditions that could, in turn, lead to significant impacts in the ability of the site to meet the performance objective. These design features and activity controls in the ESF design include separation of the ESF tests from potential emplacement drifts, control of drainage directions in the MTL, deliberate limiting of water use in testing, control of water used in testing including use of tracers and recovery and disposal of waste water, blasting control, separation of surface-based exploratory boreholes from planned ESF drifts, the ability to separate tests from each other and from operations activities to preclude interference, and the flexibility to relocate tests because of site specific conditions.

The underground drifts and alcoves for testing within the ESF will be permanent features, but they are not expected to function as preferential

pathways for either liquid or gaseous radionuclides. The mechanical disturbances to fracture apertures and hydraulic conductivity from testing activities are expected to be insignificant on the scale of the repository. Changes to the site from introducing fluids and materials from testing activities are expected to be generally transient and insignificant. The permanent changes are not expected to significantly impact the hydrologic, geochemical, and thermal/mechanical conditions of the site for reasons stated on the individual criteria sheets.

Based primarily upon the approaches presented in SCP Section 8.4 and the design features present in the ESF Title I design, it is generally concluded that the ESF Title I design is adequate to indicate that the ESF performance confirmation testing activities would not be expected to impact the ability of the site and engineered features to meet the postclosure performance objectives. Additional assurance is provided by the results of the Design Adequacy Assessments relative to the numerous additional design criteria that, if satisfied, will likely contribute to meeting the performance objectives. In addressing the potential performance related and waste isolation impacts from underground site characterization and performance confirmation testing, sixteen of the applicable criteria were considered to have been adequately treated with respect to the Title I design. These included criteria related to fluids and materials control, thermal and thermomechanical effects of testing, appropriate location of boreholes, and design flexibility. Criteria judged to be inadequately addressed are related mostly to procedural controls (i.e., fluid and material use in testing) and the disposal of waste water from underground construction, operations, and testing. In this respect, the Title I design contains insufficient information or is not sufficiently explicit to permit suitable assessment; however, it is expected that the ESF Title II design will contain more detailed specifications of procedures. The detailed results of these additional assessments are contained in the complete writeups in Appendix I-5.

RECOMMENDATIONS AND CORRECTIVE MEASURES:

A number of recommendations relative to the requirements of 10 CFR 60.140(d)(1) were made in the evaluation of the criteria developed for this DAA. Details of those evaluations can be found in Appendix I-5; the following is a brief summary of the recommendations:

1. Perform impact analyses prior to the initiation of specific performance confirmation tests for which analyses are not already complete.

2. Formulate explicit controls for fluids, materials, and gases to be used in testing. Develop inventory controls for introduction of hydrocarbons, solvents and special chemicals.

3. Attempt to identify the composition of natural water in the unsaturated zone early in the construction stages so that distinction from J-13 water is possible.

4. Additional evaluations of possible geochemical effects of gaseous materials to be used in testing should be made as detailed test plans evolve, and use of such materials should be limited.

REVIEWER	SIGNATURE	DATE
W. ARCH Girdley	W. A. Girdley	2-1-89

ORGANIZATION: DOE/YMP

CRITERIA 2

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

2.1.4.1 (ES-1) The structures, systems, components and operation of the exploratory shafts shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.5.1 (ES-2) Same as above.

2.1.6.1 (UG EXC) The dedicated test area should include adequate allowance for additional testing that may be required by the NRC.

2.1.6.2 (UG EXC) The dedicated test area shall be designed to support such additional testing as may be required by the NRC without disruption of or interference with testing in progress or planned testing.

2.1.7.1 (UG UTIL) The structures, systems, components, and operation of the shaft breakouts and main test level of the ESF shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.8.1 (UG TEST) The underground test program shall be designed to accommodate the requirements of 10 CFR Part 60.74.

2.1.8.2 (UG TEST) The testing program shall be designed to be able to accommodate additional testing that may be deemed appropriate by the Commission.

2.1.8.3 (UG TEST) Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests in the first and second shafts and the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or other planned testing.

In the shafts, additional testing could be readily incorporated because the construction sequence and schedules have contingency plans for delays for testing. Specific plans exist to delay construction for additional testing if

perched water zones or anomalous geologic structures are encountered or for any other reason deemed necessary by the Project (SCP Section 8.4.2.3.4.4). Additional testing could also be done after construction is completed. Complete geologic and fracture mapping records of the formations penetrated by the shaft will allow an investigator to locate any specific feature or area even after the liner is in place. Further, small sections of the unreinforced liner could easily be removed or drilled through for instrument installation. Additional testing in ES-2 during construction of the main test level would require a halt in mining operations if the testing required the hoist to be shut down for any significant period of time.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to allow reasonable expansion for additional testing if needed. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate reasonable expansion of the testing program. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

Regarding Criteria 2.1.8.1, if the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required.

Criteria 2.1.8.3 is specific to the design of any additional test that may be proposed and would apply only in the future. Therefore, it is not a requirement on the Title I design.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

2.1.4.1 (ES-1)	The structures, systems, components and operation of the exploratory shafts shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.
2.1.5.1 (ES-2)	Same as above.
2.1.6.1 (UG EXC)	The dedicated test area should include adequate allowance for additional testing that may be required by the NRC.
2.1.6.2 (UG EXC)	The dedicated test area shall be designed to support such additional testing as may be required by the NRC without disruption of or interference with testing in progress or planned testing.
2.1.7.1 (UG UTIL)	The structures, systems, components, and operation of the shaft breakouts and main test level of the ESF shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.
2.1.8.1 (UG TEST)	The underground test program shall be designed to accommodate the requirements of 10 CFR Part 60.74.
2.1.8.2 (UG TEST)	The testing program shall be designed to be able to accommodate additional testing that may be deemed appropriate by the Commission.
2.1.8.3 (UG TEST)	Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests in the first and second shafts and the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or other planned testing.

In the shafts, additional testing could be readily incorporated because the construction sequence and schedules have contingency plans for delays for testing. Specific plans exist to delay construction for additional testing if

perched water zones or anomalous geologic structures are encountered or for any other reason deemed necessary by the Project (SCP Section 8.4.2.3.4.4). Additional testing could also be done after construction is completed. Complete geologic and fracture mapping records of the formations penetrated by the shaft will allow an investigator to locate any specific feature or area even after the liner is in place. Further, small sections of the unreinforced liner could easily be removed or drilled through for instrument installation. Additional testing in ES-2 during construction of the main test level would require a halt in mining operations if the testing required the hoist to be shut down for any significant period of time.

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Regarding Criteria 2.1.8.1, if the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required.

Criteria 2.1.8.3 is specific to the design of any additional test that may be proposed and would apply only in the future. Therefore, it is not a requirement on the Title I design.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

2.1.4.1 (ES-1)	The structures, systems, components and operation of the exploratory shafts shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.
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2.1.8.3 (UG TEST)	Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

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RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests in the first and second shafts and the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or other planned testing.

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perched water zones or anomalous geologic structures are encountered or for any other reason deemed necessary by the Project (SCP Section 8.4.2.3.4.4). Additional testing could also be done after construction is completed. Complete geologic and fracture mapping records of the formations penetrated by the shaft will allow an investigator to locate any specific feature or area even after the liner is in place. Further, small sections of the unreinforced liner could easily be removed or drilled through for instrument installation. Additional testing in ES-2 during construction of the main test level would require a halt in mining operations if the testing required the hoist to be shut down for any significant period of time.

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Regarding Criteria 2.1.8.1, if the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required.

Criteria 2.1.8.3 is specific to the design of any additional test that may be proposed and would apply only in the future. Therefore, it is not a requirement on the Title I design.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

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2.1.8.1 (UG TEST) The underground test program shall be designed to accommodate the requirements of 10 CFR Part 60.74.

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2.1.8.3 (UG TEST) Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

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Regarding Criteria 2.1.8.1, if the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required.

Criteria 2.1.8.3 is specific to the design of any additional test that may be proposed and would apply only in the future. Therefore, it is not a requirement on the Title I design.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

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ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

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2.1.8.3 (UG TEST) Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests in the first and second shafts and the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or other planned testing.

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ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

2.1.4.1 (ES-1) The structures, systems, components and operation of the exploratory shafts shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.5.1 (ES-2) Same as above.

2.1.6.1 (UG EXC) The dedicated test area should include adequate allowance for additional testing that may be required by the NRC.

2.1.6.2 (UG EXC) The dedicated test area shall be designed to support such additional testing as may be required by the NRC without disruption of or interference with testing in progress or planned testing.

2.1.7.1 (UG UTIL) The structures, systems, components, and operation of the shaft breakouts and main test level of the ESF shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.8.1 (UG TEST) The underground test program shall be designed to accommodate the requirements of 10 CFR Part 60.74.

2.1.8.2 (UG TEST) The testing program shall be designed to be able to accommodate additional testing that may be deemed appropriate by the Commission.

2.1.8.3 (UG TEST) Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests in the first and second shafts and the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or other planned testing.

In the shafts, additional testing could be readily incorporated because the construction sequence and schedules have contingency plans for delays for testing. Specific plans exist to delay construction for additional testing if

perched water zones or anomalous geologic structures are encountered or for any other reason deemed necessary by the Project (SCP Section 8.4.2.3.4.4). Additional testing could also be done after construction is completed. Complete geologic and fracture mapping records of the formations penetrated by the shaft will allow an investigator to locate any specific feature or area even after the liner is in place. Further, small sections of the unreinforced liner could easily be removed or drilled through for instrument installation. Additional testing in ES-2 during construction of the main test level would require a halt in mining operations if the testing required the hoist to be shut down for any significant period of time.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to allow reasonable expansion for additional testing if needed. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate reasonable expansion of the testing program. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

Regarding Criteria 2.1.8.1, if the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required.

Criteria 2.1.8.3 is specific to the design of any additional test that may be proposed and would apply only in the future. Therefore, it is not a requirement on the Title I design.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.1.4.1, 2.1.5.1, 2.1.6.1, 2.1.6.2, 2.1.7.1, 2.1.8.1, 2.1.8.2, 2.1.8.3 [60.74(a)]

2.1.4.1 (ES-1) The structures, systems, components and operation of the exploratory shafts shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.5.1 (ES-2) Same as above.

2.1.6.1 (UG EXC) The dedicated test area should include adequate allowance for additional testing that may be required by the NRC.

2.1.6.2 (UG EXC) The dedicated test area shall be designed to support such additional testing as may be required by the NRC without disruption of or interference with testing in progress or planned testing.

2.1.7.1 (UG UTIL) The structures, systems, components, and operation of the shaft breakouts and main test level of the ESF shall be designed to accommodate additional tests that may be required by the NRC for site characterization and performance confirmation.

2.1.8.1 (UG TEST) The underground test program shall be designed to accommodate the requirements of 10 CFR Part 60.74.

2.1.8.2 (UG TEST) The testing program shall be designed to be able to accommodate additional testing that may be deemed appropriate by the Commission.

2.1.8.3 (UG TEST) Prior to initiation of additional tests requested by the Commission, an analysis of the potential for the tests to affect the ability of the site to be characterized shall be performed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed (1) to accommodate additional tests in the first and second shafts and the dedicated test area as may be required by the NRC; and (2) to support additional tests without disruption of or interference with testing in progress or other planned testing.

In the shafts, additional testing could be readily incorporated because the construction sequence and schedules have contingency plans for delays for testing. Specific plans exist to delay construction for additional testing if

perched water zones or anomalous geologic structures are encountered or for any other reason deemed necessary by the Project (SCP Section 8.4.2.3.4.4). Additional testing could also be done after construction is completed. Complete geologic and fracture mapping records of the formations penetrated by the shaft will allow an investigator to locate any specific feature or area even after the liner is in place. Further, small sections of the unreinforced liner could easily be removed or drilled through for instrument installation. Additional testing in ES-2 during construction of the main test level would require a halt in mining operations if the testing required the hoist to be shut down for any significant period of time.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to allow reasonable expansion for additional testing if needed. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate reasonable expansion of the testing program. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

Regarding Criteria 2.1.8.1, if the NRC determines that tests using radioactive materials are required, special, test specific, procedures would be required.

Criteria 2.1.8.3 is specific to the design of any additional test that may be proposed and would apply only in the future. Therefore, it is not a requirement on the Title I design.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.2.4.1, 2.2.5.1, 2.2.6.1 [60.130]

2.2.4.1 (ES-1) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

2.2.5.1 (ES-2) Same as above.

2.2.6.1 (UG EXC) Fluids and materials planned for use in the ESF underground facility shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: An independent evaluation of fluids and materials planned for use in the shafts and underground excavations was reported by West (1988). The overall conclusion of the evaluation is that the use of the specified fluids and materials during construction will not have a significant impact on site characterization or other testing. Based on the evaluation by West (1988) and the description of fluid and material controls given in SCP Section 8.4.2, it is concluded that the design incorporates appropriate and sufficient controls on the use of fluids and materials and contains other design and operational features so that the use of designated fluids and materials will not have as significant impact on site characterization or other testing. The details of fluid and materials controls will be part of Title II design.

Specific controls, design, and operational features listed below were considered adequate to insure site characterization would not be adversely affected by fluids or materials introduced into the ESF: (1) control and tracer tagging of all construction water; (2) removal of any excess construction water not absorbed into the formation; (3) limiting the amount of water used in drilling, blasting, dust suppression, and wall washing to the minimum practical; (4) shutting off water supplies to drilling equipment when equipment is not actually in use; (5) control of blasting damage and explosive products so that contamination of the rock is reduced to a small volume near the excavation walls; (6) sequencing and location of construction and testing activities so that tests sensitive to water or chemical contamination are conducted remote from construction activities and outside the zone of material near the excavation walls that may have absorbed construction fluids or gases; (7) restricting the use of certain classes of chemicals such as hydrocarbons and chemicals containing chlorine; and (8) separating operational areas, haulage drifts, and other rooms and alcoves by at least two drift diameters from test areas.

In addition, planned testing in the radial boreholes and the MPBHs is to be used to monitor the movement of construction fluids from the shafts. If construction fluids enter the rock in greater quantities or travel further than current estimates suggest, controls, construction methods and/or the testing program could be re-evaluated and modified.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.2.4.1, 2.2.5.1, 2.2.6.1 [60.130]

2.2.4.1 (ES-1) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

2.2.5.1 (ES-2) Same as above.

2.2.6.1 (UG EXC) Fluids and materials planned for use in the ESF underground facility shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: An independent evaluation of fluids and materials planned for use in the shafts and underground excavations was reported by West (1988). The overall conclusion of the evaluation is that the use of the specified fluids and materials during construction will not have a significant impact on site characterization or other testing. Based on the evaluation by West (1988) and the description of fluid and material controls given in SCP Section 8.4.2, it is concluded that the design incorporates appropriate and sufficient controls on the use of fluids and materials and contains other design and operational features so that the use of designated fluids and materials will not have as significant impact on site characterization or other testing. The details of fluid and materials controls will be part of Title II design.

Specific controls, design, and operational features listed below were considered adequate to insure site characterization would not be adversely affected by fluids or materials introduced into the ESF: (1) control and tracer tagging of all construction water; (2) removal of any excess construction water not absorbed into the formation; (3) limiting the amount of water used in drilling, blasting, dust suppression, and wall washing to the minimum practical; (4) shutting off water supplies to drilling equipment when equipment is not actually in use; (5) control of blasting damage and explosive products so that contamination of the rock is reduced to a small volume near the excavation walls; (6) sequencing and location of construction and testing activities so that tests sensitive to water or chemical contamination are conducted remote from construction activities and outside the zone of material near the excavation walls that may have absorbed construction fluids or gases; (7) restricting the use of certain classes of chemicals such as hydrocarbons and chemicals containing chlorine; and (8) separating operational areas, haulage drifts, and other rooms and alcoves by at least two drift diameters from test areas.

In addition, planned testing in the radial boreholes and the MPBHs is to be used to monitor the movement of construction fluids from the shafts. If construction fluids enter the rock in greater quantities or travel further than current estimates suggest, controls, construction methods and/or the testing program could be re-evaluated and modified.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.2.4.1, 2.2.5.1, 2.2.6.1 [60.130]

2.2.4.1 (ES-1) Fluids and materials planned for use in the shaft shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

2.2.5.1 (ES-2) Same as above.

2.2.6.1 (UG EXC) Fluids and materials planned for use in the ESF underground facility shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: An independent evaluation of fluids and materials planned for use in the shafts and underground excavations was reported by West (1988). The overall conclusion of the evaluation is that the use of the specified fluids and materials during construction will not have a significant impact on site characterization or other testing. Based on the evaluation by West (1988) and the description of fluid and material controls given in SCP Section 8.4.2, it is concluded that the design incorporates appropriate and sufficient controls on the use of fluids and materials and contains other design and operational features so that the use of designated fluids and materials will not have as significant impact on site characterization or other testing. The details of fluid and materials controls will be part of Title II design.

Specific controls, design, and operational features listed below were considered adequate to insure site characterization would not be adversely affected by fluids or materials introduced into the ESF: (1) control and tracer tagging of all construction water; (2) removal of any excess construction water not absorbed into the formation; (3) limiting the amount of water used in drilling, blasting, dust suppression, and wall washing to the minimum practical; (4) shutting off water supplies to drilling equipment when equipment is not actually in use; (5) control of blasting damage and explosive products so that contamination of the rock is reduced to a small volume near the excavation walls; (6) sequencing and location of construction and testing activities so that tests sensitive to water or chemical contamination are conducted remote from construction activities and outside the zone of material near the excavation walls that may have absorbed construction fluids or gases; (7) restricting the use of certain classes of chemicals such as hydrocarbons and chemicals containing chlorine; and (8) separating operational areas, haulage drifts, and other rooms and alcoves by at least two drift diameters from test areas.

In addition, planned testing in the radial boreholes and the MPBHs is to be used to monitor the movement of construction fluids from the shafts. If construction fluids enter the rock in greater quantities or travel further than current estimates suggest, controls, construction methods and/or the testing program could be re-evaluated and modified.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.2.8.1 [60.130]

2.2.8.1 (UG TEST) Fluids and materials planned for use in testing in the ESF shall be evaluated with respect to intended use and possible effects on site characterization or other testing, and appropriate controls will be implemented.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: An independent evaluation of fluids and materials planned for use in the shafts and underground excavations was reported by West (1988). The overall conclusion of the evaluation is that the use of the specified fluids and materials during construction will not have a significant impact on site characterization or other testing. Based on the evaluation by West (1988) and the description of fluid and material controls given in SCP Section 8.4.2, it is concluded that the design incorporates appropriate and sufficient controls on the use of fluids and materials and contains other design and operational features so that the use of designated fluids and materials will not have as significant impact on site characterization or other testing.

Specific controls are specified on a test-by-test basis (SCP Sections 8.3 and 8.4.2.3.1) to insure that fluids used in tests are tracer tagged for identification and limited in volume. In addition, the planned standoffs between tests and between tests and other constructed areas are sufficient to preclude migration of test or construction fluids from one test from interfering with other tests (West, 1988; SCP Sections 8.4.2.3.6.1, 8.4.2.3.6.2).

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.1.1 [60.133(a)(2)]

2.3.1.1 (SITE) The areas around the shaft collar shall be designed and constructed to prevent water inflow from the probable maximum flood such that testing in the underground portion of the ESF is not adversely affected.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIONALE:

The areas around the shaft collar are designed to prevent water influx from probable maximum flooding. As a result there will be virtually no impact on the ability of the repository to isolate waste, and testing in the underground portion of the ESF will not be affected. Section 6.2.3 of the ESF Title I Design Summary Report states: "Drainage channels and ditches are used to control flows in the existing water courses. ...The main pad is protected from the probable maximum flood by deepening and widening the existing wash above the pad. Added protection by way of an earth berm is added on the upper side of the pad to deflect any possible uncontained flood waters." Section 3.2.2.1 of the ESF Title I Design Summary Report states: "There are two 12-foot benches, 30 and 60 feet above the main pad, serving as a catchment for rocks and access for maintenance. At the base of the high wall there is a 10-foot wide drainage channel that diverts runoff from the slope, off the main pad. Surface water encroachment into the shafts will be further limited because the finished collars will be one foot above grade (see SCP page 8.4.2-163 and ESF drawings FS-GA-0026 and FS-GA-0043). Figure 8.4.3-3 in the SCP shows the relationships of the exploratory shafts to probable maximum flooding in the nearby wash. The entrance to ES-1 will be located 16 feet above the maximum height of a probable flood and the entrance to ES-2 will be over 37 feet above the probable maximum flood (this can be seen by comparing the ESF drawings with the height of flooding in figure 8.4.3-3). The surface of the main pad will slope away from the exploratory shafts at about a 2% grade (see ESF Drawing JS-025-ESF-C6). A postclosure aspect of the site that contributes to the ability to prevent water inflow during a maximum probable flood is that the site is located above the flood level in a relatively small wash which has very small erosion rates. Shaft seals and site restoration will further contribute to postclosure water influx prevention.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.4.1 [60.133(A)(2)]

2.3.4.1 (ES-1) The exploratory shaft collar shall be designed to prevent significant water inflow from a maximum credible floodng event during site characterization and the planned period of repository operation, such that testing in the underground portion of the ESF is not adversely affected.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIONALE:

The shaft collars are designed to prevent water influx from probable maximum flooding. As a result there will be virtually no impact on testing in the underground portion of the ESF. Surface water encroachment into the shafts will be limited because the finished collars will be one foot above grade (see SCP page 8.4.2-163 and ESF drawings FS-GA-0026 and FS-GA-0043). Figure 8.4.3-3 in the SCP shows the relationships of the exploratory shafts to probable maximum flooding in the nearby wash. The entrance to ES-1 will be located 16 feet above the maximum height of a probable flood and the entrance to ES-2 will be over 37 feet above the probable maximum flood (this can be seen by comparing the ESF drawings with the height of flooding in figure 8.4.3-3). The surface of the main pad will slope away from the exploratory shafts at about a 2% grade (see ESF Drawing JS-025-ESF-C6). Inflow into the top of the shafts is unlikely, but if water should enter the top of a shaft it will probably flow down the side of the collar to a collection ring located at the bottom of the collar (see Design Drawing FS-GA-0026). Any water that flows past this ring will collect in the sump at the bottom of the shaft. Any water thus collected will be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.5.1 [60.133(A)(2)]

2.3.5.1 (ES-1) The exploratory shaft collar shall be designed to prevent significant water inflow from a maximum credible floodng event during site characterization and the planned period of repository operation, such that testing in the underground portion of the ESF is not adversely affected.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIONALE:

The shaft collars are designed to prevent water influx from probable maximum flooding. As a result there will be virtually no impact on testing in the underground portion of the ESF. Surface water encroachment into the shafts will be limited because the finished collars will be one foot above grade (see SCP page 8.4.2-163 and ESF drawings FS-GA-0026 and FS-GA-0043). Figure 8.4.3-3 in the SCP shows the relationships of the exploratory shafts to probable maximum flooding in the nearby wash. The entrance to ES-1 will be located 16 feet above the maximum height of a probable flood and the entrance to ES-2 will be over 37 feet above the probable maximum flood (this can be seen by comparing the ESF drawings with the height of flooding in figure 8.4.3-3). The surface of the main pad will slope away from the exploratory shafts at about a 2% grade (see ESF Drawing JS-025-ESF-C6). Inflow into the top of the shafts is unlikely, but if water should enter the top of a shaft it will probably flow down the side of the collar to a collection ring located at the bottom of the collar (see Design Drawing FS-GA-0026). Any water that flows past this ring will collect in the sump at the bottom of the shaft. Any water thus collected will be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.6.1, 2.3.6.2 [60.133(a)(2)]

2.3.6.1 (UG EXC) The Exploratory Shaft Underground Facility shall be designed so that the effects of credible disruptive events shall be limited from spreading through the facility and affecting characterization.

2.3.6.2 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be designed to ensure that the effects of flooding shall be limited from spreading through the facility and affecting characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__√__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, and the repository interface drawings in the SDRD, I conclude that the underground excavations have been designed so that the effects of credible disruptive events during the period of operations such as flooding, fires and explosions shall be limited from spreading through the facility and will therefore be limited such that testing in the ESF is not adversely impacted. First, as regards flooding, it is unlikely that significant quantities of water will enter the underground excavations as a result of floods (see discussions of criteria 1/133(a)(2)/4/1 and 1/133(a)(2)/5/1) because of the location of the shaft entrances relative to flooding and because of the presence of pumps at the bottom of each shaft. It is also unlikely that water will spread through the facility because 1) the dedicated test area is designed so that water will, in general, drain toward ES-1 (see drwg. R07048A/5), 2) skid-mounted pumps are provided during construction near the drift faces and additional pumps are planned as necessary in the dedicated testing area and in drifts near the Ghost Dance Fault, Drill Hole Wash, and the imbricate fault zone (drwg. FS-GA-0235), 3) pumps are provided (drwg. FS-GA-0235) during ESF operations in the shaft bottoms and sump areas for removal of this water (if any is present), and 4) the long lateral drifts are designed so that they are on grades or alignment coincident with planned repository access drifts so that water that might enter such a drift would drain away from repository emplacement drifts in which waste would be stored (Title I rpt. section 3.7.2, and SCP section 8.4.2.3.6.3). Second, as regards spreading of fires or explosions, it is unlikely that they could spread through the facility. Significant evidence exists to indicate that these considerations have been adequately addressed in the Title I design. Examples of the consideration of the need to control and/or prevent such events are provided by 1) the use of applicable codes in developing the design (Title I rpt. sec. 5.1), 2) the safety evaluations completed to date related to the credible accident list (Title I rpt. table 5-5) that includes flooding, fire and explosion considerations, 3) the relatively noncombustible nature of materials generally used in underground excavations (shotcrete, rockbolts,

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

etc.), and 4) the presence of design design features that should contribute to preventing, controlling and responding to such events. These design features include the presence of communications systems, monitoring systems with alarms and shut-off valves, and fire protection systems (including sprinkler systems, portable extinguishers, fire doors in selected areas, and special purpose systems in areas of high potential hazard, such as mine shops or the data system). These features are depicted in drwgs. FS-GA-0220, -0222, -0225, -0227 -0230, and-0235 and in drwgs. JS-025-ESF-W12, -W13, -W14,- W15, and -W16.

ADEQUACY OF TREATMENT: An adequate treatment of the considerations for limiting the spread of credible disruptive events through the underground excavtions is evidenced and the drainage plan for the ESF and the long exploratory drifts is adequately designed to limit flooding.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.6.1, 2.3.6.2 [60.133(a)(2)]

2.3.6.1 (UG EXC) The Exploratory Shaft Underground Facility shall be designed so that the effects of credible disruptive events shall be limited from spreading through the facility and affecting characterization.

2.3.6.2 (UG EXC) The drainage plan for the ESF and long exploratory drifts should be designed to ensure that the effects of flooding shall be limited from spreading through the facility and affecting characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_√_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, and the repository interface drawings in the SDRD, I conclude that the underground excavations have been designed so that the effects of credible disruptive events during the period of operations such as flooding, fires and explosions shall be limited from spreading through the facility and will therefore be limited such that testing in the ESF is not adversely impacted. First, as regards flooding, it is unlikely that significant quantities of water will enter the underground excavations as a result of floods (see discussions of criteria 1/133(a)(2)/4/1 and 1/133(a)(2)/5/1) because of the location of the shaft entrances relative to flooding and because of the presence of pumps at the bottom of each shaft. It is also unlikely that water will spread through the facility because 1) the dedicated test area is designed so that water will, in general, drain toward ES-1 (see drwg. R07048A/5), 2) skid-mounted pumps are provided during construction near the drift faces and additional pumps are planned as necessary in the dedicated testing area and in drifts near the Ghost Dance Fault, Drill Hole Wash, and the imbricate fault zone (drwg. FS-GA-0235), 3) pumps are provided (drwg. FS-GA-0235) during ESF operations in the shaft bottoms and sump areas for removal of this water (if any is present), and 4) the long lateral drifts are designed so that they are on grades or alignment coincident with planned repository access drifts so that water that might enter such a drift would drain away from repository emplacement drifts in which waste would be stored (Title I rpt. section 3.7.2, and SCP section 8.4.2.3.6.3). Second, as regards spreading of fires or explosions, it is unlikely that they could spread through the facility. Significant evidence exists to indicate that these considerations have been adequately addressed in the Title I design. Examples of the consideration of the need to control and/or prevent such events are provided by 1) the use of applicable codes in developing the design (Title I rpt. sec. 5.1), 2) the safety evaluations completed to date related to the credible accident list (Title I rpt. table 5-5) that includes flooding, fire and explosion considerations, 3) the relatively noncombustible nature of materials generally used in underground excavations (shotcrete, rockbolts,

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

etc.), and 4) the presence of design design features that should contribute to preventing, controlling and responding to such events. These design features include the presence of communications systems, monitoring systems with alarms and shut-off valves, and fire protection systems (including sprinkler systems, portable extinguishers, fire doors in selected areas, and special purpose systems in areas of high potential hazard, such as mine shops or the data system). These features are depicted in drwgs. FS-GA-0220, -0222, -0225, -0227 -0230, and-0235 and in drwgs. JS-025-ESF-W12, -W13, -W14,- W15, and -W16.

ADEQUACY OF TREATMENT: An adequate treatment of the considerations for limiting the spread of credible disruptive events through the underground excavtions is evidenced and the drainage plan for the ESF and the long exploratory drifts is adequately designed to limit flooding.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R. Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.6.3 [60.133(a)(2)]

2.3.6.3 (UG EXC) The presence of combustible materials in the underground facility shall be controlled and limited such that testing in the ESF is not adversely affected.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: The design (Title I, Vol. 2, FS-GA-0160) provides for locating the shop and fueling and service areas near ES-2, away from the dedicated test area, and the SDRD (1.2.6.0, p. 0-5,) includes a constraint that, to the extent practical, the ESF will incorporate the use of noncombustible materials. The Title I report (Vol. I, p. 4-4) also indicates that hazardous substances will be controlled according to both federal and state regulations such that such substances are managed from cradle to grave. The report further indicates (p. 3-39) that explosives are to be delivered on a day-by-day basis and stored in approved containers located in unused and unoccupied single-ended drifts away from active mining.

ADEQUACY OF TREATMENT: This criterion appears to be adequately addressed on both a safety-related and test-interference basis.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.7.1 [60.133(a)(2)]

2.3.7.1 (UG UTIL) The ESF shall have redundant mine water discharge systems to control and limit the impact of water intrusion on testing in the ESF.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIONALE:

The systems for discharge of mine waste water are fully redundant so the impact of water intrusion on testing in the ESF is limited. Section 3.8.6 of the Design Summary report states: "The mine waste water system is fully redundant in that each MTL sump pump is duplicated, and each shaft discharge pipe is capable of the 500-gpm design flow compared to the 250-gpm expected flow." Section 6.6.6 of the Design Summary Report says that each of the two main sump pumps is capable of transferring the full design peak flow, as is each shaft riser pipe. Details on line sizes and pump locations are presented in Design Drawing FS-GA-0235. The bottom of each sump will be lined so any water collected will be isolated from the formation (see Design Drawing FS-GS-0062).

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.7.2 [60.133(a)(2)]

2.3.7.2 (UG UTIL) The underground portion of the ESF shall incorporate a fire protection system to control and limit the impact of a credible fire on testing in the ESF.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, it is evident that the design provides an underground fire protection system to control and limit the impact of fire on testing. As regards fires, it is unlikely that they could spread through the facility. Significant evidence exists to indicate that these considerations have been adequately addressed in the Title I design. Examples of the consideration of the need to control and/or prevent such events are provided by 1) the use of applicable codes in developing the design (Title I rpt. sec. 5.1), 2) the safety evaluations completed to date related to the credible accident list (Title I rpt. table 5-5) that include fires in numerous parts of the underground, 3) the relatively noncombustible nature of materials generally used in underground excavations (shotcrete, rockbolts, etc.), and 4) the presence of design design features that should contribute to preventing, controlling and responding to such events. These design features include the presence of communications systems, monitoring systems with alarms and shut-off valves, and fire protection systems (including sprinkler systems, portable extinguishers, fire doors in selected areas, and special purpose systems in areas of high potential hazard, such as mine shops or the data system). These features are depicted in drwgs. FS-GA-0220, -0222, -0225, -0227 -0230, and-0235 and in drwgs. JS-025-ESF-W12, -W13, -W14,- W15, and -W16.

ADEQUACY OF TREATMENT: The underground portion of the ESF adequately incorporates a fire protection system to limit impacts of a credible fire on testing.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.7.3 [60.133(a)(2)]

2.3.7.3 (UG UTIL) The underground utility system shall be designed to control and limit the impact, of utility system failures caused by credible disruptive events such as fire, explosion, or seismic events, on site characterization and other testing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on an evaluation of the ESF design report, Volumes 1 and 2, I conclude that the utility system has been designed to control and limit the impact on testing of failures caused by credible disruptive events . Specific features include reduncancy in many areas such as that afforded by having ventilation in both shafts, power transmission down both shafts, and water-related piping in both shafts so that testing will not be impacted by maintenance or other operations. Additionally, relief valves, pressure regulators, line break valves, UPS backup, automatic and manual operation features, and monitoring systems (with warning devices) are evidenced in the design. Examples of specific drawings reviewed include FS-GA-0204, -0220, -0222, -0230, and -0235. The text in section 6.6 of Volume 1 of the design report also provided significant indication of inclusion of features related to assuring that the impact of utility system failures can be limited.

ADEQUACY OF TREATMENT: Adequate for ESF Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Joe R. Tillerson	Joe R Tillerson	1/31/89

ORGANIZATION: Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.3.7.4 [60.133(a)(2)]

2.3.7.4 (UG UTIL) The mine water collection, control, and removal system shall be designed with capacity for emergency situations such as unexpected inflow or water line breakage, inflow from penetrations of fault structures during drifting, or from perched water encountered during shaft sinking and ESF development, such that the capability to adequately characterize the site is maintained.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIONALE:

The mine water collection, control, and removal system is designed with capacity for emergency situations such as inflow or water line breakage, inflow from penetrations of faults during drifting or from perched water such that the capability to adequately characterize the site will be maintained. The surface of the main pad will slope away from the exploratory shafts at about a 2% grade (see ESF Drawing JS-025-ESF-C6), so any water line rupture that is away from the shafts or surface flooding will not result in water entering the shafts. Water lines in the ESF will be controlled by gate valves, surge protectors, air release valves and blow-off valves, which will reduce the likelihood of a pipe rupture (see section 3.4.2 of the Design Summary Report). These valves can be shut in the event of pipe rupture to limit further influx of water into the facility. Section 3.8.5 of the Design Summary Report states: "For system reliability, automatic, excess flow (line break) valves are utilized at strategic locations in the piping system to limit the amount of water being introduced into the ground structure..." Any water that does enter the facility will flow naturally to a low spot (a lined sump) where it will be collected and pumped to the surface. The sumps in the bottom of each exploratory shaft will have two pumps in each rated at 250 GPM and 110 Feet discharge head (see section 3.66 of the Summary Design Report or Design Drawing FS-GA-035).

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.4.1 [60.133(b)]

2.4.4.1 (ES-1) The configuration of the shaft shall be adequate to support site characterization testing and future testing that may be reasonably expected for site characterization. This shall include an allowance to accomodate site specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The above conclusion is based on review of SCP section 8.4.2 and Volumes 1 and 2 of the ESF Title I design report. The 12-foot shaft diameter provides for the equipment and working space required for drilling horizontal boreholes where needed for testing (Title I, Vol. I, p. 0-5 and Sec. 3.5) as well as supporting material handling and ventilation requirements. The shaft size and outfitting, as well as construction plan, are designed to support tests already identified and to maintain flexibility (SCP Sec. 8.4.2, p. 218-219) to relocate planned tests as may be required by specific conditions encountered as shaft sinking progresses. Additional testing could be implemented following construction and outfitting of the shaft if needed, as the unreinforced liner could be drilled or small sections removed to install test instruments; results of full coverage geologic mapping during shaft sinking would provide information for revisiting a selected geologic feature. Flexibility of location of additional tests would be limited by consideration of zone of influence with regard to on-going tests. Provision for flexibility in connecting to utilities, including the IDS, and configuration of the working stage system allows access to most of the shaft length.

ADEQUACY OF TREATMENT: There is considerable emphasis in the design on planning for ES-1 to be capable of providing access needed for data gathering.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN DAA CRITERIA

CRITERIA: 2.4.4.2 [60.133 (b)]

2.4.4.2 The design of ES-1 shall include flexibility to deepen the shaft to at least 1,500 feet, or approximately 100' deeper than the Topopah/Calico Hills unit contact, without adversely affecting other testing that may be ongoing. Such flexibility shall consider aspects of hoisting capacity, underground utilities, ground support, and muck handling.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: The current design layout does not specifically show any deepening of ES-1 into the Calico Hills, but an Engineering Change Request (ECR #21) to the SDRD requires that sufficient flexibility be maintained should a decision be made to do so at some future time. An impact analysis conducted by Fenix and Scisson (WMPO Action Item #88-1995, June 23, 1988) indicated that various options to penetrate the Calico Hills would have negligible impact upon the present design, construction, and testing in the MTL, although an expansion of some utilities and construction equipment would be required. Although ES-1 outfittings might be modified to accomodate continued construction use of ES 1, an assumption in the Fenix and Scisson analysis was that access to tests in the shaft would be maintained during shaft deepening.

ADEQUACY OF TREATMENT: In view of there being no present intent to penetrate the Calico Hills unit and on the basis of conclusions in the Fenix and Scisson analysis the present treatment appears to be adequate.

RECOMMENDATIONS AND CORRECTIVE MEASURES: It is recommended only that flexibility to extend ES-1 into the Calico Hills be explicitly included in Title II design.

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.5.1 [60.133(b)]

2.4.5.1 (ES-2) The configuration of the shaft shall be adequate to support site characterization testing and future testing that may be reasonably expected for site characterization. This shall include an allowance to accomodate site specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The above conclusion is based on review of SCP section 8.4.2 and Volumes 1 and 2 of the ESF Title I design report. The 12-foot shaft diameter provides for the equipment and working space required for drilling horizontal boreholes where needed for testing (Title I, Vol. I, p. 0-5 and Sec. 3.5) as well as supporting material handling and ventilation requirements. The shaft size and outfitting, as well as construction plan, are designed to support tests already identified and to maintain flexibility (SCP Sec. 8.4.2, p. 218-219) to relocate planned tests as may be required by specific conditions encountered as shaft sinking progresses. Additional testing could be implemented following construction and outfitting of the shaft if needed, as the unreinforced liner could be drilled or small sections removed to install test instruments; results of full coverage geologic mapping during shaft sinking would provide information for revisiting a selected geologic feature. Flexibility of location of additional tests would be limited by consideration of zone of influence with regard to on-going tests. Provision for flexibility in connecting to utilities, including the IDS, and configuration of the working stage system allows access to most of the shaft length. If additional testing were required in ES-2 while construction of the MTL was still underway, however, mining might have to be suspended if continued operation of the ES-2 hoist interfered with the tests.

ADEQUACY OF TREATMENT: There is considerable emphasis in the design on planning for ES-1 to be capable of providing access needed for data gathering.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.6.1 [60.133(b)]

2.4.6.1 (UG EXC) The ESF shall be designed so that testing areas are separated from possible repository shop, training, operations, or waste emplacement areas, to limit adverse effects from activities in these areas on future testing, including performance confirmation, in the dedicated test area.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on an evaluation of selected parts of Volumes 1 and 2 of the ESF Title I design report and the interference analysis discussed in SCP Section 8.4.2.3.6.2, it is concluded that test areas (with the exception of the third drift of the waste package test) are separated sufficiently from any repository area to preclude activities in the repository from interfering with planned or future testing in the dedicated test area. A two drift diameter standoff is maintained between the boundary of the dedicated test area and the repository mains, except for the third drift of the waste package test (Drawing FS-GA-0160), which, in the present configuration, is closer than two drift diameters from the repository main running between points D and H (in SCP Figure 8.4.2.4). Standoffs between waste emplacement areas or shop and training areas of the repository are considerably greater than two drift diameters. Analyses discussed in SCP Sections 8.4.2 and 8.4.3 demonstrate that two drift diameters is sufficient standoff to preclude mechanical, hydrological or geochemical effects resulting from drift construction in the repository area from affecting testing activities in the dedicated test area.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Third drift of the waste package test is too close to the boundary of the dedicated test area. Some rearrangement of the waste package test may be necessary or further analysis could be performed to demonstrate that the separation distance is adequate or the proposed repository drift could be moved.

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/26/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.6.2 [60.133(b)]

2.4.6.2 (UG EXC) The design of the shaft breakouts and main test level of the ESF shall: (1) limit the extent of interference between tests and (2) limit interference between ESF construction and operation activities and testing activities.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The potential for interference between tests and between ESF construction and operations activities and testing activities is evaluated in SCP Sections 8.4.2.3.6.1 and 8.4.2.3.6.2. Based on these evaluations, it is concluded that the criteria for limiting the extent of such interferences has been satisfied by the Title I design of the shaft breakouts and the main test level.

The design limits test-to-test interference by insuring that tests are sufficiently separated such that the zones of influence of the tests do not overlap (SCP Figure 8.4.2-39). In addition, the test locations and layout are flexible enough to allow for relocation or additional separation between tests if required. The estimates of zones of influence of each test are based on thermal, mechanical, hydrological, and geochemical analyses of preliminary test configurations. During Title II design, the test geometries and procedures will have to be more completely defined and further analyses may be necessary to accurately define the zones of influence.

Construction-to-test interference is limited by the design by (1) locating test areas sufficiently far from the shafts that the potential for mechanical or hydrological interference from shaft construction is minimal, (2) separating experiment areas from shop and training areas, (3) locating experiments requiring isolation from construction activities farthest away from ES-2 and the haulage drifts, (4) arranging the muck handling area near ES-2 in such a way that dumping and muck removal operations are isolated from the testing areas in the dedicated test area (Drawings FS-GA-0160 and FS-GA-0110), and (5) incorporating flexibility in the layout to accommodate site specific conditions.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I Design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.6.3 [60.133(b)]

2.4.6.3 (UG EXC) The design of the shaft breakouts and main test level shall have sufficient flexibility to: (1) relocate experiments as necessary to limit interference between tests and aid in ensuring that test location acceptance criteria are met, (2) incorporate additional tests, as needed, in the dedicated test area, (3) allow development and testing in other areas as needed (e.g., southern portion of repository block or Calico Hills Tuff), and (4) accommodate schedule changes as needed.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The flexibility of the underground excavations to accommodate test location acceptance and interference criteria and to provide for additional testing or development of other areas is discussed in SCP Section 8.4.2.3.6.4. Based on this evaluation and sections of Volume 1 and 2 of the ESF Title I design report, it is concluded that sufficient flexibility in the design exists to satisfy the criteria to provide flexibility to relocated tests if necessary, to perform additional tests, to develop other areas, and to accommodate schedule changes.

Flexibility for relocation of tests because of poor ground conditions, interference concerns, or undesirable local hydrology is provided by insuring that there is sufficient area near each proposed test location to provide for alternate siting or orientation changes without violating the interference constraints from nearby testing or construction.

The design also provides ample space for additional testing within the boundary of the dedicated test area (SCP Figure 8.4.2-4). If necessary some operational areas could be converted to test areas or additional test areas could be developed.

Sufficient flexibility in the construction and operations plans to extend the scope of many of the planned activities and open additional regions for exploration or testing was included in the design. If deemed necessary, shaft sinking and mining operations could continue into the Calico Hills horizon or additional areas in the Topopah Spring Member could be explored by mining along planned repository drifts (at repository grade) as far as the planned repository boundary. Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) and other support facilities are design to support additional mining capability (drilling jumbos, muck haulers, blasting crews, etc.) so that additional mining could be done without greatly compromising the schedule.

The operational schedule for development of the underground areas and the coordination with testing activities has significant latitude to accommodate delays in the construction of the main test level if additional testing is added. In addition, the design allows the rate of excavation to increase so that multiple test areas could be constructed simultaneously. Further mining capacity could be gained by adding mining equipment. The mining capacity is essentially limited only by the capacity of the ventilation system, which was designed with a capacity exceeding that required to support planned activities (Volume 1, Sections 3.3.1 and 3.8.4).

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/26/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.6.4 [60.133(b)]

2.4.6.4 (UG EXC) A contingency plan shall be established for underground excavation to accommodate unexpected or site specific conditions that may be encountered, such as highly fractured zones, lithophysae-rich zones, perched water, or pathways for significant water movement.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The flexibility of the ESF underground design is evaluated in SCP Section 8.4.2.3.6.4. Based on this evaluation and the descriptions of the ground support and mining sequences to be used in the ESF underground given in Volume 1 of the ESF Title I design report (Section 6.5.2.4 and Table 6-1) and SCP Section 8.4.2.3.4., it is concluded that the criteria for providing contingency plans to accommodate unexpected site conditions is satisfied.

Uncertainties in ground conditions and water flow are always part of any mining operation. The underground design for the ESF, therefore, provides for flexibility in ground support to ensure stable drifts for all areas. The ground support design is based on rock quality determinations and, thus, is tailored to the specific ground conditions encountered (Table 6-1). Additional ground support may be required in experimental areas where severe environmental conditions may be imposed on the rock mass. In addition, poor rock conditions or excessive water may be encountered in planned test areas requiring the relocation of some tests. Additional area is provided for this contingency. Further, in the exploratory drifting, pilot holes will be drilled ahead of an advancing drift to ensure that the construction methods and ground support are sufficient to provide support for the next section of the drift. Design changes can be made to accommodate changes in ground conditions as they are encountered.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/25/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.6.5, 2.4.7.1 [60.133(b)]

2.4.6.5 (UG EXC) The ESF underground excavation shall be of adequate size to support site characterization testing and future testing that may be reasonably expected for site characterization. This shall include an allowance to accommodate site specific conditions encountered in the dedicated test area, and capacity to extend an exploratory drift from the main test level, if necessary, up to approximately 10,000 feet to other parts of the repository block.

2.4.7.1 (UG UTIL) The design of underground utilities for the ESF shall be capable of supporting expansion of the main test level for additional testing and an exploratory drift from the main test level, if necessary, up to approximately 10,000 feet to other parts of the repository block.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The flexibility of the design of the underground excavations to be of adequate size to support site characterization testing and future testing, to accommodate site specific conditions, and if necessary, provide for additional construction and testing is evaluated in SCP Section 8.4.2.3.6.4. Based on this evaluation and selected parts of Volumes 1 and 2 of the ESF Title I design report dealing with ventilation, hoisting, and utility capacities, it is concluded that the criteria for providing adequate underground area to support site characterization and retain the capability for further exploratory drifting including sufficient utility capacity, are satisfied.

The design provides ample space for planned and additional testing within the boundary of the dedicated test area (SCP Figure 8.4.2-4). If necessary, some operational areas could be converted to test areas or additional test areas could be developed. Larger scale experiments con be incorporated by additional drifting within the dedicated test area.

Sufficient flexibility in the construction and operations plans to extend the scope of many of the planned activities and open additional regions for exploration or testing was included in the design. Additional areas in the Topopah Spring Member could be explored by mining along planned repository drifts (at repository grade) as far as the planned repository boundary. Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) and other support facilities are design to support additional mining capability (drilling jumbos, muck haulers, blasting crews, etc.) so that additional mining could be done without greatly compromising the schedule.

Uncertainties in ground conditions and water flow are always part of any mining operation. The underground design for the ESF, therefore, provides for flexibility in ground support to ensure stable drifts for all areas. The ground support design is based on rock quality determinations and, thus, is tailored to the specific ground conditions encountered (Table 6-1). Additional ground support may be required in experimental areas where severe environmental conditions may be imposed on the rock mass. In addition, poor rock conditions or excessive water may be encountered in planned test areas requiring the relocation of some tests. Additional area is provided for this contingency. Further, in the exploratory drifting, pilot holes will be drilled ahead of an advancing drift to ensure that the construction methods and ground support are sufficient to provide support for the next section of the drift. Design changes can be made to accommodate changes in ground conditions as they are encountered.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.6.5, 2.4.7.1 [60.133(b)]

2.4.6.5 (UG EXC) The ESF underground excavation shall be of adequate size to support site characterization testing and future testing that may be reasonably expected for site characterization. This shall include an allowance to accommodate site specific conditions encountered in the dedicated test area, and capacity to extend an exploratory drift from the main test level, if necessary, up to approximately 10,000 feet to other parts of the repository block.

2.4.7.1 (UG UTIL) The design of underground utilities for the ESF shall be capable of supporting expansion of the main test level for additional testing and an exploratory drift from the main test level, if necessary, up to approximately 10,000 feet to other parts of the repository block.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The flexibility of the design of the underground excavations to be of adequate size to support site characterization testing and future testing, to accommodate site specific conditions, and if necessary, provide for additional construction and testing is evaluated in SCP Section 8.4.2.3.6.4. Based on this evaluation and selected parts of Volumes 1 and 2 of the ESF Title I design report dealing with ventilation, hoisting, and utility capacities, it is concluded that the criteria for providing adequate underground area to support site characterization and retain the capability for further exploratory drifting including sufficient utility capacity, are satisfied.

The design provides ample space for planned and additional testing within the boundary of the dedicated test area (SCP Figure 8.4.2-4). If necessary, some operational areas could be converted to test areas or additional test areas could be developed. Larger scale experiments con be incorporated by additional drifting within the dedicated test area.

Sufficient flexibility in the construction and operations plans to extend the scope of many of the planned activities and open additional regions for exploration or testing was included in the design. Additional areas in the Topopah Spring Member could be explored by mining along planned repository drifts (at repository grade) as far as the planned repository boundary. Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) and other support facilities are design to support additional mining capability (drilling jumbos, muck haulers, blasting crews, etc.) so that additional mining could be done without greatly compromising the schedule.

Uncertainties in ground conditions and water flow are always part of any mining operation. The underground design for the ESF, therefore, provides for flexibility in ground support to ensure stable drifts for all areas. The ground support design is based on rock quality determinations and, thus, is tailored to the specific ground conditions encountered (Table 6-1). Additional ground support may be required in experimental areas where severe environmental conditions may be imposed on the rock mass. In addition, poor rock conditions or excessive water may be encountered in planned test areas requiring the relocation of some tests. Additional area is provided for this contingency. Further, in the exploratory drifting, pilot holes will be drilled ahead of an advancing drift to ensure that the construction methods and ground support are sufficient to provide support for the next section of the drift. Design changes can be made to accommodate changes in ground conditions as they are encountered.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.4.7.2 [60.133(b)]

2.4.7.2 (UG UTIL) The underground utilities for the ESF shall not preclude monitoring and investigation of in situ conditions and shall be designed to accomodate site specific conditions, construction, and operation of the ESF.

CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Functional requirements (#3) in the SDRD (1.2.6.7) provide for the distribution of utilities around the operations area of the MTL in such a manner to allow for flexibility in siting and construction of testing locations. Uncertainty allowances for utilities have been considered in Title I (SDRD, 1.2.6.0) to provide for capabilities beyond those required to support the current conceptual design. For example, the mine power center is fully backed up by surface standby generators which are in turn backed up by the UPS system that feeds all subsurface critical loads, and redundancy is also designed in the lighting, ventilation, and other utilitiy systems (Title I, Vol. I, Sec. 6.6).

ADEQUACY OF TREATMENT: Considerable emphasis has been placed on utility flexibility and redundancy in the Title I documents.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.1, 2.5.5.1, 2.5.6.1, 2.5.8.1 [60.133(d)]

2.5.4.1 (ES-1) The amount of water used in the construction and operation of the shaft should be limited to preclude interference with tests.

2.5.5.1 (ES-2) Same as above.

2.5.6.1 (UG EXC) The amount of water used in the construction and operations of the underground facility should be limited to preclude interference with tests.

2.5.8.1 (UG TEST) The amount of water used in testing in the shaft should be limited to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on review of selected sections of Volumes 1 and 2 of the Title I design report and SCP Section 8.4.2.3, it is concluded that it is the intent of the design that water use during construction be controlled to a sufficient degree to satisfy the criteria that water used in construction should be limited to preclude interference with tests. While some specific controls are noted explicitly in the design, it is acknowledged that work is in progress to establish a basis for determining the necessary controls on water used in the underground.

When drilling blast holes, small amounts of water must be circulated through the drill steel and out the hole to flush the cuttings. This action not only suppresses the dust created by the drilling action, but also serves to cool the drill bit. Water used in this fashion will be controlled by adjusting the water flow through each drill to the minimum required to prevent dusting. Water will also be kept turned off at any time the drill is not actually drilling. Another use of water is to suppress dust and fumes and to wash the rock faces for geological mapping during and after a blast. Special geologic mapping requirements and bulk sampling techniques may require more or less water to be used based on individual testing program rubble. All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface. All water introduced into the ESF, other than naturally occurring ground water, will be tagged with nontoxic chemical tracers to distinguish it from the ground water. A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited.

West (1988) evaluated the use of water in construction. This evaluation was used in SCP Section 8.4.2.3.6.2 to demonstrate that the probability of water

absorbed into the rock as a result of construction and operations traveling far enough through the formation to interfere with testing was very remote. Tests will be conducted during shaft construction (radial boreholes and the MPBHs) to evaluate the effect of construction and to substantiate the analyses cited in West (1988).

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: Work should be completed to establish a basis for determining the necessary controls on water use.

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.2, 2.5.5.2, 2.5.6.2 [60.133(d)]

2.5.4.2 (ES-1) Shaft construction and operating procedures shall require the removal of excess water to preclude interference with tests.

2.5.5.2 (ES-2) Same as above.

2.5.6.2 (UG EXC) Underground facility construction and operating procedures shall require the removal of excess water to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Shaft and underground facility construction and operating procedures will enable the removal of excess water to preclude interference with tests. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.3 [60.133(d)]

2.5.4.3 (ES-1) The shafts should be separated to maintain reasonable distances for power and instrument cabling and water piping as well as to provide for redundancy in mine water discharge to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

✓ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on the 300 feet separation between ES-1 and ES-2 identified in the Title I design and upon the electrical system, the mine water system and the mine waste water system designs, I conclude that the shafts are separated a reasonable distance to preclude a significant potential for interference with tests. As regards power and instrument cabling, it is evident that there is power cabling planned for each of the shafts. This appropriately allows for maintenance in either shaft to be conducted without affecting the underground activities. However, this does result in more than 300 feet of high voltage cabling underground between the shaft breakouts and the mine power center or unit substation (drwg. FS-GA-0204). While it is desirable to limit the amount of high voltage cabling underground, the 300 feet distance is, in my opinion, a very reasonable length when you consider the advantages of having redundant power sources but is not likely to be a the controlling or most important factor in the selection of the separation distance. As regards concerns related to the water systems (drwgs. FS-GA-0230 and -0235), they are also likely to be relatively minor considerations relative to shaft separation; nevertheless, the distance between shafts should, if consistent with other constraints, be limited to preclude having long distances underground with pipes that contain fluids under high pressure.

ADEQUACY OF TREATMENT: The treatment of this criteria is considered adequate in the current design based on the rationale and observations described above.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.1, 2.5.5.1, 2.5.6.1, 2.5.8.1 [60.133(d)]

2.5.4.1 (ES-1) The amount of water used in the construction and operation of the shaft should be limited to preclude interference with tests.

2.5.5.1 (ES-2) Same as above.

2.5.6.1 (UG EXC) The amount of water used in the construction and operations of the underground facility should be limited to preclude interference with tests.

2.5.8.1 (UG TEST) The amount of water used in testing in the shaft should be limited to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on review of selected sections of Volumes 1 and 2 of the Title I design report and SCP Section 8.4.2.3, it is concluded that it is the intent of the design that water use during construction be controlled to a sufficient degree to satisfy the criteria that water used in construction should be limited to preclude interference with tests. While some specific controls are noted explicitly in the design, it is acknowledged that work is in progress to establish a basis for determining the necessary controls on water used in the underground.

When drilling blast holes, small amounts of water must be circulated through the drill steel and out the hole to flush the cuttings. This action not only suppresses the dust created by the drilling action, but also serves to cool the drill bit. Water used in this fashion will be controlled by adjusting the water flow through each drill to the minimum required to prevent dusting. Water will also be kept turned off at any time the drill is not actually drilling. Another use of water is to suppress dust and fumes and to wash the rock faces for geological mapping during and after a blast. Special geologic mapping requirements and bulk sampling techniques may require more or less water to be used based on individual testing program rubble. All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface. All water introduced into the ESF, other than naturally occurring ground water, will be tagged with nontoxic chemical tracers to distinguish it from the ground water. A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited.

West (1988) evaluated the use of water in construction. This evaluation was used in SCP Section 8.4.2.3.6.2 to demonstrate that the probability of water

absorbed into the rock as a result of construction and operations traveling far enough through the formation to interfere with testing was very remote. Tests will be conducted during shaft construction (radial boreholes and the MPBHs) to evaluate the effect of construction and to substantiate the analyses cited in West (1988).

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: Work should be completed to establish a basis for determining the necessary controls on water use.

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.2, 2.5.5.2, 2.5.6.2 [60.133(d)]

2.5.4.2 (ES-1) Shaft construction and operating procedures shall require the removal of excess water to preclude interference with tests.

2.5.5.2 (ES-2) Same as above.

2.5.6.2 (UG EXC) Underground facility construction and operating procedures shall require the removal of excess water to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Shaft and underground facility construction and operating procedures will enable the removal of excess water to preclude interference with tests. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.1, 2.5.5.1, 2.5.6.1, 2.5.8.1 [60.133(d)]

2.5.4.1 (ES-1) The amount of water used in the construction and operation of the shaft should be limited to preclude interference with tests.

2.5.5.1 (ES-2) Same as above.

2.5.6.1 (UG EXC) The amount of water used in the construction and operations of the underground facility should be limited to preclude interference with tests.

2.5.8.1 (UG TEST) The amount of water used in testing in the shaft should be limited to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on review of selected sections of Volumes 1 and 2 of the Title I design report and SCP Section 8.4.2.3, it is concluded that it is the intent of the design that water use during construction be controlled to a sufficient degree to satisfy the criteria that water used in construction should be limited to preclude interference with tests. While some specific controls are noted explicitly in the design, it is acknowledged that work is in progress to establish a basis for determining the necessary controls on water used in the underground.

When drilling blast holes, small amounts of water must be circulated through the drill steel and out the hole to flush the cuttings. This action not only suppresses the dust created by the drilling action, but also serves to cool the drill bit. Water used in this fashion will be controlled by adjusting the water flow through each drill to the minimum required to prevent dusting. Water will also be kept turned off at any time the drill is not actually drilling. Another use of water is to suppress dust and fumes and to wash the rock faces for geological mapping during and after a blast. Special geologic mapping requirements and bulk sampling techniques may require more or less water to be used based on individual testing program rubble. All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface. All water introduced into the ESF, other than naturally occurring ground water, will be tagged with nontoxic chemical tracers to distinguish it from the ground water. A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited.

West (1988) evaluated the use of water in construction. This evaluation was used in SCP Section 8.4.2.3.6.2 to demonstrate that the probability of water

absorbed into the rock as a result of construction and operations traveling far enough through the formation to interfere with testing was very remote. Tests will be conducted during shaft construction (radial boreholes and the MPBHs) to evaluate the effect of construction and to substantiate the analyses cited in West (1988).

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: Work should be completed to establish a basis for determining the necessary controls on water use.

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.2, 2.5.5.2, 2.5.6.2 [60.133(d)]

2.5.4.2 (ES-1) Shaft construction and operating procedures shall require the removal of excess water to preclude interference with tests.

2.5.5.2 (ES-2) Same as above.

2.5.6.2 (UG EXC) Underground facility construction and operating procedures shall require the removal of excess water to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Shaft and underground facility construction and operating procedures will enable the removal of excess water to preclude interference with tests. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	Jan 31, 1989

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.6.3 [60.133(d)]

2.5.6.3 (UG EXC) The drainage for the ESF and long exploratory drifts should be consistent with repository operations and not impact the capability to characterize the site. Specifically, drainage in the dedicated test area should be toward ES-1 and that in long drifts should be compatible with repository grades.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_✓_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on my evaluation of selected parts of volumes 1 and 2 of the ESF Title I design report, the design description and other discussions in SCP section 8.4, plans for seal and repository designs (see SCP-CDR, SCP Chapter 6, and SCP section 8.3.3), and the repository interface drawings in the SDRD, I conclude that the drainage plan for the ESF and long exploratory drifts are consistent with planned repository operations and will not impact the capability to characterize the site. As regards the two shafts that are part of the ESF, my conclusions are related to the fact that the shaft design is consistent with the performance allocation presented in the SCP for sealing. Specifically, the bottoms of the shafts are well below the main test levels (about 50 feet for ES-1 (drwg. FS-GA-0057) and about 100 feet for ES-2 (drwg. FS-GA-0113)) and because the design of the proposed liner is such that it can be removed during decommissioning if necessary to aid in sealing the repository. As specifically regards the underground excavations, my conclusions are related again to the consistency between the ESF Title I design, the repository conceptual design, and the performance allocation presented in the SCP for sealing. Specifically, the proposed exploratory drifts in the ESF are consistent with the planned repository drifts as evidenced by the agreement between the ESF Title I design (drwgs. FS-GA-0195, -0196, -0197, -0198, and -0199) and the ESF-Repository interface drawing (R0748A in Appendix A of the SDRD). This will aid in assuring that the drifts in the repository are graded to allow the slope to be from (rather than toward) emplacement drifts in which waste has been stored. Additionally, the intersections between the long lateral drifts and the dedicated test areas are both above the elevation of the shaft breakouts with the breakout for ES-1 representing the lower of the two breakouts (see drwgs. FS-GA-0057, -0113, and -0195). As a result, the drainage in the dedicated test area would generally be toward ES-1 (see drwg. R07048A/5 in ESF SDRD). The only exception to this drainage toward ES-1 in the current design of the dedicated test area is, I believe, the vertical testing drift (about 230 feet long) in the waste package environment test (drwg. FS-GA-0166); the grade of this drift is obviously based on the testing need for instrumentation access.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: Adequate treatment of this criteria is evidenced as indicated in the rationale presented above.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
JOE R. TILLERSON	Joe R Tillerson	1/31/89

ORGANIZATION Sandia National Laboratories

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.6.4 [60.133(d)]

2.5.6.4 (UG EXC) Construction methods shall be designed and implemented so that effects of fluids, gases, or other materials used do not adversely affect the adequacy or reliability of information from site characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on review of selected sections of Volumes 1 and 2 of the Title I design report and SCP Section 8.4.2.3, it is concluded that it is the intent of the design that controls on construction methods be sufficient to satisfy the criteria that construction methods be designed and implemented so that the effects of fluids, gases, or other materials used do not adversely affect the adequacy or reliability of information from site characterization. While some specific controls are noted explicitly in the design, it is acknowledged that work is in progress to establish a basis for determining the necessary controls on water and blasting methods used in the underground excavations. These studies will also help determine the effects of construction water and explosive products may have on the hydrological and chemical tests to be performed on rock samples taken during construction. Specific controls on the quantity and types of explosives that can be used without affecting planned tests are to be determined from this effort.

Operational controls included in the design to reduce the effect of construction and operations on the testing environment include (1) plans for blast control to limit damage to surrounding rock, (2) control of fluids introduced in the shafts and main test level from mining or other sources, (3) control of dust, vibration, and traffic near sensitive experimental areas, (4) use of phased construction and testing, and (5) inclusion of sufficient separation distances between experiments and between testing and construction to reduce the potential for interference.

West (1988) estimated the effects of fluids and materials (including explosive products) on rock near the excavations. It can be concluded from this work that the separation of tests from each other and the separation of hydrologically or chemically sensitive tests from the zone of disturbed material surrounding the underground openings, as designated in the Title I design, is sufficient to preclude interference of construction fluids and materials with the test results, with the exception of tests on samples collected from blast rubble.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: Work needs to be completed to establish a basis for determining the necessary controls on water and blasting methods.

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/25/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.6.5 [60.133(d)]

2.5.6.5 (UG EXC) Methods for dust control and cleaning of walls in the underground portion of the ESF shall be designed to limit adverse effects on the adequacy and reliability of information from site characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Title I design (Vol. I, Sec. 3.8.4.3) calls for the use of water as a dust suppressant during blast-hole drilling, rock bolting, rock excavation and after-blasting as well as at loading/unloading pockets and dump stations, but a dust collector is planned for use where use of water or other wetting agents is not feasible or must be limited because of possible adverse impact on site characterization activities. Dust suppressants on subsurface roadways will consist of water and a biodegradable, nontoxic chemical additive. A specific technique for cleaning walls was not found in either the Title I documents or the SCP; water will be used in the cleaning process in preparation for geologic mapping but, according to the SCP (Sec. 8.4.2, p. 107), the amount used is to be less than that for dust suppression. The water distribution system incorporates a chemical tracer injection capability (Title I, Vol. I, Sec. 6.6.5); water use is to be limited to the minimum required (SCP Sec. 8.4, p.188).,

ADEQUACY OF TREATMENT: Fluid control described in SCP indicates high priority is placed on limiting adverse effects, but details of how activities such as wall cleaning are to be conducted were not found.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Address fluid controls more explicitly in Title II design.

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.6.6 [60.133(d)]

2.5.6.6. (UG EXC) Fluids, gases, and other materials used in ESF construction and operations, and/or injected into the rock mass, shall be appropriately tagged. Selection of tracers shall consider, but not be limited to: (1) the possible future need to account for the mobility and disposition of all such materials as part of site characterization, and (2) the effects of tracers on site characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The Title I SDRD (1.2.6.7.5) specifically calls for all water used during construction and operation of the ESF to be tagged with tracers as required for site characterization. Title I, Vol. I, Sec. 6.6.5 also indicates that the designed water distribution system incorporates a chemical tracer injection capability. Review of SCP Section 8.4.2 (p. 188) indicates that fluid controls are planned that include use of tracers in a manner that will ensure integrity of geochemical analyses, based on analyses and methods developed during prototype testing; for example, restricting the use of certain classes of chemicals such as hydrocarbons and chemicals containing chlorine.

ADEQUACY OF TREATMENT: Treatment appears adequate for conceptual design, as designed water system can accommodate addition of tracers as needed.

RECOMMENDATIONS AND CORRECTIVE MEASURES: It is recommend that test requirements developed in Title II contain specific constraints, where needed, on type of tracers to be used.

REVIEWER (PRINT)-	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.7.1 [60.133(d)]

2.5.7.1 (UG UTIL) The mine water collection, control, and removal system shall be designed to accommodate inflow from penetrations of fault structures during drifting, or from perched water encountered during shaft sinking and ESF development such that the capability to adequately characterize the site is maintained. The mine water control system shall be designed with capacity for emergency situations such as unexpected inflow or water line breakage.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIONALE:

The mine water collection, control and removal system is designed to include possible inflow from penetrations of fault structures during drifting and from perched water encountered during shaft sinking and facility development, such that the ability to characterize the site will be maintained. In addition the mine water control system is designed with the capacity for emergency situations such as unexpected inflows and line breakage. Inflow into the top of the shaft is unlikely, but if water should enter the top of the shaft it will probably flow down the side of the collar to a collection ring located at the bottom of the collar (see Design Drawing FS-GA-0026). Any water that flows past this ring will collect in the sump at the bottom of the shaft. Any water thus collected will be pumped to the surface. On page 8.4.2-191, Section 8.4.2.3.4.4, of the SCP it says: "If a seep or perched-water zone is encountered...any excess water will be pumped to the surface and discharged..." Natural drainage in the facility will be to the sump at the bottom of ES-1. On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.7.2 [60.133(d)]

2.5.7.2 (UG UTIL) The design of the ESF underground utility system, including ventilation, shall facilitate monitoring of moisture influx to the ESF from the rock mass and from ventilation, and moisture efflux from mine water removal and ventilation exhasut to limit possible impacts on the capability to adequately characterize the site.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES _____ NO _____ DON'T KNOW

RATIOANLE:

The design of the ESF underground utility system, including ventilation, shall facilitate monitoring of moisture influx to the ESF from the rock mass and from ventilation, and moisture efflux from mine water removal and ventilation exhaust to limit possible impacts on the capability to adequately characterize the site. Utility water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states: "A water balance of water piped into the facility and water removed will be maintained at the shaft collars." Sections 3.8.2.2 and 3.8.11 of the Design Summary report discuss environmental monitoring which includes humidity and velocity of ventilation air. Humidity and air flow will also be monitored at several locations throughout the facility. Page 8.4.2-165 and section 8.4.2.3.5 of the SCP discuss ventilation requirements. Section 8.4.2.3.2.1 discusses use of the automated data acquisition system to monitor things such as ventilation mass balance, water in and out flows.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER	SIGNATURE	DATE
Keith M. Kersch	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.4.1, 2.5.5.1, 2.5.6.1, 2.5.8.1 [60.133(d)]

2.5.4.1 (ES-1)	The amount of water used in the construction and operation of the shaft should be limited to preclude interference with tests.
2.5.5.1 (ES-2)	Same as above.
2.5.6.1 (UG EXC)	The amount of water used in the construction and operations of the underground facility should be limited to preclude interference with tests.
2.5.8.1 (UG TEST)	The amount of water used in testing in the shaft should be limited to preclude interference with tests.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on review of selected sections of Volumes 1 and 2 of the Title I design report and SCP Section 8.4.2.3, it is concluded that it is the intent of the design that water use during construction be controlled to a sufficient degree to satisfy the criteria that water used in construction should be limited to preclude interference with tests. While some specific controls are noted explicitly in the design, it is acknowledged that work is in progress to establish a basis for determining the necessary controls on water used in the underground.

When drilling blast holes, small amounts of water must be circulated through the drill steel and out the hole to flush the cuttings. This action not only suppresses the dust created by the drilling action, but also serves to cool the drill bit. Water used in this fashion will be controlled by adjusting the water flow through each drill to the minimum required to prevent dusting. Water will also be kept turned off at any time the drill is not actually drilling. Another use of water is to suppress dust and fumes and to wash the rock faces for geological mapping during and after a blast. Special geologic mapping requirements and bulk sampling techniques may require more or less water to be used based on individual testing program rubble. All construction water that does not get absorbed and removed in the rubble will be collected by pumps located at both the shaft bottom and drift face. This water is then transferred to the main wastewater disposal system for pumping to the surface. All water introduced into the ESF, other than naturally occurring ground water, will be tagged with nontoxic chemical tracers to distinguish it from the ground water. A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited.

West (1988) evaluated the use of water in construction. This evaluation was used in SCP Section 8.4.2.3.6.2 to demonstrate that the probability of water

absorbed into the rock as a result of construction and operations traveling far enough through the formation to interfere with testing was very remote. Tests will be conducted during shaft construction (radial boreholes and the MPBHs) to evaluate the effect of construction and to substantiate the analyses cited in West (1988).

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: Work should be completed to establish a basis for determining the necessary controls on water use.

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.8.2 [60.133(d)]

2.5.8.2 (UG TEST) Test procedures shall require the removal of excess water.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Testing procedures will enable the removal of excess water. Water use will be controlled so that the need for removal of excess water is slight. On page 8.4.2-191 of the SCP it states: "At the shaft bottom, a sump pump will be excavated and pumps installed for water removal...any excess water will be pumped to the surface and discharged..." On page 8.4.2-217 of section 8.4.2.3.6.3 of the SCP is states: "...excess water entering the dedicated test area either through shaft flooding or encountering perched water zones will be expected to remain in the area and drain into the formation or to the ES-1 shaft sumps." From there it would be pumped to the surface.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS FOR CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
KEITH M. KERSCH	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.5.8.3 [60.133(d)]

2.5.8.3 (UG TEST) Test procedures shall be developed to ensure that water entering the ESF is managed appropriately, including quantity, location, and water balance.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Not all testing procedures have been developed at this time. The goal is to have testing procedures be developed to ensure water entering the ESF is managed properly. Utility water entering the ESF will be carefully monitored, which includes measurement of quantity, location and water balance. Under section 8.4.2.3.4.4 of the SCP (page 8.4.2-188) it states that water used to cool drill bits during drilling will be controlled to the minimum needed to keep the bit from overheating and the water flow will be shut off when not drilling. It also states: "A water balance of water piped into the facility and water removed will be maintained at the shaft collars. Excessive, uncontrolled use of water underground will be prohibited."

ADEQUACY OF TREATMENT: Not all testing procedures have been developed at this time, so it is impossible to determine the impact of future testing on the capability of the repository to isolate waste until those procedures are written.

RECOMMENDATIONS FOR CORRECTIVE MEASURES: Review testing procedures as they are written to determine their impact on the capability of the repository to isolate waste.

REVIEWER (PRINT)	SIGNATURE	DATE
KEITH M. KERSCH	Keith M Kersch	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.6.4.1, 2.6.5.1 [60.133(e)(2)]

2.6.4.1 (ES-1) The shaft shall be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that could impact the capability to reliably and adequately characterize the site.

2.6.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I Design addresses the need to provide shaft stability and reduce the potential for deleterious rock movement or fracturing is based on several references. The ESF Title I Design Summary Report references 60.133(e)(2) and states that the underground openings of the ESF that become part of the repository are designed to the same criteria that govern the design of the repository drifts in terms of the control of potential deleterious rock movement or fracturing for 100 years (Design Summary Narrative Report, Volume 1, Section 7.2). The decision to adapt one of the controlled blasting techniques for constructing the shaft (smooth blasting) was influenced by 10 CFR Part 60 requirements to minimize the effects of excavation on the rock (Design Summary Narrative Report, Volume 1, Section 6.4.1).

The ESF Title I Design specifies that the shafts will be constructed using the drill and blast method. Other methods are available that would likely result in less fracturing of the intact rock as a result of construction, such as shaft drilling. The decision to use conventional methods is based on the conclusions reached by the Ad Hoc Committee Evaluation of the Construction Technique Alternatives for the Exploratory Shaft (Vieth to M Gates, "Decision on Method for Constructing the Exploratory Shaft at Yucca Mountain," 1982). The committee considered two construction methods for the exploratory shafts: drilling, and conventional sinking (drill and blast method). The Figure of Merit technique was used for comparing the two alternatives. A number of objectives and criteria were used for decision making including the need to minimize the introduction of fluids into the rock that may alter the hydrologic and geochemical conditions. Some significant fluid losses had been recorded during the drilling of 4 inch diameter boreholes at the site. Based on the objectives considered, the committee recommended the drill and blast method for constructing the exploratory shafts. This recommendation was subsequently approved by the NNWSI Project.

Excavation-induced effects on permeability of the rock surrounding the shafts is discussed in Section 8.4.3.2 of the SCP and is based on analyses by Case and Kelsall (1987). The model developed is based upon analyses which consider modification in the rock mass permeability around the shaft resulting from stress redistribution and blast damage. The constitutive relationships for

permeability changes from stress redistribution are based on theoretical considerations and laboratory data. The effects of blast damage are estimated from case histories.

ADEQUACY OF TREATMENT: The ESF Title I Design explicitly recognizes the 60.133(e)(2) requirement. The construction method in the shaft design was chosen to minimize the disturbance to the rock surrounding the shaft while minimizing the introduction of fluids.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.6.4.2, 2.6.5.2 [60.133(e)]

2.6.4.2 (ES-1) An adequate distance between shafts shall be provided to limit potential mechanical and hydrological interference between the two shafts to the extent that it could impact the capability to reliably and adequately characterize the site.

2.6.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on analyses summarized by West (1988) and those reported in Costin and Bauer (1988) regarding the extent of hydrological and mechanical disturbance of the rock near the shafts, it is concluded that the location and separation distance of ES-1 and ES-2 are acceptable because (1) general hydrologic interference is not likely to be observed; (2) significant reductions in the probability of an interference event are not likely to be gained by reasonable increases in shaft separation or by changes in the sequence of construction of ES-1 and ES-2, although the possibility of flow in large aperture fractures reaching the adjacent shaft cannot be precluded; (3) no mechanical interference or unacceptable vibratory interference is expected; and (4) tests to be conducted during shaft construction (radial boreholes and MBPHs) are to be used to determine the extent of hydrologic influence of the shaft construction.

Several calculations were performed (West, 1988) to estimate the effects of construction water (SCP Section 8.4.2.3.6.2). A matrix imbibition analysis shows that after 10 yr, a zone 10 m in radius from the shaft centerline will have been affected by a change in saturation of approximately 0.08. Fracture flow was also analyzed. For small fractures (24 to 100 μm aperture) the results indicate that water could move 10 to 15 m. For larger aperture fractures (250 μm), the water in the fracture may extent to 50 to 60 m from the shaft. Occurrences of fluid transport over longer distances were encountered in USW UZ-1 as a result of drilling of USW G-1 where it was evident that drilling fluid moved a great distance along possible geologic structures in Drill Hole Wash. However, Drill Hole Wash may be along geologic structures, while the orientation of ES-1 and ES-2 is oblique to the apparent structural trends at Yucca Mountain.

Mechanical interference between the shafts was also considered. The stress altered region around each shaft was found to extend approximately 1.5 to 2.0 shaft diameters from the shaft centerline (Costin and Bauer, 1988). Since ES-1 and ES-2 are located approximately 20 diameters apart, mechanical interference is unlikely. Since both shafts will be constructed by drill and blast methods, blasting in ES-2 is not expected to affect experiments being conducted in ES-1 any more than blasting in ES-1 itself. Preliminary testing

in G-Tunnel has demonstrated survivability of geomechanical instrumentation placed within 1.0 m of a full face blast (Zimmerman et al., 1988).

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.6.4.1, 2.6.5.1 [60.133(e)(2)]

2.6.4.1 (ES-1) The shaft shall be designed to provide stability and to reduce the potential for deleterious rock movement or fracturing that could impact the capability to reliably and adequately characterize the site.

2.6.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The conclusion that the ESF Title I Design addresses the need to provide shaft stability and reduce the potential for deleterious rock movement or fracturing is based on several references. The ESF Title I Design Summary Report references 60.133(e)(2) and states that the underground openings of the ESF that become part of the repository are designed to the same criteria that govern the design of the repository drifts in terms of the control of potential deleterious rock movement or fracturing for 100 years (Design Summary Narrative Report, Volume 1, Section 7.2). The decision to adapt one of the controlled blasting techniques for constructing the shaft (smooth blasting) was influenced by 10 CFR Part 60 requirements to minimize the effects of excavation on the rock (Design Summary Narrative Report, Volume 1, Section 6.4.1).

The ESF Title I Design specifies that the shafts will be constructed using the drill and blast method. Other methods are available that would likely result in less fracturing of the intact rock as a result of construction, such as shaft drilling. The decision to use conventional methods is based on the conclusions reached by the Ad Hoc Committee Evaluation of the Construction Technique Alternatives for the Exploratory Shaft (Vieth to M Gates, "Decision on Method for Constructing the Exploratory Shaft at Yucca Mountain," 1982). The committee considered two construction methods for the exploratory shafts: drilling, and conventional sinking (drill and blast method). The Figure of Merit technique was used for comparing the two alternatives. A number of objectives and criteria were used for decision making including the need to minimize the introduction of fluids into the rock that may alter the hydrologic and geochemical conditions. Some significant fluid losses had been recorded during the drilling of 4 inch diameter boreholes at the site. Based on the objectives considered, the committee recommended the drill and blast method for constructing the exploratory shafts. This recommendation was subsequently approved by the NNWSI Project.

Excavation-induced effects on permeability of the rock surrounding the shafts is discussed in Section 8.4.3.2 of the SCP and is based on analyses by Case and Kelsall (1987). The model developed is based upon analyses which consider modification in the rock mass permeability around the shaft resulting from stress redistribution and blast damage. The constitutive relationships for

permeability changes from stress redistribution are based on theoretical considerations and laboratory data. The effects of blast damage are estimated from case histories.

ADEQUACY OF TREATMENT: The ESF Title I Design explicitly recognizes the 60.133(e)(2) requirement. The construction method in the shaft design was chosen to minimize the disturbance to the rock surrounding the shaft while minimizing the introduction of fluids.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.6.4.2, 2.6.5.2 [60.133(e)]

2.6.4.2 (ES-1) An adequate distance between shafts shall be provided to limit potential mechanical and hydrological interference between the two shafts to the extent that it could impact the capability to reliably and adequately characterize the site.

2.6.5.2 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on analyses summarized by West (1988) and those reported in Costin and Bauer (1988) regarding the extent of hydrological and mechanical disturbance of the rock near the shafts, it is concluded that the location and separation distance of ES-1 and ES-2 are acceptable because (1) general hydrologic interference is not likely to be observed; (2) significant reductions in the probability of an interference event are not likely to be gained by reasonable increases in shaft separation or by changes in the sequence of construction of ES-1 and ES-2, although the possibility of flow in large aperture fractures reaching the adjacent shaft cannot be precluded; (3) no mechanical interference or unacceptable vibratory interference is expected; and (4) tests to be conducted during shaft construction (radial boreholes and MBPHs) are to be used to determine the extent of hydrologic influence of the shaft construction.

Several calculations were performed (West, 1988) to estimate the effects of construction water (SCP Section 8.4.2.3.6.2). A matrix imbibition analysis shows that after 10 yr, a zone 10 m in radius from the shaft centerline will have been affected by a change in saturation of approximately 0.08. Fracture flow was also analyzed. For small fractures (24 to 100 μm aperture) the results indicate that water could move 10 to 15 m. For larger aperture fractures (250 μm the water in the fracture may extent to 50 to 60 m from the shaft. Occurrences of fluid transport over longer distances were encountered in USW UZ-1 as a result of drilling of USW G-1 where it was evident that drilling fluid moved a great distance along possible geologic structures in Drill Hole Wash. However, Drill Hole Wash may be along geologic structures, while the orientation of ES-1 and ES-2 is oblique to the apparent structural trends at Yucca Mountain.

Mechanical interference between the shafts was also considered. The stress altered region around each shaft was found to extend approximately 1.5 to 2.0 shaft diameters from the shaft centerline (Costin and Bauer, 1988). Since ES-1 and ES-2 are located approximately 20 diameters apart, mechanical interference is unlikely. Since both shafts will be constructed by drill and blast methods, blasting in ES-2 is not expected to affect experiments being conducted in ES-1 any more than blasting in ES-1 itself. Preliminary testing

in G-Tunnel has demonstrated survivability of geomechanical instrumentation placed within 1.0 m of a full face blast (Zimmerman et al., 1988).

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.6.6.1, 2.6.6.2 [60.133(e)(2)]

2.6.6.1 (UG EXC) The main test level of the ESF shall be designed to limit overall response to excavation, including rock fall, considering all planned drifts and future drifting that may be performed in the dedicated test area, consistent with obtaining adequate and reliable information from site characterization.

2.6.6.2 (UG EXC) The design of underground openings and their supports in the ESF shall utilize pillar and opening geometries that limit stress concentration, changes in rock mass permeability, and changes in rock mass deformability to levels consistent with acquiring adequate and reliable information from site characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The need for the ESF design to limit the potential for rock falls, hydraulic permeability changes, and rock mass deformability is addressed in Title I. This conclusion is based on a number of analyses of the ESF referenced in the SCP and the ESF Title I Design Summary Report. The related requirements in 10 CFR Part 60.113 and 60.133 are recognized in Title I Design (Volume 1, Section 7.2) and influenced the decision to adapt one of the controlled blasting techniques for constructing the underground openings.

ADEQUACY OF TREATMENT: Several analyses have been performed to evaluate the structural stability of openings in tuff. The ESF main test level design was analyzed by Hill (1985) using a two-dimensional finite element model. The analyses employed a nonlinear, jointed, rock constitutive law to evaluate the influence of pillar size on the stress field between parallel drifts. Differences between the current ESF design and that at the time of the analyses include the assumed ESF depth (approximately 100 m greater depth in the analyses) and several of the material property values (80% higher deformation modulus and 40% lower Poison's ratio values). The 0.2 horizontal-to-vertical stress ratio assumed in the analyses is at the low end of the range contained in Version 3.0 of the RIB (i.e., the highest deviatoric stress). Overall, the results of the analyses are likely to be conservative compared to results if average RIB values were used. Comparison of the redistributed stresses with the intact strength indicated a factor of safety of 4 around the openings. The regions of stress redistribution were localized.

St. John (1987) performed a series of analyses to evaluate the influence that dimension and shape of an emplacement drift has on the deformation and stress around the drift immediately after excavation. Several different horizontal-to-vertical stress ratios were considered and the parameter values used are very similar to those contained in Version 3.0 of the RIB. The drift dimensions analyzed varied from 22 x 16 ft to a 13 x 20 ft openings. Based on

the results of the analyses, St. John concluded that stable openings of the dimensions investigated could be constructed within a tuff rock mass with the assumed properties. Stability problems could be encountered if the in situ horizontal stress is very low (i.e., below the current estimate of the lower bound).

In summary, the analyses indicate the ESF openings are likely to be stable with only localized regions of rock failure expected. Furthermore, there are no obvious changes to the layout or drift cross sections in the ESF design that would result in significant reductions in the conditions mentioned in the criterion.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Hill, J., 1985. "Structural Analysis of the NNWSI Exploratory Shaft," SAND84-2354, Sandia National Laboratories, Albuquerque, NM.

St. John, C., 1987. "Investigative Study of the Underground Excavations for a Nuclear Waste Repository in Tuff," SAND83-7451, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.6.6.1, 2.6.6.2 [60.133(e)(2)]

2.6.6.1 (UG EXC) The main test level of the ESF shall be designed to limit overall response to excavation, including rock fall, considering all planned drifts and future drifting that may be performed in the dedicated test area, consistent with obtaining adequate and reliable information from site characterization.

2.6.6.2 (UG EXC) The design of underground openings and their supports in the ESF shall utilize pillar and opening geometries that limit stress concentration, changes in rock mass permeability, and changes in rock mass deformability to levels consistent with acquiring adequate and reliable information from site characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The need for the ESF design to limit the potential for rock falls, hydraulic permeability changes, and rock mass deformability is addressed in Title I. This conclusion is based on a number of analyses of the ESF referenced in the SCP and the ESF Title I Design Summary Report. The related requirements in 10 CFR Part 60.113 and 60.133 are recognized in Title I Design (Volume 1, Section 7.2) and influenced the decision to adapt one of the controlled blasting techniques for constructing the underground openings.

ADEQUACY OF TREATMENT: Several analyses have been performed to evaluate the structural stability of openings in tuff. The ESF main test level design was analyzed by Hill (1985) using a two-dimensional finite element model. The analyses employed a nonlinear, jointed, rock constitutive law to evaluate the influence of pillar size on the stress field between parallel drifts. Differences between the current ESF design and that at the time of the analyses include the assumed ESF depth (approximately 100 m greater depth in the analyses) and several of the material property values (80% higher deformation modulus and 40% lower Poison's ratio values). The 0.2 horizontal-to-vertical stress ratio assumed in the analyses is at the low end of the range contained in Version 3.0 of the RIB (i.e., the highest deviatoric stress). Overall, the results of the analyses are likely to be conservative compared to results if average RIB values were used. Comparison of the redistributed stresses with the intact strength indicated a factor of safety of 4 around the openings. The regions of stress redistribution were localized.

St. John (1987) performed a series of analyses to evaluate the influence that dimension and shape of an emplacement drift has on the deformation and stress around the drift immediately after excavation. Several different horizontal-to-vertical stress ratios were considered and the parameter values used are very similar to those contained in Version 3.0 of the RIB. The drift dimensions analyzed varied from 22 x 16 ft to a 13 x 20 ft openings. Based on

the results of the analyses, St. John concluded that stable openings of the dimensions investigated could be constructed within a tuff rock mass with the assumed properties. Stability problems could be encountered if the in situ horizontal stress is very low (i.e., below the current estimate of the lower bound).

In summary, the analyses indicate the ESF openings are likely to be stable with only localized regions of rock failure expected. Furthermore, there are no obvious changes to the layout or drift cross sections in the ESF design that would result in significant reductions in the conditions mentioned in the criterion.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCES:

Hill, J., 1985. "Structural Analysis of the NNWSI Exploratory Shaft," SAND84-2354, Sandia National Laboratories, Albuquerque, NM.

St. John, C., 1987. "Investigative Study of the Underground Excavations for a Nuclear Waste Repository in Tuff," SAND83-7451, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
Charles F. Voss	Charles F. Voss	2/1/89

ORGANIZATION: PNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.6.6.3 [60.133(e)(2)]

2.6.6.3 (UG-EXC) The spacing between adjacent ESF drifts shall be a minimum of two drift diameters (using the maximum diameter of either opening, and considering the closest proximity of any part of each opening) consistent with obtaining reliable and adequate information from site characterization.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

____ YES X NO ____ DON'T KNOW

RATIONALE: The general arrangement of the main test level drifts is shown in drawing FS-GA-0160. The ESF drifts listed below do not meet the minimum criterion of a two drift-diameter spacing:

LOCATION ON DWG.	DRIFT NAME	Ratio DRIFT SPACING / DIAM. LARGER DRIFT
A 3 (last 32 ft of Vertical Testing drift)	Waste Package Vertical Vertical Testing	1.9
	Waste Package Vertical	1.9
C 4	Sequential Drift Mining 1, 2, & 3	1.4
B 5	UPS alcove Service Drift No 4	1.6
C 5	Canister Scale Heater Test alcove Heated Block alcove	1.3
D 4	ES-2 North Access Drift Panel Access Drift No. 2	1.7
C 5	Service Drift No. 3 Heated Block alcove	1.1
C 5	End of Refuge Chamber Service Drift No. 3	1.9

The criterion specifies "drifts", and would appear to apply to long drifts rather than to short drifts or alcoves. Although the UPS alcove, Heater Block alcove, and Canister Scale Heater Test alcove do not strictly meet this criterion, it appears that the spacing requirement could be reduced for these alcoves. This should be the focus of additional Title II studies.

No tests will be conducted in the UPS alcove, the ES-2 North Access Drift, the Refuge Chamber, or Service Drift No. 3. The last 32 feet of the Vertical Testing drift almost meets the criterion - no impact on DOE's ability to characterize the site is expected. The Heated Block Test will be unaffected by possible interference from the Service Drift No. 3, since the heated block will be more or less isolated from the surrounding rock mass by thin slots cut into the rock. The Canister Scale Heater Test alcove is only used to provide access for instrumentation, so that any mechanical interference between this alcove and the Heated Block alcove will have a negligible impact on the Canister Scale Heater Test (which will take place in an emplacement hole 25 feet away on the other side of the Canister Scale Heater Test alcove).

Thus the principal drifts that do not meet this criterion are the three Sequential Drift Mining drifts. Unless one of the purposes of this test is to investigate drift and pillar failure under higher than expected stresses (resulting from more stress redistribution due to the locally higher extraction ratio), these drifts should be spaced a minimum of two diameters apart. There appears to be enough room in this part of the ESF to modify the layout accordingly, without impacting the overall ESF design or the ESF testing program.

A more serious violation of this criterion is the spacing between the repository drift to the southeast of the ESF and the adjacent Waste Package Vertical drift. Here the ratio of drift spacing to the diameter of the larger drift is 1.1 (this is also discussed in Criteria 2.7.6.1 and 1.15.6.3). As presently planned, this will not affect DOE's ability to characterize the site, since the repository drift is not expected to be constructed until after the Waste Package Test is completed. An interference problem could arise, however, if the Waste Package Test is extended in time to become a performance confirmation test. For this reason it seems prudent to increase the spacing between the SE Waste Package Vertical drift and the adjacent repository drift.

ADEQUACY OF TREATMENT: The criterion is not met for the Sequential Drift Mining drifts, the Waste Package Vertical drifts, and five alcoves or short drifts. Also, the proposed pillar between the SE Waste Package Vertical drift and the adjacent repository drift does not meet the criterion.

RECOMMENDATIONS AND CORRECTIVE MEASURES: As part of the Title II Design, examine the applicability of the criterion to short drifts or alcoves, and make appropriate adjustments to the layout as required. Unless one of the purposes of the Sequential Drift Mining test is to investigate the behavior of the drifts and intervening pillars at higher than expected stresses, increase the spacing between the Sequential Drift Mining drifts to meet the two drift-diameter criterion. Also, increase the width of the pillar between the

SE Waste Package Vertical drift and the adjacent repository drift to at least twice the diameter of the larger drift, i.e., at least 40 feet.

REVIEWER (PRINT)	SIGNATURE	DATE
Dermot Ross-Brown	D M Ross Brown	2/2/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

Criteria: 2.6.8.1 [60.133(e)(2)]

2.6.8.1 (UG TEST) The ESF shall be designed to limit mechanical, hydrologic, or geochemical interference between underground tests that may be associated with damage to the rock mass caused by excavation.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The potential for interference between tests and between ESF construction and operations activities and testing activities is evaluated in SCP Sections 8.4.2.3.6.1 and 8.4.2.3.6.2. Based on these evaluations, it is concluded that the criteria for limiting the extent of mechanical, hydrological, or geochemical interferences associated with damage to the rock mass caused by excavation has been satisfied by the ESF Title I design.

Operational controls included in the design to reduce the effect of excavation damage and the associated potential for mechanical, hydrological, or geochemical interference with testing include (1) plans for blast control to limit damage to surrounding rock, (2) control of fluids introduced in the shafts and main test level from mining or other sources, (3) control of dust, vibration, and traffic near sensitive experimental areas, (4) use of phased construction and testing, and (5) inclusion of sufficient separation distances between experiments and between testing and construction to reduce the potential for interference.

Using control blasting methods, it is estimated that the extent of damage to the rock will be at most 1 to 2 m into the rock face (West, 1988). These estimates were confirmed by field tests of rock permeability changes in the rock surrounding an excavation before and after mining (Zimmerman et al., 1988). Allowing for this zone of weakened material around an excavation, Costin and Bauer (1988) estimated that the changes in mechanical response of the drift were not significant, even in the absence of ground support. The estimates of hydrological zones of influence around excavations (West, 1988 and SCP Section 8.4.2.3.6.2) also included the effect of enhanced permeability zones (resulting from blast damage) of 1 to 2 m thickness around the drifts. Finally, West (1988) estimated the extent of chemical contamination resulting from explosive products to be 1 to 2 m into the drift walls. The mechanical, hydrological, geochemical zones of influence resulting from drift construction are all less than the two drift diameter standoff maintained between excavations on the main test level. In addition, tests requiring access to undisturbed rock, have provisions for drilling to points well beyond the zone of influence to conduct the test. Therefore, it can be concluded that the design limits the possibility of mechanical, hydrological, or geochemical interference to the extent practical.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.7.1.1 [60.133(f)]

2.7.1.1 (SITE) The main pad shall be constructed using excavation methods such as controlled blasting to limit damage to the underlying rock mass, to the extent that it could affect the adequacy or reliability of information from site characterization. Methods shall be designed to facilitate investigation and monitoring of such effects during and after construction.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_____ YES __X__ NO _____ DON'T KNOW

RATIONALE: Major ESF facilities are housed on the 5-1/2 acre main pad. The pad slopes away from the shafts at a 2 percent grade. The cut side of the pad to the northwest is blasted out of rock to a maximum height of 80 feet at a 1:4 horizontal to vertical slope. The main pad is shown in drawings JS-025-ESF-C3, -C4, -C6.

Excavation techniques are covered in the following H&N specifications:

Section	Title
02110	Site Clearing
02202	Rock Removal
02211	Rough Grading
02222	Excavation
02223	Backfilling
02225	Trenching

The above specifications represent standard civil engineering practice. There are no special provisions for controlling overbreak or limiting damage to the adjoining rock mass. Conventional blasting methods are unlikely to cause damage of the rock mass beyond 2 m from the walls and base of the excavation (see Table 3 of Case and Kelsall, 1987, included in the discussion of Criteria 1.16.4.2, and note that in many of the case histories blast damage was not distinguished from stress relief effects). The damage zone is small enough and far enough away from the test areas that pad construction will not interfere with site characterization tests in the shafts or the underground testing areas. While controlled drilling and blasting of rock for pad construction is not necessary to ensure that DOE's ability to characterize the site will not be compromised, careful blasting is required to avoid very large or deep blasts which might cause fracturing of the rock, especially in the vicinity of the shafts. Consequently some controls are required to specifically eliminate the possibility of the contractor drilling deep blast holes or detonating very large blasts.

ADEQUACY OF TREATMENT: The Title 1 Design does not specifically consider excavation techniques for controlling overbreak or limiting disturbance to the adjoining rock mass during pad construction. Although, in practice, the potential impact of this on DOE's ability to characterize the site is negligible, it would be prudent to impose some controls, such as specifying the maximum diameter and length of blast holes and the types of explosives which may be used.

RECOMMENDATIONS AND CORRECTIVE MEASURES: Impose controls on excavation techniques for pad construction as part of Title II design. In particular, specify the maximum diameter and length of blast holes, and the types of explosives which may be used. Also, require a Blasting Plan to be submitted for approval by the Contracting Officer at least 4 hours prior to each blast, and implement a vibration monitoring program.

REFERENCE:

Case, J.B. and P.C. Kelsall, 1987, "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
D. M. Ross-Brown	D M Ross Brown	1/31/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.7.4.1, 2.7.5.1 [60.133(f)]

2.7.4.1 (ES-1) The shaft and shaft stations of the exploratory shaft shall be constructed using controlled blasting methods, to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of information from site characterization. The methods shall be designed to facilitate investigation and monitoring of such effects during and after construction.

2.7.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Controlled blasting methods will be used to excavate the shafts and the shaft stations. The measures that will be used to limit overbreak and damage to the surrounding rock mass are covered in specifications FS-SP-0204 (Excavations for Stations, Drifts and Alcoves) and FS-SP-0205 (Controlled Drilling and Blasting). Also, see the discussions of Criteria 1.6.4.2, 1.6.4.3, and 1.6.4.4. Note that a vibration monitoring program will be implemented.

While controlled blasting methods are expected to limit blasting damage to the first 0.5 m of rock from the shaft wall (Case and Kelsall, 1987), stress redistribution as a result of creating the void will affect the stress field and permeability of the rock mass for at least 5 m from the shaft wall. The effects of stress redistribution will occur regardless of the excavation method used.

From the point of view of site characterization, it must be recognized that the volume of rock extending 5 m (or just over one opening diameter) from the shaft wall will not necessarily be representative of the rock mass as a whole. Rock properties will be less representative of the undisturbed rock mass close to the shaft wall where the effects of stress redistribution and blast damage are both at a maximum, and will become more representative as the distance from the shaft wall increases in a radial direction. Some properties will be affected more than others. Beyond the 0.5 m blast-damage zone thermomechanical and geochemical properties are not expected to be significantly affected, as compared to hydrological properties. Stress measurements, of course, will not be representative of the virgin stress field until distances from the shaft in excess of two shaft diameters are reached.

Hydrologic properties, such as permeability, are likely to be most affected within the disturbed zone surrounding the shaft. Case and Kelsall (1987, Figure 24) have calculated rock mass permeability to be enhanced by factors of approximately 60, 6.5, 3, and 2 times the value in the undisturbed state at distances of 0 - 0.5 m, 0.5 - 1 m, 1 - 2 m, 2 - 3 m, respectively, from the

shaft wall in Topopah Spring welded tuff at 310 m depth. This is the reason that permeability tests to characterize the overall rock mass will not be conducted close to the shafts. However, two tests (Excavation Effects Test, Radial Boreholes Test) will be carried out in this disturbed zone to characterize the hydrologic properties of the disturbed zone itself. This information is required for performance assessment and the design of seals.

The Excavation Effects Test is shown in drawings FS-GA-0151, 0151, -0164 and discussed in Section 8.3.1.2.2.4.5 of the SCP, while the Radial Boreholes Test is shown in drawing FS-GA-0058 and discussed in Section 8.3.1.2.2.4.4 of the SCP. Both tests will investigate and monitor stress redistribution effects, and the effectiveness of controlled blasting techniques to limit damage in the surrounding rock mass. Other tests, such as the Shaft Convergence Test (drawing FS-GA-0059 and Section 8.3.1.15.1.5.1 of the SCP) and the multi-purpose boreholes will provide data on rock mass deformation around the shaft.

In conclusion, the Title I specifications include procedures to limit overbreak and damage to the surrounding rock mass during shaft construction. In addition, the testing program is designed to investigate and monitor the effects of stress redistribution and blast damage during and after shaft construction, and to enable an evaluation to be made of the impact of these effects on other test results.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCE:

Case, J.B. and P.C. Kelsall, 1987, "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
Dermot Ross-Brown	[signature]	1/31/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.7.4.1, 2.7.5.1 [60.133(f)]

2.7.4.1 (ES-1) The shaft and shaft stations of the exploratory shaft shall be constructed using controlled blasting methods, to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of information from site characterization. The methods shall be designed to facilitate investigation and monitoring of such effects during and after construction.

2.7.5.1 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Controlled blasting methods will be used to excavate the shafts and the shaft stations. The measures that will be used to limit overbreak and damage to the surrounding rock mass are covered in specifications FS-SP-0204 (Excavations for Stations, Drifts and Alcoves) and FS-SP-0205 (Controlled Drilling and Blasting). Also, see the discussions of Criteria 1.6.4.2, 1.6.4.3, and 1.6.4.4. Note that a vibration monitoring program will be implemented.

While controlled blasting methods are expected to limit blasting damage to the first 0.5 m of rock from the shaft wall (Case and Kelsall, 1987), stress redistribution as a result of creating the void will affect the stress field and permeability of the rock mass for at least 5 m from the shaft wall. The effects of stress redistribution will occur regardless of the excavation method used.

From the point of view of site characterization, it must be recognized that the volume of rock extending 5 m (or just over one opening diameter) from the shaft wall will not necessarily be representative of the rock mass as a whole. Rock properties will be less representative of the undisturbed rock mass close to the shaft wall where the effects of stress redistribution and blast damage are both at a maximum, and will become more representative as the distance from the shaft wall increases in a radial direction. Some properties will be affected more than others. Beyond the 0.5 m blast-damage zone thermomechanical and geochemical properties are not expected to be significantly affected, as compared to hydrological properties. Stress measurements, of course, will not be representative of the virgin stress field until distances from the shaft in excess of two shaft diameters are reached.

Hydrologic properties, such as permeability, are likely to be most affected within the disturbed zone surrounding the shaft. Case and Kelsall (1987, Figure 24) have calculated rock mass permeability to be enhanced by factors of approximately 60, 6.5, 3, and 2 times the value in the undisturbed state at distances of 0 - 0.5 m, 0.5 - 1 m, 1 - 2 m, 2 - 3 m, respectively, from the

shaft wall in Topopah Spring welded tuff at 310 m depth. This is the reason that permeability tests to characterize the overall rock mass will not be conducted close to the shafts. However, two tests (Excavation Effects Test, Radial Boreholes Test) will be carried out in this disturbed zone to characterize the hydrologic properties of the disturbed zone itself. This information is required for performance assessment and the design of seals.

The Excavation Effects Test is shown in drawings FS-GA-0151, 0151, -0164 and discussed in Section 8.3.1.2.2.4.5 of the SCP, while the Radial Boreholes Test is shown in drawing FS-GA-0058 and discussed in Section 8.3.1.2.2.4.4 of the SCP. Both tests will investigate and monitor stress redistribution effects, and the effectiveness of controlled blasting techniques to limit damage in the surrounding rock mass. Other tests, such as the Shaft Convergence Test (drawing FS-GA-0059 and Section 8.3.1.15.1.5.1 of the SCP) and the multi-purpose boreholes will provide data on rock mass deformation around the shaft.

In conclusion, the Title I specifications include procedures to limit overbreak and damage to the surrounding rock mass during shaft construction. In addition, the testing program is designed to investigate and monitor the effects of stress redistribution and blast damage during and after shaft construction, and to enable an evaluation to be made of the impact of these effects on other test results.

ADEQUACY OF TREATMENT: Satisfactory

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REFERENCE:

Case, J.B. and P.C. Kelsall, 1987, "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

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Dermot Ross-Brown	D M Ross Brown	1/31/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.7.6.1 [60.133(f)]

2.7.6.1 (UG EXC) The shaft breakouts and main test level of the ESF shall be constructed using controlled blasting methods, to limit overbreak and damage to the surrounding rock mass, which could affect the adequacy or reliability of site characterization. The methods shall be designed to provide for the requirements of specific site characterization tests, such as limitations on the extent of excavation-induced damage, or the type of ground support that may be installed. The methods shall be designed to facilitate monitoring and investigation of excavation effects during and after construction.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE:

Controls to Limit Overbreak and Rock Damage

Controlled blasting methods will be used to excavate the shaft breakouts and drifts in the main test level of the ESF. The measures which will be used to limit overbreak and damage to the surrounding rock mass are included in specifications FS-SP-0204 (Excavations for Stations, Drifts and Alcoves) and FS-SP-0205 (Controlled Drilling and Blasting). Also, see the discussions for Criteria 1.6.4.2 and 1.6.4.3. Note that a vibration monitoring program will be implemented.

The study by Case and Kelsall (1987) indicated that controlled blasting methods in tuff, when carefully executed, could limit blasting damage to the first 0.5 m of rock from the shaft wall. It is anticipated that controlled blasting methods could similarly limit blasting damage to the first 0.5 m of rock in any opening in tuff, including the ESF drifts. Much will depend upon the implementation of the procedures outlined in FS-SP-0204 and FS-SP-0205, and the ability of the contractor to adapt his blasting plans to changing underground conditions (rock characteristics, geometry and configuration of excavations, direction of mining, etc.). The Title 1 specifications mentioned above indicate that the designers are aware of the potential problems and have taken steps to implement procedures to limit overbreak and damage to the surrounding rock mass.

Investigation of Excavation Effects

Stress redistribution effects due to the creation of voids is likely to be a more significant factor affecting rock properties in the disturbed zone than blasting, particularly beyond the expected 0.5 m blast-damaged zone. These effects are largely independent of the method of excavation. Furthermore, they will be more significant in the roof and walls of the underground drifts

than in the walls of the shaft at a similar depth. Examples of how the virgin stress field will be modified by the presence of the ESF drifts are shown in the report by St. John (1987, SAND83-7451) and Figure 8.4.2-38 of the SCP (from Costin and Bauer, 1988).

As mentioned in the discussion of Criteria 2.7.4.1, it must be recognized that the volume of rock within one opening diameter of the walls of an excavation may not be representative of the rock mass as a whole, especially in the roof and sides of a horizontal excavation. Much will depend upon the properties being measured. As in the case of shafts, hydrological properties, such as permeability, may be significantly affected. The results of the study on shafts by Case and Kelsall (1987) is generally indicative of the modified permeability zone that will exist around the ESF drifts (see discussion of Criterion 2.7.4.1.). However, horizontal openings, such as drifts, can be expected to have the modified permeability zone further extended into the roof of the excavation (with some reduction in the floor), as compared to shafts.

For the above reasons permeability tests to characterize the overall rock mass will not be conducted close to excavations, but generally in boreholes a minimum of one opening diameter away from the walls of an excavation.

The disturbed zone around an opening together with the size of the modified permeability zone, can be partly controlled from further deterioration with ground support. For instance, rock bolts and mesh are planned in the main test areas. Roof bolt plans are anticipated as part of the final design.

Many tests carried out in the disturbed zone around excavations will help to characterize the properties of the disturbed zone itself; this information is required for performance assessment and the design of seals. For instance hydrologic information obtained from the Excavation Effects Test and the Radial Boreholes Test carried out in the disturbed zone of the ES-1 shaft will have some applicability to the ESF drifts (refer to drawings FS-GA-0058, -0151, -0164, and sections 8.3.1.2.2.4.4 and 8.3.1.2.2.4.5 of the SCP for further details of these tests). The Shaft Convergence Test (drawing FS-GA-0059 and Section 8.3.1.15.1.5.1 of the SCP) and the multi-purpose boreholes will provide data on rock-mass deformation around the shaft.

Other tests which will directly investigate and monitor excavation effects in the disturbed zone of the underground drifts include Geologic Mapping (Section 8.3.1.4.2.2.4 of the SCP) and Plate Loading Tests (drawing FS-GA-0165 and Section 8.3.1.15.1.7.1 of the SCP) to provide data on the zone of increased fracturing around underground openings, and Overcore Stress Tests (Section 8.3.1.15.2.1.2 of the SCP) to provide data on stress redistribution and changes in deformation modulus around these openings.

The Demonstration Breakout Rooms (drawings FS-GA-0150, -0151, -0161, -0165 and Section 8.3.1.15.1.5.2 of the SCP) and the Sequential Drift Mining Test (drawing FS-GA-0165 and Section 8.3.15.1.5.3 of the SCP) will provide data on the deformation response of underground drifts. A table summarizing all the activities that monitor the effects of site characterization is attached.

Allowance for Excavation Effects on the Testing Program

There are three categories of potential interference concerns affecting the underground tests, namely, construction/operation interference, test-to-test interference, and interference between the ESF and repository layouts (see Section 8.4.2.3.6 of the SCP). There are four main mechanisms of interference, namely, mechanical, thermal, hydrologic and chemical. Table 8.4.2-14 from the SCP (attached) gives the potential interference effects for each test. In evaluating construction methods using controlled blasting, mechanical effects are of prime concern but it must be recognized that there are coupling effects between mechanical and the other three mechanisms.

An analysis of the layout with regard to the potential for construction or operational interference is included in Section 8.4.2.3.6.2 of the SCP. The conclusions are that the layout is consistent with the constraints imposed upon the design by the experimental program, and that no constraints were found which were not addressed directly or indirectly by the design.

The analysis of test-to-test inference is included in Section 8.4.2.3.6.1 of the SCP. Zones of influence were estimated for each experiment, based upon numerical analyses, results of prototype tests, and assumptions regarding the physical nature of the rock mass. An overlay of the zones of influence for each main level test was made (Figure 8.4.2-39 of the SCP), and the conclusion drawn that the current layout provides sufficient separation between tests for the mechanisms analyzed. (See also the discussion of Criterion 2.6.6.3)

Potential interference between the ESF and repository layouts is considered in Section 8.4.2.3.6.3 of the SCP. There are a number of concerns addressed in that analysis which will need to be revisited in Title II. For instance, the standoff distance between the repository drift to the southeast of the ESF is separated from the adjacent Waste Package Vertical drift by a pillar only 22 feet wide (see Drawing FS-GA-0160). This is less than the generally recommended standoff of two drift diameters (also, see discussion of Criteria 1.15.6.3 and 1.16.6.3). Therefore it is recommended that a modification be made to the layout in Title II to increase this pillar width to 40 feet (i.e., twice the diameter of the larger drift). Since the repository drift is not expected to be excavated until after the waste package tests are complete, it would not in any case interfere with the quality of the data obtained from these tests. However, this does not allow for the possibility of the Waste Package Test being extended in time and becoming part of the performance confirmation program.

Conclusion

The Title I specifications include procedures to limit overbreak and damage to the surrounding rock mass during excavation of the shaft breakouts and the drifts on the main test level. The testing program includes provisions to investigate and monitor the effects of stress redistribution and blast damage during and after construction of the drifts. Finally, the potentially adverse effects of blast damage and stress redistribution have been taken into account in designing the ESF tests, and allowances for these effects are anticipated when the individual test results are interpreted.

ADEQUACY OF TREATMENT: In general, the treatment is adequate. However, the proposed pillar between the repository and the southeast edge of the ESF is only 22 feet wide. This will have no impact on the quality of data obtained in the Vertical Waste Package Test since the repository drift is not expected to be excavated until after the test is completed. The repository drift might interfere with the test, if the test is extended in time and becomes part of the repository confirmation program.

RECOMMENDATIONS AND CORRECTIVE MEASURES: The pillar between the repository and the SE side of the ESF should be increased to at least twice the diameter of the larger drift i.e., at least 40 feet.

REFERENCES:

Case, J.B. and P.C. Kelsall, 1987. "Modification of Rock Mass Permeability in the Zone Surrounding a Shaft in Fractured, Welded Tuff," SAND86-7001, Sandia National Laboratories, Albuquerque, NM.

St. John, C., 1987. "Investigative Study of the Underground Excavations for a Nuclear Waste Repository in Tuff," SAND83-7451, Sandia National Laboratories, Albuquerque, NM.

REVIEWER (PRINT)	SIGNATURE	DATE
Dermot Ross-Brown	D M Ross-Brown	1/31/89

ORGANIZATION: SAIC

ACTIVITIES THAT MONITOR EFFECTS OF SITE CHARACTERIZATION

TITLE OF ACTIVITY	DESCRIPTION
• ARTIFICIAL RECHARGE; MATRIX HYDROLOGIC PROPERTIES; SITE BOREHOLES	• MONITOR INFILTRATION RATE AND TRACERS IN WATER
• RADIAL BOREHOLE TESTS; EXCAVATION EFFECTS; PLATE LOAD	• MONITOR EXCAVATION EFFECTS ON PROPERTIES
• PERCHED WATER; HYDRO-CHEMISTRY; MPBH; HYDRO-CHEMICAL SATURATED ZONE	• MONITOR PERCHED WATER, DRILLING FLUID CONTAMI-NATION IN SATURATED AND UNSATURATED ZONE
• GEOLOGIC MAPPING; OVERCORE STRESS	• MONITOR EXCAVATION EFFECTS ON SITE CONDITIONS

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ACTIVITIES THAT MONITOR EFFECTS OF SITE CHARACTERIZATION
(CONTINUED)

TITLE OF ACTIVITY	DESCRIPTION
• HEAT CAPACITY; THERMAL CONDUCTIVITY AND EXPANSION; AIR QUALITY	• CONFIRM DATA VALUES FOR CALCULATING RESPONSES
• VARIABLE CONDITIONS ON MECHANICAL PROPERTIES AND FRACTURES	• INVESTIGATE EFFECTS OF VARIABLE ENVIRONMENTAL CONDITIONS ON SAMPLES AND FRACTURES
• SHAFT CONVERGENCE; DBR; SEQUENTIAL DRIFT MINING; HEATER (TSw1); CANISTER SCALE HEATER, HEATED BLOCK, THERMAL STRESS, HEATED ROOM	• ROOM SCALE MONITORING OF STABILITY, DEFORMATION AND THERMAL AND MECHANICAL RESPONSE
• MINING METHODS, GROUND SUPPORT, DRIFT STABILITY	• MONITORING EFFECTS OF MINING OPERATIONS

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Table 8.4.2-14. Categories of effects considered in evaluating the zone of influence for each site characterization test (page 1 of 3)

Test	Mechanical[a]	Thermal[b]	Hydrologic[c]	Chemical[d]	No effects[e]
Geologic mapping of the exploratory shaft and drifts					X
Fracture mineralogy studies of exploratory shafts and drifts					X
Seismic tomography and vertical seismic profiling					X
Shaft convergence	X				
Demonstration breakout rooms	X				
Sequential drift mining	X				
Heater experiment in unit TSw1		X			
Canister-scale heater experiment		X			
Yucca Mountain heated block	X	X			
stress measurements	X	X			
Heated room experiment	X	X			
Development and demonstration of required equipment					X
Plate loading tests	X				
Rock mass strength experiment	X				

Table 8.4.2-14. Categories of effects considered in evaluating the zone of influence for each site characterization test (page 2 of 3)

Test	Mechanical[a]	Thermal[b]	Hydrologic[c]	Chemical[d]	No effects[e]
Monitoring drift stability					X
Air quality and ventilation					X
Evaluation of mining methods					X
Evaluation of ground support systems					X
Seal components testing			To be determined		
Overcore stress experiments					X
Matrix hydrological properties testing					X
Intact-fracture test	X				
Percolation tests	X		X		
Bulk permeability test	X		X		
Radial borehole tests			X		
Excavation effects test					X
Perched water test					X
Hydrochemistry tests					X
Diffusion tests				X	

Table 8.4.2-14. Categories of effects considered in evaluating the zone of influence for each site characterization test (page 3 of 3)

Test title	Mechanical[a]	Thermal[b]	Hydrologic[c]	Chemical[d]	No effects[e]
Chloride and chlorine-36 measurements					X
Engineered barrier system field tests (waste package test)	X	X			
Laboratory tests of geoengineering properties					X
Hydrologic properties of faults	x		x		
Multipurpose boreholes[f]	x[g]				

[a]Mechanical effects include stress alteration due to the drifting required for the test as well as due to the test itself and potential interferences from instrumentation arrangement. The effects do not explicitly include rock damage resulting from the controlled blasting mining method or stress alterations due to general construction in the exploratory shaft facility; these construction effects are considered in the discussions of constraints related to standoff from service drifts that provide access to the testing areas.

[b]Thermal effects include coupled effects resulting from the addition of heat; e.g., vapor movement resulting from heating

[c]Hydrologic effects include only the effects from the fluids added to the formation by the test. Fluids used in construction are not included.

[d]Chemical effects include the effects from tracers in fluids used in construction and in chemical analyses of explosives and by-products resulting from blasting materials.

[e]No effects means no physical mechanism was identified that would cause additional perturbation to the natural condition (stress, temperature, moisture, etc.) from conducting this test. Test may be primarily observational or laboratory based with only sample collection activities in the underground excavations.

[f]Multipurpose boreholes MP-1 and MP-2 are described in Section 8.3.1.2.2.4.9.

[g]Zone of influence is based upon a preliminary evaluation of multipurpose borehole concepts.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.1.1 [60.137]

2.8.1.1 (SITE) The ESF site shall be designed to facilitate appropriate performance confirmation measurement and monitoring to obtain adequate and reliable information about the site. The performance confirmation program shall include measurement and monitoring of the performance of the ESF site to the extent that aspects of the site are part of the geologic setting that could contribute to the waste isolation performance of a repository.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

____ YES ____ NO X DON'T KNOW

RATIONALE: No explicit plan or methodology for performance confirmation measurements or monitoring in regard to the above-ground portion of the ESF was found during review of the Title I documents or the SCP. In the sense that the ESF site (interpreted to mean the above-ground part of the ESF) supports all operations (including testing) in the underground facility and shafts for the designated operational period, the current design implicitly addresses the criterion. Also, it seems possible that, because excavation of the two shafts would logically cause most insult to the site, the multipurpose boreholes planned to be dry-drilled near each shaft (SCP Sec. 8.4.2, p. 145) could be part of a performance confirmation program to monitor long-term, near-surface changes in site conditions at the surface facility even though the current expressed purpose is to monitor behavior of the rock mass between each MPBH and the nearby shaft in response to shaft sinking.

ADEQUACY OF TREATMENT: Title I design appears not to preclude meeting this criterion, but treatment needs to be more explicit.

RECOMMENDATIONS AND CORRECTIVE MEASURES: A methodology for performance confirmation activities that address the ESF site needs to be formulated or clarified in Title II design. This might include a strategy for assembling "baseline" data accumulated in appropriate surface-based testing on and close to the ESF site.

REVIEWER (PRINT)	SIGNATURE	DATE
W. A. Girdley	W. A. Girdley	1-27-89

ORGANIZATION DOE/YMP

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.4.1 [60.137]

2.8.4.1 (ES-1) The configuration of the shaft shall be adequate to support site performance confirmation testing and future performance confirmation testing that may be reasonably expected for site characterization. This shall include an allowance to accomodate site-specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The 12-foot shaft diameter provides for the equipment and working space required for drilling horizontal boreholes where needed for testing (Title I, Vol. I, p. 0-5 and Sec. 3.5) as well as supporting material handling and ventilation requirements. The shaft size and outfitting, as well as construction plan, are designed to support tests already identified and to maintain flexibility (SCP Sec. 8.4.2, p. 218-219) to relocate planned tests as may be required by specific conditions encountered as shaft sinking progresses. Additional testing could be implemented following construction and outfitting of the shaft if needed, as the unreinforced liner could be drilled or small sections removed to install test instruments; results of full coverage geologic mapping during shaft sinking would provide information for revisiting a selected geologic feature. Flexibility of location of additional tests would be limited by consideration of zone of influence with regard to on-going tests. Provision for flexibility in connecting to utilities, including the IDS, and configuration of the working stage system allows access to most of the shaft length. Because the shaft is designed as a ventilation conduit for the duration of planned repository operation, access for performance confirmation testing should be sufficient to gather needed data.

ADEQUACY OF TREATMENT: There is considerable emphasis in the design on planning for ES-1 to be capable of providing access needed for data gathering. Treatment emphasizes site characterization, but the design seems equally capable of supporting performance confirmation testing.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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W. A. Girdley	W. A. Girdley	1-27-89

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.4.2 [60.137]

2.8.4.2 (ES-1) The shafts of the ESF shall be designed to facilitate performance confirmation testing to obtain adequate and reliable information about the site, during and after construction, as required for the geologic repository by 10 CFR 60, Subpart F.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES (Qualified) ____ NO ____ DON'T KNOW

RATIONALE: Details of planned performance confirmation testing are still to be defined, although the SCP (Section 8.3.6.16) indicates that some of the planned site characterization tests will produce baseline data in what is regarded as the initial phase of performance confirmation testing and that the second phase will be designed in part on the basis of these data. Therefore, no explicit treatment of this criterion was found in the Title I design documents. This assessment is made therefore on the basis that the design provides for stability and environmental protection needed for long-term tests selected to provide performance data. Appendix B of the SDRD provides specific design requirements for installation of test equipment in a manner that provides protection both from traffic activity and adverse environmental conditions where required. Instrument alcoves are included in the design for selected tests planned for site characterization but which may become performance confirmation tests once baseline site data are collected. The IDS on which several tests depend for data collection and transfer, is similarly protected.

ADEQUACY OF TREATMENT: The shaft design does not directly address performance confirmation testing in terms of this criterion, but the testing requirements and constraints in the SDRD specify such design accommodations.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.4.3, 2.8.5.3 [60.137]

2.8.4.3 (ES-1) The shafts of the ESF shall be designed so that baseline performance confirmation data can be acquired, pertaining to parameters and natural processes that may be significantly altered by site characterization. In addition, the ESF shall be designed to facilitate monitoring of changes to the baseline condition of parameters that could affect performance of a geologic repository.

2.8.5.3 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on selected sections of Volume I of the ESF Title I design report and the testing and operations descriptions given in SCP Section 8.4.2, it can be concluded that the criteria for providing the ability to acquire baseline performance confirmation data and to facilitate monitoring of changes to the baseline data is addressed by the design.

Several direct means of acquiring baseline data are provided in the design. First, before shaft construction is begun, the MPBH boreholes will be completed to depth and baseline measurements of hydrological properties in the vicinity of the shafts will be recorded. The MPBHs will also be used for long term monitoring of changes to hydrological and geochemical properties as the shaft is constructed and for the following performance period. Second, pilot holes for in situ stress measurement and other baseline rock property measurements will be drilled ahead of the shaft face as construction proceeds. Third, contingency test are provided for in the event perched water or other unusual ground conditions are encountered. Fourth, Shaft tests such as the radial boreholes test are intended to monitor changes near-shaft hydrology and measure the extent of construction water movement into the rock. Fifth, load cells will be cast into the shaft liner at several stations in order to monitor the changes in liner loading as the shaft is constructed and throughout the performance confirmation period to insure that the shafts remain stable and safe for operations. Finally, the ventilation system for the underground will be continuously monitored and a water balance performed to determine if there are net gains or losses to the quantity of water in the natural hydrological system

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.5.1 [60.137]

2.8.5.1 (ES-2) The configuration of the shaft shall be adequate to support site performance confirmation testing and future performance confirmation testing that may be reasonably expected for site characterization. This shall include an allowance to accomodate site-specific conditions encountered in the shaft without adversely affecting testing that is planned or ongoing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES (Qualified) ____ NO ____ DON'T KNOW

RATIONALE: ES-2 is not designed specifically for testing purposes, and Title I design does not explicitly address ES-2 in this regard. However, ES-2 has essentially the same capabilities to support testing, if necessary, as ES-1; although use of ES-2 for any long-term performance confirmation testing would probably have to await completion of mining the underground excavations. The 12-foot shaft diameter provides for the equipment and working space required for drilling horizontal boreholes where needed for testing (Title I, Vol. I, p. 0-5 and Sec. 3.5) as well as supporting material handling and ventilation requirements. The shaft size and outfitting, as well as construction plan, are designed to support tests already identified and to maintain flexibility (SCP Sec. 8.4.2, p. 218-219) to relocate planned tests as may be required by specific conditions encountered as shaft sinking progresses. Additional testing could be implemented following construction and outfitting of the shaft, if needed, as the unreinforced liner could be drilled or small sections removed to install test instruments; geologic mapping, though not anticipated to be as detailed as in ES-1, during shaft sinking would provide information for revisiting a selected geologic feature. Flexibility of location of tests would be limited by consideration of zone of influence with regard to on-going tests, if any, or operational requirements. Because the shaft is designed as a ventilation conduit for the duration of planned repository operation, access for performance confirmation testing should be sufficiently long to gather needed data.

ADEQUACY OF TREATMENT: There is considerable emphasis in the design on planning for ES-1 to be capable of providing access needed for data gathering. Treatment emphasizes site characterization, but the design seems equally capable of supporting performance confirmation testing. The general configuration of ES-2 appears capable of also supporting performance confirmation testing, but its use in this respect is not specifically addressed in the design documents.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.5.2 [60.137]

2.8.5.2 (ES-2) The shafts of the ESF shall be designed to facilitate performance confirmation testing to obtain adequate and reliable information about the site, during and after construction, as required for the geologic repository by 10 CFR 60, Subpart F.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES (Qualified) ____ NO ____ DON'T KNOW

RATIONALE: Details of planned performance confirmation testing are still to be defined, although the SCP (Section 8.3.6.16) indicates that some of the planned site characterization tests will produce baseline data in what is regarded as the initial phase of performance confirmation testing and that the second phase will be designed in part on the basis of these data. Therefore, no explicit treatment of this criterion was found in the Title I design documents. Also, ES-2 is not specifically designed as a science shaft, although its configuration is such that it is reasonable to consider that it can accomodate testing if needed. This assessment is made therefore on the basis that the design provides for stability and environmental protection needed for long-term tests selected to provide performance data. Appendix B of the SDRD provides specific design requirements for installation of test equipment in a manner that provides protection both from traffic activity and adverse environmental conditions where required. Instrument alcoves are included in the design for selected tests planned for site characterization but which may become performance confirmation tests once baseline site data are collected. The IDS, on which several tests depend for data collection and transfer, is similarly protected. It would probably be necessary to formulate test protection requirements, similar to those developed for ES-1 planned tests, to accompany any future decision to utulize ES-2 for performance confirmation testing.

ADEQUACY OF TREATMENT: The shaft design does not directly address performance confirmation testing in terms of this criterion, but the testing requirements and constraints for ES-1 tests should be equally applicable to ES-2.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.4.3, 2.8.5.3 [60.137]

2.8.4.3 (ES-1) The shafts of the ESF shall be designed so that baseline performance confirmation data can be acquired, pertaining to parameters and natural processes that may be significantly altered by site characterization. In addition, the ESF shall be designed to facilitate monitoring of changes to the baseline condition of parameters that could affect performance of a geologic repository.

2.8.5.3 (ES-2) Same as above.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on selected sections of Volume I of the ESF Title I design report and the testing and operations descriptions given in SCP Section 8.4.2, it can be concluded that the criteria for providing the ability to acquire baseline performance confirmation data and to facilitate monitoring of changes to the baseline data is addressed by the design.

Several direct means of acquiring baseline data are provided in the design. First, before shaft construction is begun, the MPBH boreholes will be completed to depth and baseline measurements of hydrological properties in the vicinity of the shafts will be recorded. The MPBHs will also be used for long term monitoring of changes to hydrological and geochemical properties as the shaft is constructed and for the following performance period. Second, pilot holes for in situ stress measurement and other baseline rock property measurements will be drilled ahead of the shaft face as construction proceeds. Third, contingency test are provided for in the event perched water or other unusual ground conditions are encountered. Fourth, Shaft tests such as the radial boreholes test are intended to monitor changes near-shaft hydrology and measure the extent of construction water movement into the rock. Fifth, load cells will be cast into the shaft liner at several stations in order to monitor the changes in liner loading as the shaft is constructed and throughout the performance confirmation period to insure that the shafts remain stable and safe for operations. Finally, the ventilation system for the underground will be continuously monitored and a water balance performed to determine if there are net gains or losses to the quantity of water in the natural hydrological system

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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Laurence S. Costin	Laurence S. Costin	1/31/89

ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.6.1 [60.137]

2.8.6.1 (UG EXC) The shaft breakouts and main test level of the ESF shall be designed to facilitate performance confirmation testing, during and after construction, as required for the geologic repository by 10 CFR 60, Subpart F.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on an evaluation of selected parts of Volumes 1 and 2 of the ESF Title I design report and SCP Section 8.4.2, it can be concluded that the ESF design will facilitate performance confirmation testing, both during and after construction of the main test level.

The performance confirmation program and associated tests are, as yet, not sufficiently defined to conduct an evaluation on a test-by-test basis. However, the design and layout of the ESF main test level provides sufficient flexibility in space, construction capabilities, and operational plans that any reasonable suite of performance confirmation tests could be constructed and performed. If required, development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area. Ventilation, hoisting, and utilities (Volume 1 Section 3) have sufficient additional capacity to accommodate both the site characterization tests and any reasonable performance confirmation tests. Mining of additional drifts in the dedicated test area for performance confirmation testing could be performed in conjunction with development of the site characterization test areas and the mining of the exploratory drifts. Additional drifting outside the dedicated test, for performance confirmation testing, could also be supported.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.6.2 [60.137]

2.8.6.2 (UG EXC) The shaft breakouts and main test level of the ESF shall be designed so that baseline performance confirmation data can be acquired, pertaining to parameters and natural processes that may be significantly altered by site characterization. In addition, the ESF shall be designed to facilitate monitoring of changes to the baseline condition of parameters that could affect performance of a geologic repository.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

X YES ____ NO ____ DON'T KNOW

RATIONALE: Based on selected sections of Volume 1 of the ESF Title I design report and the testing and operations descriptions given in SCP Section 8.4.2, it can be concluded that the criteria for providing the ability to acquire baseline performance confirmation data and to facilitate monitoring of changes to the baseline data is addressed by the design.

Several direct means of acquiring baseline data are provided in the design. First, before shaft construction is begun, the MPBH boreholes will be completed to depth and baseline measurements of hydrological properties in the vicinity of the shaft breakouts will be recorded. The MBPHs will also be used for long term monitoring of changes to hydrological and geochemical properties as the construction of the main test level proceeds. Second the excavation effects tests will be used acquire baseline data from the shaft breakouts at the upper and lower DBRs. Third, contingency tests are provided for in the event perched water or other unusual ground conditions are encountered. Fourth, several tests are planned for the long exploratory drifts to monitor changes in ground support and drift closure, to insure that the designed ground support is sufficient to insure stable drifts for the 100 yr expected lifetime. Finally, the ventilation system for the underground will be continuously monitored and a water balance performed to determine if there are net gains or losses to the quality of water in the natural hydrological system.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.6.3, 2.8.7.1 [60.137]

2.8.6.3 (UG EXC) The ESF underground excavation shall be of adequate size to support performance confirmation testing and future testing that may be reasonably expected for performance confirmation. This shall include an allowance to accommodate site specific conditions encountered in the dedicated test area.

2.8.7.1 (UG UTIL) The design of underground utilities for the ESF shall be capable of supporting the performance confirmation testing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

__X__ YES _____ NO _____ DON'T KNOW

RATIONALE: Based on an evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed to support performance confirmation testing and future testing that may be reasonably expected for performance confirmation.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to support a reasonable performance confirmation testing program and allow for for additional testing if needed. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate a performance confirmation test program, in addition to site characterization tests. Reasonable expansion of the testing programs can also be accommodated. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

Uncertainties in ground conditions and water flow are always part of any mining operation. The underground design for the ESF, therefore, provides for flexibility in ground support to ensure stable drifts for all areas. The ground support design is based on rock quality determinations and, thus, is tailored to the specific ground conditions encountered (Table 6-1). Additional ground support may be required in experimental areas where severe environmental conditions may be imposed on the rock mass. In addition, poor rock conditions or excessive water may be encountered in planned test areas requiring the relocation of some tests. Additional area is provided for this contingency. Further, in the exploratory drifting for site characterization

and for any additional exploratory drifting that may be done for, pilot holes will be drilled ahead of an advancing drift to ensure that the construction methods and ground support are sufficient to provide support for the next section of the drift. Design changes can be made to accommodate changes in ground conditions as they are encountered.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.6.4 [60.137]

2.8.6.4 (UG EXC) The design of the shaft breakouts and main test level of the ESF shall: limit the extent of interference between characterization tests, performance confirmation tests and ESF construction and operation activities.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The potential for interference between tests and between ESF construction and operations activities and testing activities is evaluated in SCP Sections 8.4.2.3.6.1 and 8.4.2.3.6.2. Although no performance confirmation test program has yet been sufficiently defined to determine whether the criteria has been satisfied, a methodology exists that would ensure that the interference between characterization test and other activities would be considered in the design and layout of those tests.

The design seeks to limit test-to-test interference by insuring that tests are sufficiently separated such that the zones of influence of the tests do not overlap (SCP Figure 8.4.2-39). In addition, the test locations and layout are flexible enough to allow for relocation or additional separation between tests if required. The estimates of zones of influence of each test are based on thermal, mechanical, hydrological, and geochemical analyses of preliminary test configurations. During Title II design, performance confirmation testing, if defined will be included in the layout and analyzed for interference potential.

Construction-to-test interference is limited by the design by (1) locating tests areas sufficiently far from the shafts that the potential for mechanical or hydrological interference from shaft construction is minimal, (2) separating experiment areas from shop and training areas, (3) locating experiments requiring isolation from construction activities farthest away from ES-2 and the haulage drifts, (4) arranging the muck handling area near ES-2 in such a way that dumping and muck removal operations are isolated from the testing areas-in the dedicated test area (Drawings FS-GA-0160 and FS-GA-0110), and (5) incorporating flexibility in the layout to accommodate site specific conditions.

ADEQUACY OF TREATMENT: Treatment is adequate for Title I Design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.6.5 [60.137]

2.8.6.5 (UG EXC) The design of the shaft breakouts and main test level shall have sufficient flexibility to: (1) relocate experiments as necessary to limit interference between tests, (2) incorporate additional performance confirmation tests, as needed, in the dedicated test area, and, (3) accommodate schedule changes as required.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: The flexibility of the underground excavations to accommodate test location acceptance and interference criteria and to provide for additional testing (performance confirmation or site characterization) or development of other areas is discussed in SCP Section 8.4.2.3.6.4. Based on this evaluation and sections of Volume 1 and 2 of the ESF Title I design report, it is concluded that sufficient flexibility in the design exists to satisfy the criteria to provide flexibility to relocated tests if necessary, to perform additional tests, to develop other areas, and to accommodate schedule changes.

Flexibility for relocation of tests because of poor ground conditions, interference concerns, or undesirable local hydrology is provided by insuring that there is sufficient area near each proposed test location to provide for alternate siting or orientation changes without violating the interference constraints from nearby testing or construction.

The design also provides ample space for additional testing within the boundary of the dedicated test area SCP Figure 8.4.2-4). If necessary some operational areas could be converted to test areas or additional test areas could be developed.

Sufficient flexibility in the construction and operations plans to extend the scope of many of the planned activities and open additional regions for exploration or testing was included in the design. If deemed necessary, shaft sinking and mining operations could continue into the Calico Hills horizon or additional areas in the Topopah Spring Member could be explored by mining along planned repository drifts (at repository grade) as far as the planned repository boundary. Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) and other support facilities are design to support additional mining capability (drilling jumbos, muck haulers, blasting crews, etc.) so that additional mining could be done without greatly compromising the schedule.

The operational schedule for development of the underground areas and the coordination with testing activities has significant latitude to accommodate delays in the construction of the main test level if additional testing is added. In addition, the design allows the rate of excavation to increase so

that multiple test areas could be constructed simultaneously. Further mining capacity could be gained by adding mining equipment. The mining capacity is essentially limited only by the capacity of the ventilation system, which was designed with a capacity exceeding that required to support planned activities (Volume 1, Sections 3.3.1 and 3.8.4).

ADEQUACY OF TREATMENT: Treatment is adequate for Title I design

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.6.3, 2.8.7.1 [60.137]

2.8.6.3 (UG EXC) The ESF underground excavation shall be of adequate size to support performance confirmation testing and future testing that may be reasonably expected for performance confirmation. This shall include an allowance to accommodate site specific conditions encountered in the dedicated test area.

2.8.7.1 (UG UTIL) The design of underground utilities for the ESF shall be capable of supporting the performance confirmation testing.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Based on an evaluation of selected parts of Volumes 1 and 2 of the ESF Title I Design Report and the design description in SCP Section 8.4.2 and the evaluation of design flexibility presented in SCP Section 8.4.2.3.6.4, it is concluded that the ESF has been designed to support performance confirmation testing and future testing that may be reasonably expected for performance confirmation.

In the underground excavations, the dedicated test area and the adjacent area set aside for performance confirmation testing are sufficient to support a reasonable performance confirmation testing program and allow for for additional testing if needed. Development of additional drifts inside or outside the dedicated test area could be supported without disturbing the planned testing in the dedicated test area because the haulage to and the muck handling at ES-2 is designed to isolate these activities from the testing areas (Drawing FS-GA-0160 and FS-GA-0110).

Ventilation (Volume 1, Sections 3.3.1 and 3.8.4), hoisting (Volume 1, Sections 3.3.2.6, 3.5.5, and 3.6.5), and utilities (Volume 1, Section 3.8) have sufficient additional capacity to accommodate a performance confirmation test program, in addition to site characterization tests. Reasonable expansion of the testing programs can also be accommodated. Mining of the exploratory drifts and additional mining of test drifts in the dedicated test area could be conducted simultaneously.

Uncertainties in ground conditions and water flow are always part of any mining operation. The underground design for the ESF, therefore, provides for flexibility in ground support to ensure stable drifts for all areas. The ground support design is based on rock quality determinations and, thus, is tailored to the specific ground conditions encountered (Table 6-1). Additional ground support may be required in experimental areas where severe environmental conditions may be imposed on the rock mass. In addition, poor rock conditions or excessive water may be encountered in planned test areas requiring the relocation of some tests. Additional area is provided for this contingency. Further, in the exploratory drifting for site characterization

and for any additional exploratory drifting that may be done for, pilot holes will be drilled ahead of an advancing drift to ensure that the construction methods and ground support are sufficient to provide support for the next section of the drift. Design changes can be made to accommodate changes in ground conditions as they are encountered.

ADEQUACY OF TREATMENT: Treatment is considered adequate for Title I

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION: SNL

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.7.2 [60.133(b)]

2.8.7.2 (UG UTIL) The underground utilities for the ESF shall not preclude monitoring and investigation of in situ conditions and shall be designed to accomodate site specific conditions, construction, and operation of the ESF.

CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: Functional requirements (#3) in the SDRD (1.2.6.7) provide for the distribution of utilities around the operations area of the MTL in such a manner to allow for flexibility in siting and construction of testing locations. Uncertainty allowances for utilities have been considered in Title I (SDRD, 1.2.6.0) to provide for capabilities beyond those required to support the current conceptual design. For example, the mine power center is fully backed up by surface standby generators which are in turn backed up by the UPS system that feeds all subsurface critical loads, and redundancy is also designed in the lighting, ventilation, and other utilitiy systems (Title I, Vol. I, Sec. 6.6).

ADEQUACY OF TREATMENT: Considerable emphasis has been placed on utility flexibility and redundancy in the Title I documents.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 2.8.8.1 [60.137]

2.8.8.1 (UG TEST) Performance confirmation testing shall be conducted in the ESF during and after construction to meet the requirements which pertain to such testing in the geologic repository as stated in 10 CFR 60, Subpart F.

HAS THE CRITERIA BEEN ADDRESSED IN THE ESF TITLE I DESIGN?

_X_ YES ____ NO ____ DON'T KNOW

RATIONALE: SCP Section 8.3.5.16 describes performance confirmation testing to be conducted in two phases in which an initial, baseline phase, will involve collection of a subset of data from selected tests designed principally for site characterization. Results from these initial data are to be utilized in planning future performance confirmation tests conducted during the second, performance confirmation, phase. Some site characterization tests initiated during construction are planned to be continued as performance confirmation tests (i.e., seal tests, room heater experiment, engineered barrier field system test). The current design provides both space and support facilities to accommodate performance confirmation testing and includes the flexibility in space and utilities to extend future testing as may be required.

ADEQUACY OF TREATMENT: Adequate in view of design provisions to accommodate performance confirmation testing and the unexpected likelihood that much detail could be given for performance confirmation testing prior to obtaining baseline site characterization data.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

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ORGANIZATION DOE/YMP

CRITERIA 3

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.1.4.1 [60.15(b)]

3.1.4.1 (ES-1)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.5.1 (ES-2)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.6.1 (UG EXC)	The main test level shall be constructed at the planned horizon
3.1.8.1 (UG TEST)	Underground testing shall be conducted in a facility constructed at the planned repository horizon

HAVE THE CRITERIA BEEN ADDRESSED IN THE DESIGN?

✓ Yes _____ No _____ Don't know

RATIONALE: The waste emplacement horizon is indicated broadly in Chapter 6 of the SCP, as the TSw2 unit (Ortiz et al., 1985). Because of potential variability in stratigraphic conditions that may be encountered during site characterization relative to what is presently known from pre-site characterization studies, the exact repository waste emplacement horizon is not specified in the SCP Conceptual Design Report (SNL, 1987). However, explanation of the rationale for the selection of the horizon for waste emplacement and the main test level of the ESF is provided by a Project position paper (memorandum, Vieth to Stein, 3-13-87).

The elevation of the main test level of the ESF is stated on Drawing FS-GA-0057 Rev.C of the Title I ESF Design Package, and is consistent with the horizon selection in the position paper. The exploratory shafts are connected by the main test level. The Title I ESF design and supporting documentation therefore meet this criterion.

REFERENCES

Ortiz, T.S., R.L. Williams, F.B. Nimick, B.C. Whittet, and D.L. South, 1985, "A Three-dimensional Model of Reference Thermal/Mechanical and Hydrological Stratigraphy at Yucca Mountain, Southern Nevada," Sandia National Laboratories report SAND84-1076.

SNL, 1987: Site Characterization Plan Conceptual Design Report, Sandia National Laboratories report SAND84-2641.

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	E L Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 3.1.4.2 [60.15(b)]

3.1.4.2 (ES-1) Selection of the horizon for the main test level shall be based on evaluation of stratigraphic information sources available during construction (e.g., from the MPBH activity, geologic mapping of the shafts, and a probe corehole drilled ahead of the shaft face in portions of the shaft) with respect to explicit horizon criteria.

3.1.5.2 (ES-2) Selection of the horizon for the main test level shall be based on evaluation of stratigraphic information sources available during construction (e.g., from the MPBH activity, geologic mapping of the shafts, and a probe corehole drilled ahead of the shaft face in portions of the shaft) with respect to explicit horizon criteria.

HAS THE CRITERION BEEN ADDRESSED IN THE DESIGN?

_✓_ Yes ____ No ____ Don't know

RATIONALE: Criteria for selection of the main test level breakout horizon are reasonably well defined in supporting documentation, including Chapter 6 of the SCP, the SCP-Conceptual Design Report, and a Project position paper on major changes to the ESF design (memorandum, Vieth to Stein, 3-13-87). However, there is significant ambiguity as to when the MTL breakout decision is to be made, and based on what information.

There is likely to be some uncertainty as to the breakout elevations in any shaft construction project. Either the uncertainty doesn't matter and the facility is constructed according to a priori specifications, or data collected during construction are used for the final selection. SCP Section 8.4.2.3.4.4 indicates that the MTL horizon selection will fall into the latter category. There are various information sources which may contribute to the horizon selection before and during construction, but which may or may not be available depending on the success of several activities.

Present uncertainty is related to the distance from the shafts to drillhole USW G-4, and to different methods for interpolating/extrapolating the stratigraphic contacts using drillhole information. One method involves using the caprock dip augmented by oriented core data from USW G-4, to project the contact from G-4. Another method involves using contact depth from various coreholes (e.g., USW G-4, UE25 a#1, USW G-1) to constrain a least-squares-based interpolative geometric model. In this reviewer's experience, the difference between the depth to the MTL at the shaft locations calculated by these different methods can be more than 100 feet depending on the assumptions made. The value used in the ESF Title I design is thus a consensus value (see SDRD ECR 003) with considerable uncertainty.

The MTL selection interfaces with these ESF design features: ESF drainage plan, integration of ESF drainage with repository drainage, haulage plans for development of the dedicated test area and the long drifts, and possibly the U/G water system and water collection and removal system (which could be designed to be readily drained to a water collection point for service). Of these, probably the most important is integration of ESF and repository drainage plans. The sensitivity of this interface is difficult to assess, because although the MTL breakout horizon uncertainty is on the order of tens of feet, the stratigraphic location for the MTL is near the top of the TSw2 unit which leaves depth flexibility to isolate the ESF and repository drainage systems.

As discussed in SCP Section 8.4.2.3.4.4 a probe hole will be cored as much as 200' ahead of the face in ES-1 to investigate perched water and ground conditions. The SCP states that probe hole data will control design items related to temporary support, shaft lining, controlled drilling/blasting, and perched water characterization. Importantly, no probe hole is planned for ES-2 yet this is the first shaft to reach the MTL horizon. For reasonable gradients and conformity with the stratigraphic dip in the ESF, the horizon selection in ES-2 determines that in ES-1 to within a few feet.

The MPBH activity will produce stratigraphic information from locations near each shaft, but there are attendant uncertainties. The MPBH holes may not penetrate to the MTL if drilling difficulties are encountered. As stated in SCP Section 8.4.2.3.1 (page 8.4.2-147) MPBH drilling will cease if there is more than about 10 feet of deviation toward the shaft. SCP Section 8.4.2.3.1 plans for the MPBH activity discuss intermittent coring but the feasibility of significant coring (suitable for MTL horizon selection) is unknown. The reliability of information other than from core (i.e., cuttings, video logs, and geophysical logs) for horizon selection has not been determined.

To summarize the above remarks, there is potentially significant uncertainty known to this reviewer as to the actual depth to the desired main test level horizon, at each shaft location. The selection decision will be made first for the breakout in ES-2, but uncertainty associated with the MPBH activity, and the probe hole concept as described in the SCP, will not necessarily provide adequate information or core samples upon which to base this breakout decision. The ES-2 decision apparently controls the ES-1 breakout horizon to within a few feet.

REFERENCES -

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: The value given for the elevation of the MTL breakout platform in ES-1 by FS-GA-0212 Rev.C is a reasonable one, and the unstated uncertainty on this value is not a serious problem at this stage of design. Although refinement is recommended below for Title II, the ESF Title I design (and supporting documentation) is adequate with respect to the selection of the depth of the MTL breakout.

RECOMMENDATIONS AND CORRECTIVE MEASURES: It is recommended that the following measures be taken during Title II design:

a) document the nature of the present uncertainty in projected depths to the ES-1 and ES-2 MTL breakouts, in the basis for design;

b) define the sensitivity and/or required accuracy of the MTL horizon selection in ES-1 and ES-2;

c) state whether a probe hole will be used in ES-2 to support the MTL breakout selection; and

d) state which information will be used for the selection in ES-1 and ES-2, specifying plans for contingencies such as: no core from the MPBH activity, and no penetration of the MTL horizon by either or both MPBH drillholes.

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	EL Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.1.5.1 [60.15(b)]

3.1.4.1 (ES-1)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.5.1 (ES-2)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.6.1 (UG EXC)	The main test level shall be constructed at the planned horizon
3.1.8.1 (UG TEST)	Underground testing shall be conducted in a facility constructed at the planned repository horizon

HAVE THE CRITERIA BEEN ADDRESSED IN THE DESIGN?

__✓__ Yes _____ No _____ Don't know

RATIONALE: The waste emplacement horizon is indicated broadly in Chapter 6 of the SCP, as the TSw2 unit (Ortiz et al., 1985). Because of potential variability in stratigraphic conditions that may be encountered during site characterization relative to what is presently known from pre-site characterization studies, the exact repository waste emplacement horizon is not specified in the SCP Conceptual Design Report (SNL, 1987). However, explanation of the rationale for the selection of the horizon for waste emplacement and the main test level of the ESF is provided by a Project position paper (memorandum, Vieth to Stein, 3-13-87).

The elevation of the main test level of the ESF is stated on Drawing FS-GA-0057 Rev.C of the Title I ESF Design Package, and is consistent with the horizon selection in the position paper. The exploratory shafts are connected by the main test level. The Title I ESF design and supporting documentation therefore meet this criterion.

REFERENCES

Ortiz, T.S., R.L. Williams, F.B. Nimick, B.C. Whittet, and D.L. South, 1985, "A Three-dimensional Model of Reference Thermal/Mechanical and Hydrological Stratigraphy at Yucca Mountain, Southern Nevada," Sandia National Laboratories report SAND84-1076.

SNL, 1987: Site Characterization Plan Conceptual Design Report, Sandia National Laboratories report SAND84-2641.

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	E L Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 3.1.5.2 [60.15(b)]

3.1.4.2 (ES-1) Selection of the horizon for the main test level shall be based on evaluation of stratigraphic information sources available during construction (e.g., from the MPBH activity, geologic mapping of the shafts, and a probe corehole drilled ahead of the shaft face in portions of the shaft) with respect to explicit horizon criteria.

3.1.5.2 (ES-2) Selection of the horizon for the main test level shall be based on evaluation of stratigraphic information sources available during construction (e.g., from the MPBH activity, geologic mapping of the shafts, and a probe corehole drilled ahead of the shaft face in portions of the shaft) with respect to explicit horizon criteria.

HAS THE CRITERION BEEN ADDRESSED IN THE DESIGN?

✓ Yes _____ No _____ Don't know

RATIONALE: Criteria for selection of the main test level breakout horizon are reasonably well defined in supporting documentation, including Chapter 6 of the SCP, the SCP-Conceptual Design Report, and a Project position paper on major changes to the ESF design (memorandum, Vieth to Stein, 3-13-87). However, there is significant ambiguity as to when the MTL breakout decision is to be made, and based on what information.

There is likely to be some uncertainty as to the breakout elevations in any shaft construction project. Either the uncertainty doesn't matter and the facility is constructed according to a priori specifications, or data collected during construction are used for the final selection. SCP Section 8.4.2.3.4.4 indicates that the MTL horizon selection will fall into the latter category. There are various information sources which may contribute to the horizon selection before and during construction, but which may or may not be available depending on the success of several activities.

Present uncertainty is related to the distance from the shafts to drillhole USW G-4, and to different methods for interpolating/extrapolating the stratigraphic contacts using drillhole information. One method involves using the caprock dip augmented by oriented core data from USW G-4, to project the contact from G-4. Another method involves using contact depth from various coreholes (e.g., USW G-4, UE25 a#1, USW G-1) to constrain a least-squares-based interpolative geometric model. In this reviewer's experience, the difference between the depth to the MTL at the shaft locations calculated by these different methods can be more than 100 feet depending on the assumptions made. The value used in the ESF Title I design is thus a consensus value (see SDRD ECR 003) with considerable uncertainty.

The MTL selection interfaces with these ESF design features: ESF drainage plan, integration of ESF drainage with repository drainage, haulage plans for development of the dedicated test area and the long drifts, and possibly the U/G water system and water collection and removal system (which could be designed to be readily drained to a water collection point for service). Of these, probably the most important is integration of ESF and repository drainage plans. The sensitivity of this interface is difficult to assess, because although the MTL breakout horizon uncertainty is on the order of tens of feet, the stratigraphic location for the MTL is near the top of the TSw2 unit which leaves depth flexibility to isolate the ESF and repository drainage systems.

As discussed in SCP Section 8.4.2.3.4.4 a probe hole will be cored as much as 200' ahead of the face in ES-1 to investigate perched water and ground conditions. The SCP states that probe hole data will control design items related to temporary support, shaft lining, controlled drilling/blasting, and perched water characterization. Importantly, no probe hole is planned for ES-2 yet this is the first shaft to reach the MTL horizon. For reasonable gradients and conformity with the stratigraphic dip in the ESF, the horizon selection in ES-2 determines that in ES-1 to within a few feet.

The MPBH activity will produce stratigraphic information from locations near each shaft, but there are attendant uncertainties. The MPBH holes may not penetrate to the MTL if drilling difficulties are encountered. As stated in SCP Section 8.4.2.3.1 (page 8.4.2-147) MPBH drilling will cease if there is more than about 10 feet of deviation toward the shaft. SCP Section 8.4.2.3.1 plans for the MPBH activity discuss intermittent coring but the feasibility of significant coring (suitable for MTL horizon selection) is unknown. The reliability of information other than from core (i.e., cuttings, video logs, and geophysical logs) for horizon selection has not been determined.

To summarize the above remarks, there is potentially significant uncertainty known to this reviewer as to the actual depth to the desired main test level horizon, at each shaft location. The selection decision will be made first for the breakout in ES-2, but uncertainty associated with the MPBH activity, and the probe hole concept as described in the SCP, will not necessarily provide adequate information or core samples upon which to base this breakout decision. The ES-2 decision apparently controls the ES-1 breakout horizon to within a few feet.

REFERENCES

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: The value given for the elevation of the MTL breakout platform in ES-1 by FS-GA-0212 Rev.C is a reasonable one, and the unstated uncertainty on this value is not a serious problem at this stage of design. Although refinement is recommended below for Title II, the ESF Title I design (and supporting documentation) is adequate with respect to the selection of the depth of the MTL breakout.

RECOMMENDATIONS AND CORRECTIVE MEASURES: It is recommended that the following measures be taken during Title II design:

a) document the nature of the present uncertainty in projected depths to the ES-1 and ES-2 MTL breakouts, in the basis for design;

b) define the sensitivity and/or required accuracy of the MTL horizon selection in ES-1 and ES-2;

c) state whether a probe hole will be used in ES-2 to support the MTL breakout selection; and

d) state which information will be used for the selection in ES-1 and ES-2, specifying plans for contingencies such as: no core from the MPBH activity, and no penetration of the MTL horizon by either or both MPBH drillholes.

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	E L Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.1.6.1 [60.15(b)]

3.1.4.1 (ES-1)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.5.1 (ES-2)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.6.1 (UG EXC)	The main test level shall be constructed at the planned horizon
3.1.8.1 (UG TEST)	Underground testing shall be conducted in a facility constructed at the planned repository horizon

HAVE THE CRITERIA BEEN ADDRESSED IN THE DESIGN?

__✓__ Yes _____ No _____ Don't know

RATIONALE: The waste emplacement horizon is indicated broadly in Chapter 6 of the SCP, as the TSw2 unit (Ortiz et al., 1985). Because of potential variability in stratigraphic conditions that may be encountered during site characterization relative to what is presently known from pre-site characterization studies, the exact repository waste emplacement horizon is not specified in the SCP Conceptual Design Report (SNL, 1987). However, explanation of the rationale for the selection of the horizon for waste emplacement and the main test level of the ESF is provided by a Project position paper (memorandum, Vieth to Stein, 3-13-87).

The elevation of the main test level of the ESF is stated on Drawing FS-GA-0057 Rev.C of the Title I ESF Design Package, and is consistent with the horizon selection in the position paper. The exploratory shafts are connected by the main test level. The Title I ESF design and supporting documentation therefore meet this criterion.

REFERENCES

Ortiz, T.S., R.L. Williams, F.B. Nimick, B.C. Whittet, and D.L. South, 1985, "A Three-dimensional Model of Reference Thermal/Mechanical and Hydrological Stratigraphy at Yucca Mountain, Southern Nevada," Sandia National Laboratories report SAND84-1076.

SNL, 1987: Site Characterization Plan Conceptual Design Report, Sandia National Laboratories report SAND84-2641.

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	E L Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.1.8.1 [60.15(b)]

3.1.4.1 (ES-1)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.5.1 (ES-2)	Shaft design and construction shall provide access for site characterization activities to be performed at the planned waste emplacement horizon
3.1.6.1 (UG EXC)	The main test level shall be constructed at the planned horizon
3.1.8.1 (UG TEST)	Underground testing shall be conducted in a facility constructed at the planned repository horizon

HAVE THE CRITERIA BEEN ADDRESSED IN THE DESIGN?

__✓__ Yes _____ No _____ Don't know

RATIONALE: The waste emplacement horizon is indicated broadly in Chapter 6 of the SCP, as the TSw2 unit (Ortiz et al., 1985). Because of potential variability in stratigraphic conditions that may be encountered during site characterization relative to what is presently known from pre-site characterization studies, the exact repository waste emplacement horizon is not specified in the SCP Conceptual Design Report (SNL, 1987). However, explanation of the rationale for the selection of the horizon for waste emplacement and the main test level of the ESF is provided by a Project position paper (memorandum, Vieth to Stein, 3-13-87).

The elevation of the main test level of the ESF is stated on Drawing FS-GA-0057 Rev.C of the Title I ESF Design Package, and is consistent with the horizon selection in the position paper. The exploratory shafts are connected by the main test level. The Title I ESF design and supporting documentation therefore meet this criterion.

REFERENCES

Ortiz, T.S., R.L. Williams, F.B. Nimick, B.C. Whittet, and D.L. South, 1985, "A Three-dimensional Model of Reference Thermal/Mechanical and Hydrological Stratigraphy at Yucca Mountain, Southern Nevada," Sandia National Laboratories report SAND84-1076.

SNL, 1987: Site Characterization Plan Conceptual Design Report, Sandia National Laboratories report SAND84-2641.

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	EL Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.2.4.1 [60.15(d)(2)]

3.2.4.1 (ES-1) The number and depth of exploratory shafts shall be consistent with obtaining needed information for site characterization.

3.2.5.1 (ES-2) The number and depth of exploratory shafts shall be consistent with obtaining needed information for site characterization

HAVE THE CRITERIA BEEN ADDRESSED IN THE DESIGN?

✓ Yes _____ No _____ Don't know

RATIONALE: The two-shaft concept is consistent with requirements to support scientific testing, while providing: a second means of emergency egress from the main test level; flexibility to accommodate additional development, or testing; and control of interference from planned or additional development and testing at the MTL, with ongoing testing. The introduction of the two-shaft concept, and the evolution of the function and design of each of the shafts, is described in SCP Section 8.4.2.3.3 (Introduction to the Description of the ESF). This text cites Gnirk et al. (1988), a more comprehensive discussion of the history of the ESF location selection and development of the design. One reference in this historical report is especially important: a Project position paper describing several major changes to the ESF design and stating the functions of each shaft, and the rationale for major features of the present (Title I) design (memorandum, Vieth to Stein, 3-13-87). These reports document a strong case that two shafts are needed for site characterization.

Each shaft will extend to the prjected depth of the main test level, plus tailshaft specifications of about 50 feet for ES-1, and about 100 feet for ES-2. The depths are consistent with the respective functions planned for the shafts. The Title I design reflects a change in the depth of ES-1, resulting from review of the Consultation Draft SCP by the NRC staff. As detailed in SCP Section 8.4.2.1.6.1, neither shaft will penetrate substantially below the main test level until the DOE has performed appropriate analyses of impacts to postclosure performance, and consulted with the NRC. The analyses to be performed include a determination of whether excavation into the Calico Hills unit is required to obtain needed information for site characterization, and if so, whether extension of the ESF is an appropriate means. Thus the depths of the shafts in the Title I ESF design is consistent with obtaining data which have thus far been identified as needed for site characterization.

REFERENCES

Gnirk, P., E.L. Hardin, and M.D. Voegele, 1988, "Exploratory Shaft Location Documentation Report," DOE/NV report NV-326.

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	EL Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.2.5.1 [60.15(d)(2)]

3.2.4.1 (ES-1) The number and depth of exploratory shafts shall be consistent with obtaining needed information for site characterization.

3.2.5.1 (ES-2) The number and depth of exploratory shafts shall be consistent with obtaining needed information for site characterization

HAVE THE CRITERIA BEEN ADDRESSED IN THE DESIGN?

✓ Yes _____ No _____ Don't know

RATIONALE: The two-shaft concept is consistent with requirements to support scientific testing, while providing: a second means of emergency egress from the main test level; flexibility to accommodate additional development, or testing; and control of interference from planned or additional development and testing at the MTL, with ongoing testing. The introduction of the two-shaft concept, and the evolution of the function and design of each of the shafts, is described in SCP Section 8.4.2.3.3 (Introduction to the Description of the ESF). This text cites Gnirk et al. (1988), a more comprehensive discussion of the history of the ESF location selection and development of the design. One reference in this historical report is especially important: a Project position paper describing several major changes to the ESF design and stating the functions of each shaft, and the rationale for major features of the present (Title I) design (memorandum, Vieth to Stein, 3-13-87). These reports document a strong case that two shafts are needed for site characterization.

Each shaft will extend to the prjected depth of the main test level, plus tailshaft specifications of about 50 feet for ES-1, and about 100 feet for ES-2. The depths are consistent with the respective functions planned for the shafts. The Title I design reflects a change in the depth of ES-1, resulting from review of the Consultation Draft SCP by the NRC staff. As detailed in SCP Section 8.4.2.1.6.1, neither shaft will penetrate substantially below the main test level until the DOE has performed appropriate analyses of impacts to postclosure performance, and consulted with the NRC. The analyses to be performed include a determination of whether excavation into the Calico Hills unit is required to obtain needed information for site characterization, and if so, whether extension of the ESF is an appropriate means. Thus the depths of the shafts in the Title I ESF design is consistent with obtaining data which have thus far been identified as needed for site characterization.

REFERENCES

Gnirk, P., E.L. Hardin, and M.D. Voegele, 1988, "Exploratory Shaft Location Documentation Report," DOE/NV report NV-326.

Vieth to Stein, 3-13-87: D. L. Vieth (DOE/NV) to R. Stein (OGR, DOE/HQ), memo re: "Background Paper for U.S. Nuclear Regulatory Commission Meeting on Exploratory Shaft Facility," March 13, 1987.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	E L Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 3.2.8.1 [60.15(d)(2)]

3.2.8.1 (UG TEST) The number and length of exploratory and monitoring boreholes from the underground portion of the ESF shall be consistent with obtaining the needed information for site characterization.

HAS THE CRITERION BEEN ADDRESSED IN THE DESIGN?

✓ Yes _____ No _____ Don't know

RATIONALE: General discussion of the need for the underground tests is given in SCP Section 8.4.2.1, and test plans for many activities are given in 8.3.1. In most cases where test plans are provided in the SCP, drilling requirements have also been produced either for the SCP or for the SDRD. The SCP has been reviewed several times, including review by DOE/HQ prior to release of the Consultative Draft (CDSCP), and review of the CDSCP by the NRC. Applicability of planned testing to the information needed for site characterization has been a subject of these reviews.

The SDRD includes a table (Appendix C) of drilling requirements for underground tests, that is based on the Exploratory Shaft Test Plan (ESTP) Rev. 2. Although never released as a Project document, the ESTP (Rev. 1) was reviewed in 1987 by an independent panel of scientific peers, wherein reasonableness of planned testing was considered. Revisions to certain tests were made for Rev. 2, for example, downscoping of the Excavation Effects Test reducing the number of boreholes and associated excavation by one third, bringing the program into line with what is needed for site characterization.

For tests that have not been described in sufficient detail for reviewers to assess the adequacy of scope, Study Plan format requires such detail and review with respect to impacts on the site, and test interference. Note that the SCP contains performance allocation tables which are available to be used such reviews; such tables contain confidence goals for various parameters which should be reconciled with the scope of planned testing. This was a principal purpose of performance allocation.

In summary, the planned program of ESF testing has been extensively reviewed and revised with respect to the need for individual tests, the choice of test methods, and scope of each test. An ongoing process is in place to review test plans for which design criteria are still under development. The result of these activities has been and will continue to be to provide assurance that the testing program, and the associated boreholes, are consistent with obtaining the information needed for site characterization. Therefore although complete information on boreholes required for testing is not yet available, the review process that is in place should assure that the overall testing program is consistent with obtaining the needed information for site characterization.

Note that the above remarks are not intended to address the overall affect of boreholes associated with the underground testing program on the waste isolation performance of the site, or the ability to characterize the site or perform other testing.

ADEQUACY OF TREATMENT: Adequate

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	EL Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERION: 3.3.8.1 [60.15(d)(3)]

3.3.8.1 (UG TEST) Exploratory, monitoring and testing boreholes shall be located where pillars are planned in the repository underground facility to the extent practicable. Implementation of this criterion within the designated test areas of the ESF shall be consistent with obtaining the needed information for site charaterization

HAS THE CRITERION BEEN ADDRESSED IN THE DESIGN?

__✓__ YES _____ NO _____ DON'T KNOW

RATIONALE: Boreholes for planned testing activities in the designated test area do not involve designated waste emplacement areas, or access drifts through which mining operations and waste tranport will be conducted.

Intervening pillars between the designated test area and waste emplacement areas will not contain test boreholes through a 30-meter minimum thickness, based on this reviewer's knowledge of the planned testing program, and the (preliminary) description of planned testing in Appendix B of the SDRD. Also, based on the SDRD description no boreholes are planned which would provide additional connections between the shaft and other openings, or the MTL and the UDBR. However, borehole requirements for some tests such as the heated room and the engineered barrier tests are not provided in the Title I ESF design package, the SDRD, or the SCP. Whereas these tests are not likely to involve boreholes that would intrude possible waste emplacement areas, or compromise the minimum thickness of an intervening pillar, the test plans should be evaluated when specific information becomes available to check compliance with this criterion.

Test boreholes will be required to characterize major structural features encountered in the long drifts. In addition, it is possible that additional boreholes may be required outside the designated test area for other tests that may be conducted in the long drifts. Because of uncertainty as to the subsurface nature of the major features and other testing that may be required, borehole requirements cannot be established at the present time. These tests should also be evaluated when specific information becomes available, to check compliance with this criterion.

ADEQUACY OF TREATMENT: While boreholes from specified and other unspecified testing in the designated test area are not likely to intrude the waste emplacement areas or a pillar separating the testing area, the information needed to reach this finding with respect to the Title I ESF design is incomplete. The Title I ESF design is nevertheless adequate with respect to this criterion because it amply provides the means for compliance with the criterion, and because none of the preliminary information attendant to the Title I design constitutes evidence that the ESF will not comply.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

RECOMMENDATIONS AND CORRECTIVE MEASURES: It is recommended that a reference description be developed during Title II design, for boreholes associated with planned testing, that are long enough to potentially intersect waste emplacement areas or significantly penetrate an intervening pillar. The information should consist of a graphical representation of the type and extent of drilling associated with each test.

Recommendations similar to that given above have also been given in relation to concern #1 (effects on the waste isolation performance of the site). Specifically, the criteria that boreholes not intersect underground openings (1.2.6.1) nor penetrate below the TSw2 unit (1.2.8.2) were considered, with the recommendation that the MTL layout plan be developed in Title II to include planned boreholes, supplemented by information as to their lateral and vertical extent, diameter, and method of construction. A similar recommendation is made here because it would be a convenient way to demonstrate that the planned boreholes, while consistent with the criteria for concern #1, are also consistent with plans for testing to obtain needed information for site characterization.

REVIEWER (PRINT)	SIGNATURE	DATE
ERNEST L. HARDIN	E L Hardin Jr	1/30/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.4.8.1 [60.74]

3.4.8.1 (UG TEST) The area set aside for future site characterization and performance confirmation testing, shall be representative of the overall designated test area with respect to rock characteristics that control acceptability of test locations.

HAS THE CRITERIA BEEN ADDRESSED IN THE DESIGN?

___✓___ YES _____ NO _____ DON'T KNOW

RATIONALE: Test location acceptance criteria (of the type referred to in SCP Sections 8.4.2.3.3.3 and 8.4.2.3.6.4) have not been generated for planned site characterization tests, or for future testing of any kind. Such criteria are needed along with site specific information on the variability of important rock characteristics, for complete evaluation of the MTL layout with respect to this criterion.

However, the Title I ESF design appears to address this criterion, insofar as the areas identified for planned testing and future testing are similar with respect to the limited available information on the variability of rock characteristics at the ESF location. A few specific characteristics are considered below:

a) The set-aside area is roughly equidistant from the nearby Ghost Dance fault as the area planned for testing, consistent with the expectation that the variability of fracture characteristics and distribution within the restricted region is strongly related to distance from the fault.

b) The lithology of the host rock tends to change relatively slowly across the site area, as determined from observations in widely spaced coreholes. Although volcanic ash flow units tend to exhibit laterally heterogeneous facies inherited from cooling and associated offgassing and alteration, it is reasonable to expect systematic variation of lithologic conditions in the host rock within an area the size of the designated test area, for reasons as presented in SCP Section 8.4.2.1.5.4.

c) The hydrologic setting of the designated test area is roughly homogeneous with respect to proximity to the Ghost Dance fault, and structures bounding the repository block. Much of the terrain above the dedicated test area consists of upland, thinly covered bedrock slopes in the welded Tiva Canyon Member.

It is also reasonable to expect that increased confidence as to the nature of lateral variability that would be important for this criterion, if present in the host rock, can be obtained from geologic mapping throughout the extent of the planned ESF.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: Although the Title I ESF design cannot be evaluated with respect to this criterion at the present time, the planned MTL layout, the inherent flexibility to change the layout during construction, and plans to acquire geologic information from the excavations for appropriate use during construction, are consistent with a reasonable approach to meeting this criterion.

RECOMMENDATIONS AND CORRECTIVE MEASURES: None

REVIEWER (PRINT)	SIGNATURE	DATE
E. L. Hardin	EL Hardin	1/27/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.5.4.1, 3.5.5.1, 3.5.6.1, 3.5.7.1 [60.133(b)]

3.5.4.1 (ES-1)	The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction
3.5.5.1 (ES-2)	The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction
3.5.6.1 (UG EXC)	The design of the shaft breakouts, and the layout of the main test level of the ESF, shall have the flexibility to ensure that the location, orientation, geometry, and configuration of each planned test can be modified, as necessary, to meet specific test location acceptance criteria, in response to actual site conditions encountered during construction
3.5.7.1 (UG UTIL)	The design of the underground utilities shall provide the flexibility needed to support the required flexibility in the design of the shafts, shaft breakouts, and the layout of the main test level of the ESF

DOES THE DESIGN ADDRESS THE CRITERIA?

__✓__ YES _____ NO _____ DON'T KNOW

RATIONALE: The significant difference between these criteria under concern #3 and the similar criteria under concern #2 (ability to characterize the site, including test-test interference and construction-test interference), is the incorporation of test location acceptance criteria. The purpose for imposing the above listed criteria under concern #3 is to indicate directly how the test location acceptance criteria are related to ESF design requirements.

The "representativeness" of data resulting from ESF testing has been the focus of review comments on the Consultation Draft SCP, and of other exchanges with the NRC. The underlying concern is that, notwithstanding the methodology used to select the ESF location (Bertram, 1984; Gnirk et al. 1988) the location selected may provide information that is favorable or unfavorable to waste isolation, relative to actual conditions throughout the site area overall, and thus bias site characterization. A strategy for dealing with this concern in the planning and performance of site characterization is documented in SCP Section 8.4.2.1.5.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

The ESF testing program is represented in SCP Section 8.4.2.1.5 as part of an overall characterization strategy encompassing surface-based sampling and testing, and ESF activities. No single location for the ESF is thought to be representative of the repository block (and immediate surroundings, as appropriate) for all of the rock characteristics which may be important to waste isolation. A strategy for siting the ESF in an optimum location from which all the tests and measurements could be readily accepted as representative of the overall site area would be quite ill-posed. Rather, the program will rely upon surface-based sampling and testing to investigate lateral variability for a limited set of measurements. ESF testing will be relied upon to support the application of these measurements in performance assessment for the overall site. The ESF should thus provide certain types of information that is not available from surface-based testing:

a) Contextual information for samples, measurements, and borehole testing (e.g. geophysical logging, packer testing), with expanded scale of observation relative to surface-based boreholes. This information will augment the interpretation of sampling, measurement, and testing in the ESF, and may assist interpretation of the same kinds of sampling, measurement, and testing in widely distributed surface-based boreholes.

b) Characterization of site processes in situ by means of controlled testing. The benefits of many of the planned ESF tests will accrue because they are conducted with appropriate controls in a suitable location that supports model validation, such that models validated through ESF testing can be extended to assess overall site performance with increased confidence.

Application of test results to site characterization is the focus of test design, and thus should be the focus of test location selection. The location chosen for each test will affect the success of testing, to the extent that rock characteristics such as fracture distribution are important to the direct or indirect application of test results in performance assessment.

The types of information that can be collected from surface-based sampling and testing are also important for extending ESF test results to other parts of the repository block. Rock characteristics that can be determined from surface-based sampling and testing, obtained through sampling and testing at candidate test locations within the ESF, should be considered as part of the basis for test location selection.

REFERENCES

Bertram, S., 1984, "NNWSI Exploratory Shaft Site and Construction Method Recommendation Report", Sandia National Laboratories report] SAND84-1003, August 1984.

Gnirk, P., E.L. Hardin, and M.D. Voegele, 1988, "Exploratory Shaft Location Documentation Report," DOE/NV-326, 12-21-88.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: "Representativeness" concerns are accommodated in several ways in the Title I ESF Design and supporting documentation. For example, the MPBH activity and the probe hole concept will be used to ensure that construction and testing activities can be modified to meet ESF design and performance criteria in response to actual site conditions. The DBR activities will provide early, site-specific information which can be used to support more representative testing. Also, the Title I ESF design appears to have ample intrinsic flexibility to accommodate site specific conditions, with respect to test location. Although incomplete, this level of treatment is adequate for preliminary design.

CORRECTIVE ACTION AND RECOMMENDATIONS: It is recommended that test location acceptance criteria for planned ESF testing be developed during Title II design. (Different nomenclature may certainly be used for these criteria, but the functional description in the Rationale section above should apply.) If operative criteria are developed, they will tend to show that the respective tests will produce representative data in the context of the strategy presented in SCP Section 8.4.2.1.5.

The needed criteria are likely to affect the ESF design, particularly the sequence of drifting and the MTL layout, and should therefore be developed during Title II. Acceptance criteria will be needed to evaluate the Title II ESF Design with regard to the MTL layout, flexibility, and representativeness concerns. For example, tests which are adjacent in the planned layout may require similar conditions (e.g., locally averaged fracture spacing, or noninterference from fluid lost in drillhole USW G-4) and may be relocated en masse if certain conditions are encountered, placing special requirements on flexibility. Whereas such scenarios are unlikely, a basic set of test location criteria should be made available during the design process.

Some additional explanation of test location acceptance criteria is appropriate here. It is not recommended that these criteria be excessively detailed, nor that they be unchangeable once ESF construction begins. However, they should be appropriate to provide the needed input to the design process on the relation between the MTL layout and variation in site specific conditions that can reasonably be expected at the ESF location. Also, it is intended that they be specific to each planned test, such that taken together with test plans that have been updated as appropriate, they support and/or further define the strategy presented in SCP Section 8.4.2.1.5 for the representativeness of ESF testing.

REVIEWER (PRINT)	SIGNATURE	DATE
ERNEST L. HARDIN	EL Hardin Jr	1/30/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.5.4.1, 3.5.5.1, 3.5.6.1, 3.5.7.1 [60.133(b)]

3.5.4.1 (ES-1) The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction

3.5.5.1 (ES-2) The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction

3.5.6.1 (UG EXC) The design of the shaft breakouts, and the layout of the main test level of the ESF, shall have the flexibility to ensure that the location, orientation, geometry, and configuration of each planned test can be modified, as necessary, to meet specific test location acceptance criteria, in response to actual site conditions encountered during construction

3.5.7.1 (UG UTIL) The design of the underground utilities shall provide the flexibility needed to support the required flexibility in the design of the shafts, shaft breakouts, and the layout of the main test level of the ESF

DOES THE DESIGN ADDRESS THE CRITERIA?

__✓__ YES _____ NO _____ DON'T KNOW

RATIONALE: The significant difference between these criteria under concern #3 and the similar criteria under concern #2 (ability to characterize the site, including test-test interference and construction-test interference), is the incorporation of test location acceptance criteria. The purpose for imposing the above listed criteria under concern #3 is to indicate directly how the test location acceptance criteria are related to ESF design requirements.

The "representativeness" of data resulting from ESF testing has been the focus of review comments on the Consultation Draft SCP, and of other exchanges with the NRC. The underlying concern is that, notwithstanding the methodology used to select the ESF location (Bertram, 1984; Gnirk et al. 1988) the location selected may provide information that is favorable or unfavorable to waste isolation, relative to actual conditions throughout the site area overall, and thus bias site characterization. A strategy for dealing with this concern in the planning and performance of site characterization is documented in SCP Section 8.4.2.1.5.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

The ESF testing program is represented in SCP Section 8.4.2.1.5 as part of an overall characterization strategy encompassing surface-based sampling and testing, and ESF activities. No single location for the ESF is thought to be representative of the repository block (and immediate surroundings, as appropriate) for all of the rock characteristics which may be important to waste isolation. A strategy for siting the ESF in an optimum location from which all the tests and measurements could be readily accepted as representative of the overall site area would be quite ill-posed. Rather, the program will rely upon surface-based sampling and testing to investigate lateral variability for a limited set of measurements. ESF testing will be relied upon to support the application of these measurements in performance assessment for the overall site. The ESF should thus provide certain types of information that is not available from surface-based testing:

a) Contextual information for samples, measurements, and borehole testing (e.g. geophysical logging, packer testing), with expanded scale of observation relative to surface-based boreholes. This information will augment the interpretation of sampling, measurement, and testing in the ESF, and may assist interpretation of the same kinds of sampling, measurement, and testing in widely distributed surface-based boreholes.

b) Characterization of site processes in situ by means of controlled testing. The benefits of many of the planned ESF tests will accrue because they are conducted with appropriate controls in a suitable location that supports model validation, such that models validated through ESF testing can be extended to assess overall site performance with increased confidence.

Application of test results to site characterization is the focus of test design, and thus should be the focus of test location selection. The location chosen for each test will affect the success of testing, to the extent that rock characteristics such as fracture distribution are important to the direct or indirect application of test results in performance assessment.

The types of information that can be collected from surface-based sampling and testing are also important for extending ESF test results to other parts of the repository block. Rock characteristics that can be determined from surface-based sampling and testing, obtained through sampling and testing at candidate test locations within the ESF, should be considered as part of the basis for test location selection.

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: "Representativeness" concerns are accommodated in several ways in the Title I ESF Design and supporting documentation. For example, the MPBH activity and the probe hole concept will be used to ensure that construction and testing activities can be modified to meet ESF design and performance criteria in response to actual site conditions. The DBR activities will provide early, site-specific information which can be used to support more representative testing. Also, the Title I ESF design appears to have ample intrinsic flexibility to accommodate site specific conditions, with respect to test location. Although incomplete, this level of treatment is adequate for preliminary design.

CORRECTIVE ACTION AND RECOMMENDATIONS: It is recommended that test location acceptance criteria for planned ESF testing be developed during Title II design. (Different nomenclature may certainly be used for these criteria, but the functional description in the Rationale section above should apply.) If operative criteria are developed, they will tend to show that the respective tests will produce representative data in the context of the strategy presented in SCP Section 8.4.2.1.5.

The needed criteria are likely to affect the ESF design, particularly the sequence of drifting and the MTL layout, and should therefore be developed during Title II. Acceptance criteria will be needed to evaluate the Title II ESF Design with regard to the MTL layout, flexibility, and representativeness concerns. For example, tests which are adjacent in the planned layout may require similar conditions (e.g., locally averaged fracture spacing, or noninterference from fluid lost in drillhole USW G-4) and may be relocated en masse if certain conditions are encountered, placing special requirements on flexibility. Whereas such scenarios are unlikely, a basic set of test location criteria should be made available during the design process.

Some additional explanation of test location acceptance criteria is appropriate here. It is not recommended that these criteria be excessively detailed, nor that they be unchangeable once ESF construction begins. However, they should be appropriate to provide the needed input to the design process on the relation between the MTL layout and variation in site specific conditions that can reasonably be expected at the ESF location. Also, it is intended that they be specific to each planned test, such that taken together with test plans that have been updated as appropriate, they support and/or further define the strategy presented in SCP Section 8.4.2.1.5 for the representativeness of ESF testing.

REVIEWER (PRINT)	SIGNATURE	DATE
ERNEST L. HARDIN	Ernest L. Hardin Jr	1/30/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.5.4.1, 3.5.5.1, 3.5.6.1, 3.5.7.1 [60.133(b)]

3.5.4.1 (ES-1) The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction

3.5.5.1 (ES-2) The shaft design shall have the flexibility needed to ensure that the location, orientation, geometry, and configuration of each test can be modified, as necessary to meet specific test location acceptance criteria for each test in the shaft, in response to actual site conditions encountered during construction

3.5.6.1 (UG EXC) The design of the shaft breakouts, and the layout of the main test level of the ESF, shall have the flexibility to ensure that the location, orientation, geometry, and configuration of each planned test can be modified, as necessary, to meet specific test location acceptance criteria, in response to actual site conditions encountered during construction

3.5.7.1 (UG UTIL) The design of the underground utilities shall provide the flexibility needed to support the required flexibility in the design of the shafts, shaft breakouts, and the layout of the main test level of the ESF

DOES THE DESIGN ADDRESS THE CRITERIA?

__✓__ YES _____ NO _____ DON'T KNOW

RATIONALE: The significant difference between these criteria under concern #3 and the similar criteria under concern #2 (ability to characterize the site, including test-test interference and construction-test interference), is the incorporation of test location acceptance criteria. The purpose for imposing the above listed criteria under concern #3 is to indicate directly how the test location acceptance criteria are related to ESF design requirements.

The "representativeness" of data resulting from ESF testing has been the focus of review comments on the Consultation Draft SCP, and of other exchanges with the NRC. The underlying concern is that, notwithstanding the methodology used to select the ESF location (Bertram, 1984; Gnirk et al. 1988) the location selected may provide information that is favorable or unfavorable to waste isolation, relative to actual conditions throughout the site area overall, and thus bias site characterization. A strategy for dealing with this concern in the planning and performance of site characterization is documented in SCP Section 8.4.2.1.5.

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

The ESF testing program is represented in SCP Section 8.4.2.1.5 as part of an overall characterization strategy encompassing surface-based sampling and testing, and ESF activities. No single location for the ESF is thought to be representative of the repository block (and immediate surroundings, as appropriate) for all of the rock characteristics which may be important to waste isolation. A strategy for siting the ESF in an optimum location from which all the tests and measurements could be readily accepted as representative of the overall site area would be quite ill-posed. Rather, the program will rely upon surface-based sampling and testing to investigate lateral variability for a limited set of measurements. ESF testing will be relied upon to support the application of these measurements in performance assessment for the overall site. The ESF should thus provide certain types of information that is not available from surface-based testing:

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Application of test results to site characterization is the focus of test design, and thus should be the focus of test location selection. The location chosen for each test will affect the success of testing, to the extent that rock characteristics such as fracture distribution are important to the direct or indirect application of test results in performance assessment.

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

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CORRECTIVE ACTION AND RECOMMENDATIONS: It is recommended that test location acceptance criteria for planned ESF testing be developed during Title II design. (Different nomenclature may certainly be used for these criteria, but the functional description in the Rationale section above should apply.) If operative criteria are developed, they will tend to show that the respective tests will produce representative data in the context of the strategy presented in SCP Section 8.4.2.1.5.

The needed criteria are likely to affect the ESF design, particularly the sequence of drifting and the MTL layout, and should therefore be developed during Title II. Acceptance criteria will be needed to evaluate the Title II ESF Design with regard to the MTL layout, flexibility, and representativeness concerns. For example, tests which are adjacent in the planned layout may require similar conditions (e.g., locally averaged fracture spacing, or noninterference from fluid lost in drillhole USW G-4) and may be relocated en masse if certain conditions are encountered, placing special requirements on flexibility. Whereas such scenarios are unlikely, a basic set of test location criteria should be made available during the design process.

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REVIEWER (PRINT)	SIGNATURE	DATE
ERNEST L. HARDIN	EL Hardin	1/30/89

ORGANIZATION: SAIC

ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA

CRITERIA: 3.5.4.1, 3.5.5.1, 3.5.6.1, 3.5.7.1 [60.133(b)]

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DOES THE DESIGN ADDRESS THE CRITERIA?

__✓__ YES ____ NO ____ DON'T KNOW

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

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ASSESSMENT OF ESF TITLE I DESIGN WITH DAA CRITERIA (CONTINUED)

ADEQUACY OF TREATMENT: "Representativeness" concerns are accommodated in several ways in the Title I ESF Design and supporting documentation. For example, the MPBH activity and the probe hole concept will be used to ensure that construction and testing activities can be modified to meet ESF design and performance criteria in response to actual site conditions. The DBR activities will provide early, site-specific information which can be used to support more representative testing. Also, the Title I ESF design appears to have ample intrinsic flexibility to accommodate site specific conditions, with respect to test location. Although incomplete, this level of treatment is adequate for preliminary design.

CORRECTIVE ACTION AND RECOMMENDATIONS: It is recommended that test location acceptance criteria for planned ESF testing be developed during Title II design. (Different nomenclature may certainly be used for these criteria, but the functional description in the Rationale section above should apply.) If operative criteria are developed, they will tend to show that the respective tests will produce representative data in the context of the strategy presented in SCP Section 8.4.2.1.5.

The needed criteria are likely to affect the ESF design, particularly the sequence of drifting and the MTL layout, and should therefore be developed during Title II. Acceptance criteria will be needed to evaluate the Title II ESF Design with regard to the MTL layout, flexibility, and representativeness concerns. For example, tests which are adjacent in the planned layout may require similar conditions (e.g., locally averaged fracture spacing, or noninterference from fluid lost in drillhole USW G-4) and may be relocated en masse if certain conditions are encountered, placing special requirements on flexibility. Whereas such scenarios are unlikely, a basic set of test location criteria should be made available during the design process.

Some additional explanation of test location acceptance criteria is appropriate here. It is not recommended that these criteria be excessively detailed, nor that they be unchangeable once ESF construction begins. However, they should be appropriate to provide the needed input to the design process on the relation between the MTL layout and variation in site specific conditions that can reasonably be expected at the ESF location. Also, it is intended that they be specific to each planned test, such that taken together with test plans that have been updated as appropriate, they support and/or further define the strategy presented in SCP Section 8.4.2.1.5 for the representativeness of ESF testing.

REVIEWER (PRINT)	SIGNATURE	DATE
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ORGANIZATION: SAIC