COMPLIANCE DETERMINATION STRATEGY
RRT 3.2.1.14 POTENTIALLY ADVERSE CONDITION: GEOMECHANICAL PROPERTIES

APPLICABLE REGULATORY REQUIREMENTS:

10 CFR 60.21(c)(1)(ii)(B)
10 CFR 60.21(c)(1)(ii)(F)
10 CFR 60.122(c)(21)

TYPES OF REVIEW:

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

RATIONALE FOR TYPES OF REVIEW:

Acceptance Review (Type 1) Rationale:

This regulatory requirement topic is considered to be license application-related because, as specified in the license application content requirements of 10 CFR 60.21(c) and the regulatory guide "Format and Content for the License Application for the High-Level Waste Repository (FCRG)" it must be addressed by the U.S. Department of Energy (DOE) in its license application. Therefore, the staff will conduct an Acceptance Review of the license application for this regulatory requirement topic.

Safety Review (Type 3) Rationale:

This regulatory requirement topic is considered to be related to radiological safety and retrievability. It is a requirement for which compliance is necessary to make a safety determination for construction authorization as defined in 10 CFR 60.31(a) (i.e., regulatory requirements in Subparts E, G, H, and I). Therefore, the staff will conduct a Safety Review of the license application to determine compliance with this regulatory requirement topic.

This regulatory requirement, concerning a potentially adverse condition (PAC), focuses on the geomechanical properties of the site, if any, that would not permit the design of an underground opening to remain stable through permanent closure. The phrase "underground opening" is not defined in 10 CFR Part 60. However, for the purposes of this review, "underground openings" are defined as the "underground facility" as defined in 10 CFR 60.2, and also includes shafts, ramps, and emplacement holes.

The geomechanical conditions of the Yucca Mountain site are to be characterized in order to understand the effect of such conditions on the preclosure aspects of repository design and performance, primarily retrievability. In the Statement of Considerations for 10 CFR Part 60 regarding geomechanical properties, this PAC is "... another criterion that pertains to the period of operations. However like the preceding one, its underlying purpose is to assure that waste isolation objectives can be achieved. Failure of underground openings could result in the inability of the licensee to retrieve the waste practicably, should such a course of action be found to be warranted" (NRC, 1983; *FR* 28213). Therefore, for this Safety Review, the time period of regulatory interest is considered to be that up to the date of final closure of the repository, but not beyond into the post-closure period.

The Yucca Mountain site is located in a region of faulted and fractured rock subject to the effects of regional tectonic stresses and the effects of earthquake ground motions. In addition, the rock around the underground openings will be subject to stress changes caused by the excavation of the openings and thermal loading due to waste emplacement. In the event of retrieval, the rock may also be subject to possible additional stress changes if the rock needs to be cooled before retrieval. These and other changes in geomechanical conditions caused by temperature changes will need to be characterized.

Sufficient technical knowledge does exist to allow for an adequate investigation and evaluation of the likelihood of this PAC. Based on information already known about the site and similar environs, and assuming that DOE will provide information about the geomechanical properties at the site, the analysts conclude that a safety determination can be made regarding this PAC by evaluating the information submitted by DOE in the license application.

Based on the above considerations, this regulatory requirement topic will be reviewed as a Type 3 (Safety Review).

REVIEW STRATEGY:

Acceptance Review:

In conducting the Acceptance Review of this PAC, the reviewer should determine if the information present in the license application and its references for determining compliance with the applicable regulatory requirements is complete in technical breadth and depth as identified in the FCRG. The reviewer should determine that all appropriate information necessary for the staff to review this PAC is presented such that the assessments required by regulatory requirements associated with total system and subsystem performance objectives can be performed.

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

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

Safety Review:

This regulatory requirement is limited to consideration of the geomechanical properties that would not permit the design of underground openings to remain stable through permanent closure. It is not concerned with the PAC described in 10 CFR 60.122(c)(20), that concerning "rock or groundwater conditions that would require complex engineering measures in the design and construction of the underground facility or in the sealing of boreholes and shafts", which will be addressed in Section 3.2.2.10 of the license application and its attendant review plan. The specific aspects of the license application on which the reviewer will focus are described in the FCRG, and the Acceptance Criteria will be identified in Section 3.0 of this review plan.

In conducting the Safety Review, the reviewer will, at a minimum, determine the adequacy of the data and analyses presented in the license application to support DOE's demonstrations regarding 10 CFR 60.122(c)(21). Specifically, DOE will need to: (1) provide information to determine whether and to what degree this PAC is present; (2) provide information regarding the likelihood that the PAC is actually present at the site, even though site characterization activities indicate that the PAC is not present; (3) assure the sufficiency of the lateral and vertical extent of data collection; and (4) evaluate the information presented in support of Items (1) and (2), with assumptions and analysis methods that adequately describe the presence of the PAC and ranges of relevant parameters.

DOE will also need to provide an explanation of the measures used to support models used to assess the presence of evidence of this PAC. Analyses and models that will be used to predict the response of underground openings and changes in the geomechanical properties shall be supported by using an appropriate combination of such methods as field tests, in situ tests, laboratory tests that are representative of field conditions, monitoring data, and natural analog studies.

Two design considerations for the underground openings proposed for the geologic repository at Yucca Mountain that are different from underground openings constructed elsewhere, for purposes other than a repository, are the heat load and the long time frames that the openings are required to be open. It is expected therefore that DOE will examine how heat and time affect the geomechanical properties and how these in turn affect the stability of the underground openings. It is expected that among the topics to be examined by the DOE are how heat affects the strength and deformation properties of the rock mass, and are there any time-dependent deformations or strength losses in the rock mass. It is also expected that DOE would identify and discuss any geomechanical properties that would tend to produce conditions that will require frequent maintenance of the underground openings.

In conducting the aforementioned evaluations, the reviewer should determine that DOE uses: (1) analyses that are sensitive to evidence of the PAC; and (2) assumptions which are not likely to underestimate its effects. In general, the reviewer will assess the adequacy of DOE's investigations for evidence of the PAC within the controlled area.

In order to conduct an effective review, the reviewer will rely on staff expertise and independently acquired knowledge, information, and data such as the results of research activities being conducted by the NRC's Office of Nuclear Regulatory Research, in addition to that provided by the DOE in its license application. The reviewer should focus on additional data which can refine knowledge of whether geomechanical properties that do not permit design of underground openings that will remain stable through permanent closure, exist or could develop at the site.

It is incumbent upon the reviewer to have acquired a body of knowledge regarding these and other critical considerations in anticipation of conducting the review to assure that DOE's Geomechanical Properties program is sufficient (see DOE, 1988, p. 8.3.5.17-80) in scope and depth to provide the information to resolve the concerns.

Finally, the following DOE site characterization program study plans are expected to provide dates and analyses needed to help in the review described above to address the presence (or absence) of this PAC:

Study Plan No. 8.3.2.2	*Configuration of Underground Facilities (Postclosure)*
Study Plan No. 8.3.2.5	*Preclosure Design and Technical Feasibility*
Study Plan No. 8.3.5.13	*Total System Performance*

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APPLICABLE REGULATORY REQUIREMENTS FOR EACH TYPE OF REVIEW:

Type 1:
10 CFR 60.21(c)(1)(ii)(B)
10 CFR 60.21(c)(1)(ii)(F)
10 CFR 60.122(c)(21)
Type 3:
10 CFR 60.122(c)(21)

REFERENCES:

U.S. DOE, "Chapter 8, Site Characterization Program" in "Site Characterization Plan, Yucca Mountain Site, Nevada Research and Development Area, Nevada," Office of Civilian Radioactive Waste Management, DOE/RW-0199, Vol. VII, Part B, December, 1988.

U.S. DOE, "Configuration of Underground Facilities Postclosure," Study Plan 8.3.2.2.

U.S. DOE, "Preclosure Design and Technical Feasibility," Study Plan 8.3.2.5.

U.S. DOE, "Total System Performance," Study Plan 8.3.5.13.

U.S. Nuclear Regulatory Commission, "Disposal of High-Level Radioactive Wastes in Geologic Repositories: Technical Criteria [Final Rule]," *Federal Register*, Vol. 48, No. 120, June 21, 1983, pp. 28194-28229.

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