UNITED STATES
NUCLEAR REGULATORY COMMISSION
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September 30, 1998

Dr. Stephan J. Brocoum
Assistant Manager for Licensing
U.S. Department of Energy
Office of Civilian Radioactive Waste Management
Yucca Mountain Site Characterization Office
P.O. Box 30307
North Las Vegas, Nevada 89036-0307

SUBJECT: ISSUE RESOLUTION STATUS REPORT - REVISION 1
KEY TECHNICAL ISSUE: STRUCTURAL DEFORMATION AND SEISMICITY

Dear Dr. Brocoum:

Consistent with U.S. Nuclear Regulatory Commission's (NRC's) program for early resolution of technical issues at the staff level, the staff is enclosing Revision 1 of its Issue Resolution Status Report (IRSR) on the Key Technical Issue (KTI) of Structural Deformation and Seismicity (SDS). The previous version of this IRSR defined four subissues to be resolved: (1) faulting; (2) seismicity; (3) fracturing; and (4) tectonics, and addressed these subissue components: for Subissue 1, seismogenic faults important to repository design and performance (i.e., Type I faults); and for Subissue 4, viable tectonic models to be used in assessing long-term performance (letter dated November 12, 1997, from N. K. Stablein to S. Brocoum).

This revision (SDS IRSR, Rev. 1) focuses on the development of acceptance criteria for the resolution of the subissue components: fault displacement hazard (component of Subissue 1); seismic hazard (component of Subissue 2); and fracturing and structural framework of the natural barrier system (component of Subissue 3). The SDS subissues addressed in this IRSR cover, but are not limited to, the U.S Department of Energy's (DOE's) Repository Safety Strategy (RSS) hypotheses of disruptive processes and events Numbers 16[1] and 17[2]. Other hypotheses, such as Number 2 regarding seepage into drifts, are related to SDS's subissue on characterization of fractures and the structural framework of Yucca Mountain.

As set forth in the IRSR (Enclosure, Section 3.2.1.1), the staff accepts DOE's RSS Hypothesis No. 16[1] (U.S. DOE, 1998b) and considers that fault movement is not likely to contribute significantly to direct releases over the next few thousand years Also, as set forth in the IRSR (Section 3.2.2.1), the staff is currently of the view that the effects of rockfall due to seismicity on failure of waste packages, as a mechanism of potential release of radionuclides, are of some significance within the limitations of the model. Staff studies of effects of rockfall bear on DOE's RSS Hypothesis No.17[2] and will continue in FY99.

It is stated throughout this IRSR that the resolution of the subissues on faulting, seismicity, and tectonics depends upon future DOE documents (e.g., Probabilistic Seismic Hazard Analysis (PSHA) and Topical Report #3 (TR #3)) that address those subissues or their components To date, the staff has identified 78 Type I faults in the vicinity of Yucca Mountain (Section 4 1 1) DOE indicated in its comment on Revision 0 of the SDS IRSR that, while it may not agree with

NRC on the classification of every fault, it would consider NRC's classification (letter dated April 28, 1998, from S. Brocoum to N. K. Stablein).

In IRSR Revision 0 and in DOE's comments on it (ibid.), DOE indicated that viable tectonic models additional to those in Revision 0 are likely to be included in future DOE documents (e.g., PSHA and Total System Performance Viability Assessment). Therefore, the staff is treating a DOE "preferred" tectonic model (Sections 4.4.1.2 and 5.4.3.2) as an open item, to be evaluated in the context of the forthcoming DOE documents. The staff has no reason at this time to change the status of the five viable tectonic models mutually agreed upon with DOE (Sections 4.4.1.2 and 5.4.2.1).

In addition to seismotectonic subissues, this IRSR provides the acceptance criteria and technical bases for evaluation of the subissue of fracturing and structural framework of Yucca Mountain (Section 4.3.1.2). This subissue addresses the need for an acceptable range of fracture models for Yucca Mountain that may depict likely pathways for migration of gases, groundwater, heat, and, possibly, magma through the natural barrier system. The staff are evaluating DOE's recent fracture data and models to ensure that assumptions, quality of data, consistency of data with models, and consideration of uncertainty are adequately addressed. This IRSR includes a summary of fracture characteristics that supports the IRSR on Unsaturated and Saturated Flow Under Isothermal Conditions.

Also, in this IRSR, the staff documents the resolution of a component of the seismicity subissue - DOE has an acceptable PSHA methodology (Section 5.2.2.1). Further, the staff documents the resolution of additional Site Characterization Analysis (SCA) comments and an SCA question, bringing the total resolved to 6 of the 19 that fall under the purview of the SDS KTI (Sections 5.1.2.4, 5.2.2.2, and Appendix D). All of the seismicity SCA comments are resolved. Moreover, the status of the staff's review and evaluation of DOE's 3D geologic framework model (GFM 3.0) and Integrated Site Model (ISM) is discussed (Sections 5.4.2.2 and 5.4.3.3; Appendix F). You specifically requested an evaluation of the ISM 2.0 model, and, in a separate letter, I will respond and reference the relevant studies documented in Appendix F of this IRSR.

During the development of acceptance criteria and technical bases on matters pertaining to the resolution of crustal conditions at Yucca Mountain that are significant to long-term performance - particularly, tectonic strain accumulation and release - an article on strain accumulation by Wernicke, et al. (*Science*; March 27, 1998) was issued. NRC is presently evaluating the new information, and future revisions of this IRSR will address the effect of this information on the probability of future structural deformation and seismicity at Yucca Mountain.

Staff-level issue resolution can be achieved during the prelicensing period, consistent with NRC regulations on prelicensing consultations and a 1992 agreement with DOE. However, such resolution at the staff level may not preclude the issue being raised and considered during the licensing proceedings. Issue resolution at the staff level during prelicensing is achieved when the staff has no further questions or comments (i.e., no open items). There may be cases where resolution at the staff level may be limited to documentation of a common understanding regarding differences in NRC and DOE points of view. Additional pertinent information could raise new questions or comments regarding a previously resolved issue.

The enclosure should be viewed as a status report that provides the staff's current views of the effects of structural deformation and seismicity on the natural barrier and engineered barrier systems and long-term performance of a repository at Yucca Mountain. NRC plans to update this report in FY99 to reflect progress on the four SDS subissues. We welcome a dialogue on the potential effects of structural deformation and seismicity on repository performance with DOE, the U.S. Nuclear Waste Technical Review Board, State of Nevada, and other interested parties. If you have any questions about this IRSR, please contact Philip Justus of my staff at (301) 415-6745, or via internet mail service at psj@nrc.gov.

Sincerely,

Original Signed By

Michael J. Bell, Chief
Engineering and Geosciences Branch
Division of Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure: As stated

cc: See attached list

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[1] "The amount of movement on faults through the repository horizon will be too small to bring waste to the surface, and too small and infrequent to significantly impact containment during the next few thousand years." (RSS, Rev. 1, January 1998, Hypothesis 16, p. 15).

[2] "The severity of ground motion in the repository horizon for tens of thousands of years will only slightly increase the amount of rockfall and drift collapse." (ibid., Hypothesis 17)

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Distribution List for Letter to Stephan Brocoum dated September 30, 1998

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ENCLOSURE

CHANGE HISTORY of "Issue Resolution Status Report, Key Technical Issue: Structural Deformation and Seismicity"
[Boldface = major change in current revision]

Revision #	Section/ Paragraph	Date	Modification
0	n/a	4/98	n/a. Initial issue
1	most	9/98	Minor editorial, format, style, consistency, section-number changes, or conform to new terminology, or new section titles
1	Acknowl.	9/98	Update
1	Quality	9/98	Update
1	3.2.1	9/98	Minor revision
1	3.2.1.1	9/98	**Major revisions** to reflect sensitivity studies completed after Rev.0
1	3.2.2	9/98	Minor revision
1	3.2.2.1	9/98	**Major revisions** to reflect sensitivity studies completed after Rev.0
1	3.2.3	9/98	**Major revision** to support USFIC KTI
1	3.2.4	9/98	Minor revision to clarify need for subissue to constrain hazards and risks
1	4.0	9/98	Minor revisions: add period of performance to last sentence, para.1; add analysis of risk to last sentence, para.2; add global analogs to first sentence, para.3
1	4.1	9/98	Minor revision
1	4.1.1	9/98	Minor revisions: add period of performance to sentence 2, para.1; add analog to sentence 2, para.2; shorten section
1	4.1.1.2	9/98	Revision of Type I fault details to reflect new data and reformat of database, Appendix B
1	4.1.2	9/98	**New section** on fault displacement hazard (FDH)
1	4.1.2.1	9/98	**New section** of FDH acceptance criteria
1	4.1.2.2	9/98	**New section** of FDH technical bases

Revision #	Section/ Paragraph	Date	Modification
1	4.2	9/98	**New section** on seismicity
1	4.2.1	9/98	**New section** on seismic hazard (SH)
1	4.2.1.1	9/98	**New section** of SH acceptance criteria
1	4.2.1.2	9/98	**New section** of SH technical bases
1	4.3	9/98	**New section** on fracturing and structural framework of the geologic setting (FSF)
1	4.3.1	9/98	**New section** on FSF
1	4.3.1.1	9/98	**New section** on FSF acceptance criteria
1	4.3.1.2	9/98	**New section** on FSF technical bases
1	4.4.1.1	9/98	Minor revision: clarify Criteria 3, 4 and 5
1	4.4.1.2	9/98	**Add paragraphs**: evaluation of viable tectonic models; role of faults in the distribution of dikes and volcanoes, planar versus listric fault geometries, and Geologic Framework Model 3.0
1	4.4.2	9/98	**New section** on crustal conditions (CC)
1	4.4.2.1	9/98	Minor new section on CC acceptance criteria TBD
1	4.4.2.2	9/98	**New section** on CC technical bases
1	5.1	9/98	**New section**
1	5.1.1	9/98	New section on faulting subissue analysis TBD
1	5.1.2.2	9/98	**New section** on resolved subissue of faulting causing waste package failures
1	5.1.2.3	9/98	**New section** on resolved subissue of faulting exhuming waste packages
1	5.1.2.4	9/98	**Major revision** reflecting resolution of four SCA items
1	5.1.3.2	9/98	Revision of Type I fault details reflect new information in Appendix B

Revision #	Section/ Paragraph	Date	Modification
1	5.1.3.4	9/98	**Major revision** to reflect reduction of SCA open items from ten to six
1	5.2	9/98	**New section**
1	5.2.1	9/98	New section on seismicity subissue analysis TBD
1	5.2.2.1	9/98	**Major new section** reflects resolution of probabilistic seismic hazard methodology
1	5.2.2.2	9/98	**Major revision** to reflect resolution of SCA item, Comment 67, omitted from Revision 0.
1	5.2.3.1	9/98	**Major revision** to reflect seismic hazard open item status
1	5.2.3.2	9/98	**Major new section** to reflect ground motion and rockfall open item
1	5.3.1	9/98	New section to reflect analysis of subissue on FSF TBD
1	5.3.2	9/98	New section TBD
1	5.3.2.1	9/98	**Major new section** states there are no SCA items on FSF
1	5.3.3	9/98	New section on FSF open items TBD
1	5.4.1	9/98	New section to reflect analysis of CC TBD
1	5.4.2.2	9/98	**Major new section** reflects resolved item on DOE's Geologic Framework Model (GFM 3.0)
1	5.4.3.2	9/98	**Major new section** reflects open item on DOE's preferred tectonic model
1	5.4.3.3	9/98	**Major new section** reflects open item on DOE Integrated Site Models
1	5.4.3.4	9/98	**Major new section** reflects open item on crustal strain at Yucca Mountain
1	6.0	9/98	Update references and combine into one section
1	7.0/App.B	9/98	**Inserted data and new column on seismic sources** considered by DOE's PSHA experts in B-1 thru B-4; **added B-5** on seismic sources

Revision #	Section/ Paragraph	Date	Modification
1	7.0/App.D	9/98	**Major format change to numerical order; new categorization list** (p. D-1); **major revisions** to reflect resolution of Comments 36, 62, 64, 67 and 71
1	7.0/App.E	9/98	**Major new figures**: E-1 - location map; E-2 and E-3 - Type I fault maps; **major new tables**: E-1 - geologic time scale; E-2 - stratigraphic nomenclature
1	7.0/App.F	9/98	**Major new tests and evaluations** of Geologic Framework Model (GFM 3.0)
1	7.0/App.G	9/98	Placeholder for 'Glossary of terms' - TBD