

MAY 18 1988

ROSS REPORT

- 1 -

MEMORANDUM FOR: B. J. Youngblood, Chief
 Operations Branch
 Division of High-Level Waste Management

FROM: Ronald L. Ballard, Chief
 Technical Review Branch
 Division of High-Level Waste Management

SUBJECT: REVIEW OF SAND85-7117 (ROSS REPORT)

Enclosed for purpose of record is the Technical Review Branch review of the Sandia National Laboratories' report (SAND85-7117) "A First Survey of Disruption Scenarios for a High-Level Waste Repository at Yucca Mountain, Nevada" by B. Ross. Informal drafts were provided by the requested date of April 22, 1988.

The attached comments were developed by three of the five TR sections (Geochemistry, Geology/Geophysics, and Hydrology). Following their review of the report, neither the Geotechnical Engineering/Design Section nor the Materials Engineering Section felt additional comments were necessary.

As a general comment, this report would have been greatly improved by the addition of scenarios that consider releases to the geologic setting during the containment period due to anticipated processes and events. Of course, updates to this report should reflect the data and EPA regulations developed in the last four years.



Ronald L. Ballard, Chief
 Technical Review Branch
 Division of High-Level Waste Management

Enclosure:
 As stated

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SUBJECT: REVIEW OF SAND85-7117 (ROSS REPORT)

Enclosed is the Technical Review Branch review of the Sandia National Laboratories' report (SAND85-7117) "A FIRST SURVEY OF DISRUPTION SCENARIOS FOR A HIGH-LEVEL-WASTE REPOSITORY AT YUCCA MOUNTAIN, NEVADA" by B. Ross.

The attached comments were developed by three of the five TR sections (Geochemistry, Geology/Geophysics, and Hydrology). Following their review of the report, neither the Geotechnical Engineering/Design Section nor the Materials Engineering Section felt additional comments were necessary.

As a general comment, this report would have been greatly improved by the addition of scenarios that consider releases to the geologic setting during the containment period due to anticipated processes and events. Of course, updates to this report should reflect the data and EPA regulations developed in the last four years.

Ronald L. Ballard, Chief
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DATE : 88/04/27	88/04/27	88/04/29	88/04/28	88/04/29	88/04/29	88/04/29	88/04/29

ROSS REVIEW

- 1 -

MEMORANDUM FOR: Ron Ballard, Chief
 Technical Review Branch
 Division High-Level Waste

THROUGH: Harold Lefevre, Acting Section Leader
 Geology/Geophysics Section
 Technical Review Branch

FROM: Charlotte Abrams
 Geology/Geophysics Section
 Technical Review Branch

SUBJECT: REVIEW OF SAND85-7117

Enclosed is the Technical Review Branch review of the Sandia report
 "A FIRST SURVEY OF DISRUPTION SCENARIOS FOR A HIGH-LEVEL-WASTE REPOSITORY AT
 YUCCA MOUNTAIN, NEVADA" by B. Ross. This review constitutes a level-of-effort
 review (one day) conducted by John Bradbury, Michael Blackford, Keith McConnell,
 Jeff Pohle, and Charlotte Abrams.

Charlotte Abrams
 Geology/Geophysics Section
 Technical Review Branch

Enclosure:
 As stated

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GENERAL COMMENTS

While the title of the report may imply that this is not intended as a comprehensive list of possible scenarios it might be helpful for the author to clarify that point early in the report.

This report is based on information four years old and does not contain more recent interpretations and data. Therefore, in many cases conclusions about scenarios do not reflect the current knowledge.

This report, with respect to tectonics, does not contain scenarios which describe performance of the waste package during the containment period (10CFR60.113). Releases to the geologic setting during the containment period due to anticipated processes and events should be addressed in the scenario development.

SPECIFIC COMMENTS

Page 8; paragraph 3:

The approach used in the report to develop "sequences" (disruptive events and processes) from various natural, human and repository induced processes and events is to not assume that current ("preferred") conceptual models are correct and to address scenarios that would be disruptive if reasonable alternative conceptual models turn out to be true.

Given the intended approach, the question as to whether a systematic and comprehensive set of alternative "conceptual models" or "hypotheses" was made available to the author by technical groups or whether the "alternatives" discussed in the report are merely the author's opinion is appropriate. Because the objective of the report is to develop scenarios and not a comprehensive set of alternatives the question as to whether the consideration of alternatives is thorough and/or complete is appropriate.

Page 9; paragraph 1:

"Scenarios leading to release of radioactivity in gaseous form are not discussed here." This may be an important deficiency of this report. When the repository is in its thermal period and the fractures in large volumes of rock are dried out, then it becomes more likely that when canisters leak, the radioactive gases can migrate long nontortuous distances within fractures.

"A substantial inventory of krypton-85 is present at closure but its half-life is 10.72 years...". The DOE concedes that it will emplace a few leaking canisters. If so, won't the escaping krypton be a problem? Its inventory is 0.5×10^7 per 1000 MTHM.

Page 22; 2.1.5:

This section on stream erosion does not consider erosion as an initiating process/event leading to failure of a surface seal. Debris flows can be very erosive and are not mentioned in the report.

Page 23; paragraph 3:

It is agreed that erosion to the repository level is very unlikely, but if the repository is expanded to the north under Drill Hole Wash erosion could become a consideration in that area if there is also an increase in precipitation.

Page 25; paragraph 2:

The second hypothesis in this paragraph is important since most northwest trending washes which overlie the repository are formed and are underlain by northwest trending faults. Therefore recharge may be greater in fault controlled washes where extensive fracturing and breccia zones may exist under alluvium.

Page 28; 2.1.11:

The author does not discuss or incorporate into scenarios the effect of stress changes associated with earthquakes. Prior to an earthquake a certain state of stress exists in the vicinity of the fault that ruptures at the time of the earthquake. This state of stress has presumably developed gradually over a period of time, hundreds to thousands of years, and at such a rate that effects on groundwater are unobservable. When the earthquake occurs this state of stress is modified very rapidly. The extent and magnitude of the effect of this stress change on the groundwater is not well understood, but dramatic effects such as sandblows, mudflows, increased or decreased flow of streams and wells have been observed coseismically in areas where the water table is relatively near the surface. Very few observations of the effects of stress changes due to earthquakes on the groundwater at depths comparable to the proposed repository depth have been reported. Wells located a few kilometers to a few tens of kilometers from a fault that is identified as the source of a moderate to large earthquake often demonstrate considerable water level changes that may last for days or even months after the earthquake. Data from wells closer than a kilometer to a seismogenic fault are very sparse but some information may be available from oil fields or other deep wells where fluid injection has induced local seismicity. These data could be assessed as possible analogs for investigations of the effects of local seismicity on groundwater.

Page 28; 2.1.11:

The author should consider that faults near and at Yucca Mountain are near failure due to stress conditions. Seismic events of great enough magnitude could trigger release along these faults opening pathways and rupturing canisters.

The author should consider the regional fault system (consisting of north-south, northwest, and northeast trending faults) when evaluating the overall tectonic model.

Most recognized faults at the site are north or near north trending. Seismic evidence indicates that north trending faults in the vicinity of the NTS are active (DOE environmental Assessment, page 3-20 and NRC staff EA Comment 1 for Yucca Mountain).

Page 29; paragraph 1:

This paragraph contains a discussion concerning which faults would be most likely to slip given the current stress field. It is stated that faults trending N25E to N30E are the most likely to slip and that these faults are not numerous in the area. This may be so, however some faults in the immediate vicinity of the proposed underground facility do indeed trend northeast. Referring to Figure 1-41 of the CDSCP, the Solitario, Abandoned Wash-Ghost Dance, Bow Ridge, and Paintbrush Canyon faults trend N7E to N10E. However, a portion of the Abandoned Wash-Ghost Dance fault between trench 6 and trench 9 and an unnamed fault to the east of the Abandoned Wash-Ghost Dance fault that terminates several of the northwest trending faults from Drill Hole Wash northward trend N25E.

Page 29; paragraph 1:

The statement that "most faults and fractures in the area strike either northwest or north-northeast, so such faults [northeast trending] are not numerous" is meaningless and serves only to unjustifiably minimize the possible effects of faulting at the repository.

Page 29, paragraph 1:

The last sentence in this paragraph is meaningless used in this context. Favorably oriented structures could exist in pre-Tertiary rocks on which there has been no movement in the last 25 m.y., are these "existing faults?"

Page 29; paragraph 2:

This paragraph includes a discussion of the rates of occurrence of large earthquakes with respect to a given area. This process tends to greatly reduce the significance of individual faults as seismic disruptive sources. It may be better to consider seismic activity with respect to the number of faults over a given length than with respect to a given area.

Page 29, paragraph 2:

The statement made in the first sentence of this paragraph and one similar to it in the Draft EA were objected to by the NRC staff because of the evidence documenting Quaternary movement on north-trending faults at Yucca Mountain. Quaternary movement along faults in this area requires that faulting be considered as an anticipated event and the issue of related seismicity is irrelevant and only serves to unjustifiably minimize the possible effects of faulting at the repository.

Page 29; paragraph 3:

It is stated that, "Rates of fault movement in the area are no more than 0.001 centimeters per year." Some rates of Quaternary movement on the Windy Wash and Bare Mountain faults exceed this value. Rates, based on offset of Miocene units, for the Paintbrush Canyon, Bow Ridge, Solitario Canyon, Windy Wash, and Bare Mountain faults exceed the rate of 0.001 centimeters per year (see Table 1-8, p.129 of the CDSCP).

Page 29; paragraph 3:

Rates of movement by the author only take into consideration vertical displacement. To date, investigators at the site have been unable to calculate lateral movement along faults of the area.

Page 29; paragraph 3:

The rates of fault movement mentioned in the second sentence of this paragraph relate only to vertical offset and do not consider lateral motion. Therefore, the figure presented here may significantly underestimate the rate of movement along faults in the Yucca Mountain area. In addition, more recent estimates for rate of movement along the Bare Mountain fault (CDSCP) are significantly higher than that presented here for "fault movement in the area."

Page 30; number 12:

This sequence addresses only those releases to the accessible environment. Releases to the geologic setting should also be considered.

Page 31; numbers 15 and 16:

Of the five sequences to be considered numbers 15 and 16 deserve the most attention. This is especially true when stress changes accompanying earthquakes is considered.

Page 32; paragraph 1:

"The principal geochemical alteration processes occurring at Yucca Mountain are the devitrification of glassy components of the tuff and their alteration to a series of zeolite minerals". In addition, the zeolites can alter to nonsorptive phases (covered elsewhere by the author).

Page 33; 2.1.15:

"Brine pockets are not credible". The author doesn't consider the generation of brines by natural processes. There is not enough information to make this statement. Possibly lithophysae could fill with water at some time in the past and through evaporation produced brines.

Page 33; last paragraph:

The information in this paragraph seems to contradict information in the last paragraph on page 29. The paragraph on page 29 states that "rates of fault movement in the area are no more than about .001 cm per year"; whereas, the last paragraph on page 33 states that in areas of the Great Basin "uplift rates are as high as 4 to 8 meters in 10,000 years."

Page 34; 2.1.19:

The possibility of undiscovered major faults at the site should not be discounted. The existence of faulting which was not recognized at the surface or in core has been documented at the Climax facility (Wilder and Yow, 1984).

Page 35; paragraph 3:

North trending faults at the site are near vertical.

Page 36; paragraph 3:

The last sentence in this paragraph is significant and the information should be referenced.

Page 38; 2.1.20 and 2.1.21:

The geologic map of Bare Mountain by Cornwall and Kleinhampl (1961) shows possible intrusives and/or flows of Miocene to Pleistocene age at the northwestern end of Yucca Mountain. These units should be evaluated before the existence of any magmatic intrusions or volcanic activity since the deposition of the Paintbrush Tuff has been discounted. Also little is known about the existence of subsurface magma bodies beneath the site. The CDSCP (page 1-261) states that "...a deep pluton...may extend from northern Bare Mountain, to northern Yucca Mountain, to the Calico Hills area" in the vicinity of the site. Although the age of this pluton is thought to be Mesozoic by Carr (1984) the age is not known.

Page 38, paragraph 2:

This statement is incorrect. 10 m.y. old basalts "intrude a fault and nearby fractures at the head of Solitario Canyon in the northwest part of the Site" (U.S.G.S., 1984).

Page 38, paragraph 3:

This statement is incorrect. 10 m.y. old basalt dikes "intrude a fault and nearby fractures at the head of Solitario Canyon in the northwest part of the Site" (U.S.G.S., 1984).

Page 38; 2.1.22:

The subsurface exploration program at Yucca Mountain has not been extensive enough to date to rule out the possible existence of dikes or sills.

Page 39; paragraph 3:

Basaltic volcanism may have occurred as recently as 10,000 to 20,000 years ago at Lathrop Wells. The current assessment of the Lathrop Wells cone is that there were multiple eruptive phases. Therefore, it cannot be assumed that the basaltic cycle is over and until further information is available it cannot be assumed that "basaltic volcanism...is at most barely credible."

Page 39; paragraph 5:

"The highest temperature the canisters would normally experience is approximately 250C. Temperatures would rise above this only if the dike was within 10 meters". However, no modeling is expected reflecting conditions of high temperatures at times after 300 years.

Page 40; paragraph 2:

Hydrothermal activity, even on a small scale during a limited time, could shorten the life of the waste package and transport radionuclides to the accessible environment.

Page 41; paragraph 1:

See preceding comment. Hydrovolcanic activity could also release contaminants to the air.

Page 42 and 43; 2.2.1:

Failure of shaft seals as an initiating process/event has been eliminated from consideration because 1) shafts and access ramps would not be sealed, except perhaps near the surface to prevent infiltration of runoff and entry by humans and 2) shafts would, if necessary, be extended slightly below floor level of the repository to ensure drainage of any infiltrating water. The report also assumes that any runoff that did enter a shaft would quickly dissipate into the surrounding rock.

If it is necessary to emplace a surface seal in the shaft to prevent runoff from entering, then the failure of that seal needs to be considered an initiating process/event. The assumption that any runoff that did enter a shaft (especially a 12 foot open shaft) would quickly dissipate into the surrounding rock is questionable. Further, given the limited observations and lack of testing at depth to date, the efficacy of a sump is speculative.

Page 52; 2.2.11:

The assumption that Yucca Mountain is an unattractive target for natural resources is unjustified based on the lack of data collected to date. New exploration, mining, and extraction concepts and techniques have evolved over the last 30 years (since the NTS was closed to exploration). Also, core from only a very limited number of drillholes has been analyzed for mineral resources.

Page 65; paragraph 4:

Mention of this scenario is important. The State of Nevada is looking into this scenario. The argument to show the geyser is not contaminated needs further thought. Even though there may be a dried out region near the hot canisters, this "barrier" could be short circuited by gaseous phase transport or aerosol transport.

Page 79; number 81:

"Water passing through the warm region around the repository is depleted of calcite by temperature-induced precipitation". No consideration is given for the effect of CO₂ pressure on the solubility of calcite in the repository.

Page 99; paragraph 3:

"One would not expect an acceleration of corrosion due to the formation of colloids because corrosion rates are kinetically controlled rather than equilibrium-limited". Not enough is known about reaction rates to make

such a statement. The author does not refer to any study supporting this observation.

Page 102; paragraph 2:

The statement that "...the 5000-year-plus time delay for unretarded species implies that any element with a retardation factor of two or more will not be released within 10,000 years" is untrue. Since the retardation factor is based on the centroid of the elution peak, for the above case, half of the species would be in the accessible environment in 10,000 years. In other words, the shape of the elution curve is necessary to calculate releases.

REFERENCES

- Carr, W.J., 1984, Regional structural setting of Yucca Mountain, southwestern Nevada, and late Cenozoic rates of tectonic activity in part of the southwestern Great Basin, Nevada and California: U.S. Geological Survey Open-File Report 84-854, 109 p.
- Cornwall, H.R., and Kleinhampl, F.J., 1961, Geology of the Bare Mountain Quadrangle, Nevada: U.S. Geological Survey Map GQ-157, scale 1:62,500.
- U.S. Geological Survey, 1984, A summary of geologic studies through January 1, 1983, of a potential high-level radioactive waste repository site at Yucca Mountain, southern Nye County, Nevada: U.S. Geological Survey Open-File Report 84-792, 103 p.
- Wilder, D.G., and Yow, J.L., Jr., 1984, Structural geology report Spent Fuel Test--Climax Nevada Test Site: Lawrence Livermore National Laboratory, UCRL-53381, 43 p.