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UNITED STATES
NUCLEAR REGULATORY COMMISSION
WASHINGTON, D. C. 20555

Reply to:
1050 East Flamingo Rd.
Suite 319
Las Vegas, Nevada 89119
Tel: (702) 388-6125
FTS: 598-6125

TO: King Stablein

FROM: Paul T. Prestholt, Sr. On-Site Licensing Representative

DATE: November 12, 1987

SUBJECT: RESPONSE TO NRC CONCERNS RELATED TO VOLCANIC INTRUSION INTO THE REPOSITORY AT THE NNWSI PROJECT

Please find the above-referenced information for your files.

PTP:nan

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PDR WASTE
WM-11 PDR

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WM Project: WM-11
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(Return to WM, 623-SS)

WM Record File: 102
LPDR w/encl

Department of Energy
Nevada Operations Office
P. O. Box 98518
Las Vegas, NV 89193-8518

NOV 09 1987

James P. Knight, Director, Licensing & Regulatory Division, HQ (RW-24) FORS

RESPONSE TO U.S. NUCLEAR REGULATORY COMMISSION (NRC) CONCERNS RELATED TO VOLCANIC INTRUSION INTO THE REPOSITORY AT THE NEVADA WASTE STORAGE INVESTIGATIONS (NNWSI) PROJECT

The NNWSI Project has prepared a draft response (see enclosure 1) to the NRC's letter (see enclosure 2) related to volcanism at the Yucca Mountain site. Enclosure 3 is the project's proposed letter from Carl Gertz, U.S. Department of Energy, to John Linehan, NRC, that would transmit Enclosure 1.

Due to the interest the NRC has expressed in this matter, we anxiously await your concurrence to formally transmit Enclosure 1 to the NRC.

If you wish to discuss this subject further, please contact me at FTS 575-8939 or Mary L. Brown at FTS 575-8658.

Robert K. Weird

for: Maxwell B. Blanchard, Chief
Regulatory & Site Evaluation Branch
Waste Management Project Office

WMPO:MBB-341

Enclosures:
1. Ltr 10/13/87 Bruce Crowe and Frank Perry, LANL, to Maxwell Blanchard, NV
2. Ltr 8/13/87 John Linehan, NRC, to Mitchell Kunich, NV
3. Draft Ltr Carl Gertz, NV, to John Linehan, NRC

cc w/encls:
J. P. Knight, HQ (RW-24) FORS
Ralph Stein, HQ (RW-24) FORS
S. J. Brocoum, HQ (RW-233) FORS
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C. P. Gertz, WMPO, NV
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M. P. Kunich, WMPO, NV

cc w/o encls:
V. J. Cassella, HQ (RW-222) FORS

NNA.871014.0035

Los Alamos

Los Alamos National Laboratory
Los Alamos, New Mexico 87545

memorandum

TO: Maxwell B. Blanchard, Chief
Regulatory & Site Evaluation Branch
Waste Management Project Office

DATE: October 13, 1987

THRU: Donald T. Oakley, LANL
Technical Project Officer for NNWSI

MAIL STOP/TELEPHONE: J514/7-3965

FROM: Bruce Crowe and Frank Perry
Isotope Geochemistry Group

SYMBOL: TWS-INC7-10/87-3

SUBJECT: NUCLEAR REGULATORY COMMISSION STAFF REPORT CONCERNING VOLCANISM, FROM JOHN J. LINEHAN

DRAFT

This memorandum has been written in response to your request for comments on the NRC "Evaluation of the Potential Effects and Risk of Volcanic Intrusion at Yucca Mountain" (WMPO Action Item #87-2507).

The NRC report was written in response to the following: First, an NRC representative attended the NNWSI TPO meeting in March 1987. A talk was presented at the meeting on the implications of new information concerning volcanism studies. Significant new information for volcanism studies that was presented at the meeting include:

a) laboratory data suggesting the lava flows at the Lathrop Wells volcanic center are younger than the age (270,000 years bp) reported in the Environmental Assessment (EA).

b) field data supporting multiple eruption cycles (polycyclic) at the Lathrop Wells volcanic center.

c) field and laboratory data suggesting the youngest volcanic event at the Lathrop Wells volcanic center may be as young as or younger than 20,000 years (bp).

Second, the NRC had specific questions concerning information and references included in the Environmental Assessment (EA) for the Yucca Mountain Site.

The following points were raised in the NRC staff report on volcanism:

1. Probability Concerns: The probability of basaltic magma intruding a repository at Yucca Mountain may be greater than the values presented in the EA if the youngest volcanic activity in the area is as young as 20,000 years (bp).

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OCT 14 1987

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ENCLOSURE 4

2. Release Calculation Concerns: The NRC expressed concern over the way release estimates of Link et al., (1982) were used in the EA. They also noted that use of a non-random dike orientation for repository intrusion could increase release estimates and that non-conservative values may have been used for repository size, repository inventory and dike width.

3. Significance of Concerns: The NRC staff expressed the opinion that neither the volcanism information nor the analyses presented in the EA are sufficient to make a licensing determination. They suggest that more reliable geologic data and more sophisticated analysis are required. Points of concern are uncertainties in the probability calculations, structural controls of volcanic sites and the need for more reliable age determinations.

Item 1: Probability Concerns:

The NRC is correct in suggesting that the potential young age of the most recent volcanism in the Yucca Mountain area should effect the probability calculations presented in the EA. Moreover, it is likely but not entirely certain that the calculations using refined age information will result in an increase in the worst case probability bound. We have completed some preliminary calculations to evaluate the potential effects of a 20,000 year age for the youngest volcanic activity. These effects are dependent on the assumptions used for the determination of the future rate of volcanic activity. However, not all the information is available to determine the changes in probability bounds for the differing rate calculations. Additional data are needed on the aeromagnetic anomalies (Crowe et al., 1986) and the detailed chronology of Quaternary volcanic centers.

While revised calculations are premature, it is useful to examine the sensitivity of probability calculations to revisions in chronology. Three approaches were used to evaluate rates of volcanic activity (Crowe et al., 1982). The first was examination of K-Ar age determinations for patterns or periodicity through time. As noted in Crowe et. al., (1982), chronology data for the Yucca Mountain area are insufficient to establish interval patterns. The addition of one new event or even several additional events (drilling of aeromagnetic anomalies) is unlikely to provide statistically significant interval patterns. We will however, test the use of this approach using data from well studied Quaternary volcanic fields in the Great Basin. Any insights gained from examining these fields will be compared with the Yucca Mountain data.

The second approach for rate determinations is to develop plots of volume versus time for Pliocene and Quaternary basaltic volcanism within the NTS region. The significant concept to test from these plots is whether the slope (equal to the rate of magma production) is changed by new data. The original plot from our 1982 paper is attached as Figure 1. Figure 2 is a plot of our current best estimates of volcanic chronology using the most recent data and assuming a 20,000 years (bp) age for the main scoria cone of the Lathrop Wells center. The slope of a regression line fitted to the revised data is nearly identical to the slope of the regression fit for the 1982 data. Figure 3 is a plot of cumulative magma volume (erupted volume) versus time for the Yucca Mountain data. Maximum information is provided by the youngest volcanic activity where individual events are easier to

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recognize. Two points are important from this plot: 1) There is an apparent decrease in eruptive volume through time and 2) subpopulations in the data sets, where there is sufficient information to separate eruptive events, have parallel slopes. This suggests that short-term events follow the long-term controls established by the overall rate of magma production. This is a concept that has been recognized recently at active volcanic fields (Shaw, 1985, 1987, Hawaii). If controlling rates of magma production at a volcanic field or volcanic center can be determined, a time-volume predictable relationship for future eruptions can be established. This is well illustrated by Figure 51.4 from Shaw (1987) for Hawaiian volcanic eruptions. Eruption rates at Kilauea and Mauna Loa volcanoes vary between 0.01 and 0.1 km^3/yr with both volcanoes showing average rates of 0.025 km^3/yr. The important point by analogy is that careful study of time-volume relations of volcanoes or volcanic fields allows the controlling eruption rates to be established. This eruption rate provides a mechanism for predicting or establishing bounds on future behavior. The fact that a newly recognized event in the Yucca Mountain area is consistent with a previously established rate provides supportive evidence that the Yucca Mountain curve is a correct reflection of the long-term behavior of the volcanic field. The suitability of this curve will be further tested by refining the chronology of volcanic events. Additionally, magma eruption rates will be examined at other volcanic fields in the Great Basin for comparison with the Yucca Mountain area.

Table III of our 1982 paper illustrates how magma production rates are used to calculate predicted times of future volcanic events. The key parameters for these calculations are the time since the last eruption and the minimum volume of eruptive events. Predicted time of the next eruption is equal to the time of magma production divided by the rate of magma production minus the time since the last eruption. Using a calculated production rate of 210 m^3/yr (Crowe et al., 1982), the first term of this equation is dependent on a minimum eruption volume. A minimum eruption volume of 7.6 x 10^7 m^3 was used in Table III because available K-Ar age determinations showed similar ages for the combined 1.2 m.y. eruptive events in Crater Flat. New concepts of polycyclic events make it more difficult to choose a representative minimum magma volume for these calculations. Small volume events tend to occur at the same volcanic center, therefore it may not be appropriate to use those values for minimum volumes. The most conservative choice for a minimum eruption volume based on the volcanic record in the Yucca Mountain area is to assume each volcanic center represents a separate pulse of magma. The smallest minimum eruptive volume is the density corrected volume for the Little Cones volcanic center (7.0 x 10 m^3, see Crowe et al., 1983, Table I). This is an order of magnitude smaller than the value used in Table III (Crowe et al., 1982). More work will be done to document the choice for representative magma volumes. The second term of the equation, the time since the last eruption, becomes 20,000 years instead of 270,000. Changing both parameters (minimum cone volume and time since the last eruption) for the worst case probability bound calculated in the 1982 paper <u>increases</u> this value by a factor of 7. This calculation should not be accepted as a firm number, but it illustrates the approximate change in the disruption, probability caused by assuming a 20,000-year age of the youngest volcanic event in the Yucca Mountain area.

Finally, the third technique used for the rate calculations is the number of volcanic events per a specified period of time. Because vents (scoria cones) were counted in this calculation

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(Crowe et al., 1982, p. 182, 17 scoria cones for 7 volcanic centers), there is no change in the probability calculation using this technique (the Lathrop Wells scoria cone was included in the calculation).

Item 2: Release Calculations:

The release calculations for the Link et al., (1982) paper were made in 1981-1982 and it is therefore not surprising that they are not consistent with the more recent EPA standards. Revised release calculations are planned using an eruption scenario with an opening phase of hydrovolcanic activity followed by Strombolian activity for the duration of the eruption. This work will be consistent with the EPA standard and the Hunter et al., (1987) methodology.

The comment on the dike orientation is important. A range of differing dike orientations were evaluated and the orientation, as pointed out by the NRC, can cause major changes in calculated releases. There clearly is a stress field control on the orientation of dikes in the Yucca Mountain area. Basalt centers younger than 6.5 m.y. show a strong N-NE orientation, parallel to the regional maximum compressive stress direction. Based on the regional stress field, the in situ stress measurements at Yucca Mountain and the preferential N-NE trends of Quaternary volcanic centers in the region, it is likely that any dike intruded into the repository block would have a N-NE orientation. The argument could be made that a repository at Yucca Mountain could be oriented to minimize contact with a N-NE striking basalt dike. Because so little information was available on the design of a possible repository at the time the report was written, Link et al., (1982) chose to use a random intersection of the repository. This was not done to minimize possible releases but rather was assumed to be the most technically honest way to undertake the calculations with so little information. This question can be reconsidered in revised release calculations.

Finally, I was not aware that an effective dike width of 0 was used in the release calculations. Dike widths at repository depths of 0.6 to 4 m and averaging 1 m (Crowe et al., 1983) were documented for use in release calculations. It would be incorrect to use a dike width of 0 and it would be useful to know exactly where in the paper this statement was made.

Item 3: Significance of Concerns:

The information in the two reports (Crowe et al., 1982; Link et al., 1982) was not intended to provide all the information that is required to make a licensing determination with respect to the significance of volcanism. Required information (some completed, some in progress or planned) for a licensing determination is described in volcanism study plans. These studies will provide the necessary information to answer the concerns mentioned in the NRC report.

In the final part of the report, the NRC noted that "... uncertainties in probability calculations can range 3 to 4 orders of magnitude". This is not correct. The probability range presented in Crowe et al., (1982) does not represent uncertainty. The range was defined as the minimum and maximum values obtained by assembling a matrix of probability values calculated using a variety of assumptions for rate calculations and area ratios. The upper or maximum annual probability bound was intended to correspond to a worst

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case approach. This probability range does not represent the uncertainty of individual calculations.

Finally, the NRC noted the need for refined ages of volcanic activity and information on the structural control of volcanic sites in the Yucca Mountain area. Work is in progress to obtain refined age data for the volcanic centers with the main focus of effort on constraining the age of the youngest activity in the region. Pending success with developmental techniques for obtaining crystallization and surface exposure ages of the Lathrop Wells scoria cone, sufficient information should be obtained to satisfy the concerns of the NRC. A more difficult topic to resolve is the structural controls of volcanism. This problem has been discussed in earlier reports (Crowe and Carr, 1980; Crowe et al., 1983b). We additionally factored structural controls in the area ratio of the probability formula in our 1982 report. How much further we can progress with this topic is somewhat uncertain. A time-space model for the distribution of basaltic volcanism in the Yucca Mountain area has been developed but has not yet been described in a formal publication. The important points of the model are: 1) volcanism, during the last 9 m.y., has migrated from northeast to southwest across the Nevada Test Site region, and 2) sites of volcanic activity during this period have been concentrated at the intersection of northeast trending faults with major northwest trending faults. Cluster analysis of aeromagnetic data will be used to attempt to identify favorable structures for volcanic pathways. These data will be combined with knowledge of the distribution of active and inactive faults in the Yucca Mountain area. From this combined information we will attempt to weigh the likelihood of future basaltic magma following identified pathways and factor this weighing into the probability formula for volcanic disruption of a repository. Several other problems remain however that may require consideration for possible impact on structural controls of volcanic sites. First, the USGS is developing a regional tectonic model of the Yucca Mountain area including information on the surface and subsurface geometry of faults and major structures. Any volcanic model needs to be integrated with their tectonic model. Second, a long recognized concept that may or may not have application to the Yucca Mountain site is the fact that basaltic eruptions tend to occur predominantly in alluvial basins. There are only a limited number of cases in the southern Great Basin where basalts have erupted in range interiors.

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Shaw, H. (1987), Uniqueness of Volcanic Systems, in "Volcanism in Hawaii", ed. R.W. Decker, T.L. Wright and P.H. Stauffer, U.S. Geol. Survey Prof. Paper 1350, 1357-1394.

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D. Dawson, SAIC
J. Szymanski, WMPO
R. Beckman, A-1
M. Johnson, A-1
TWS File

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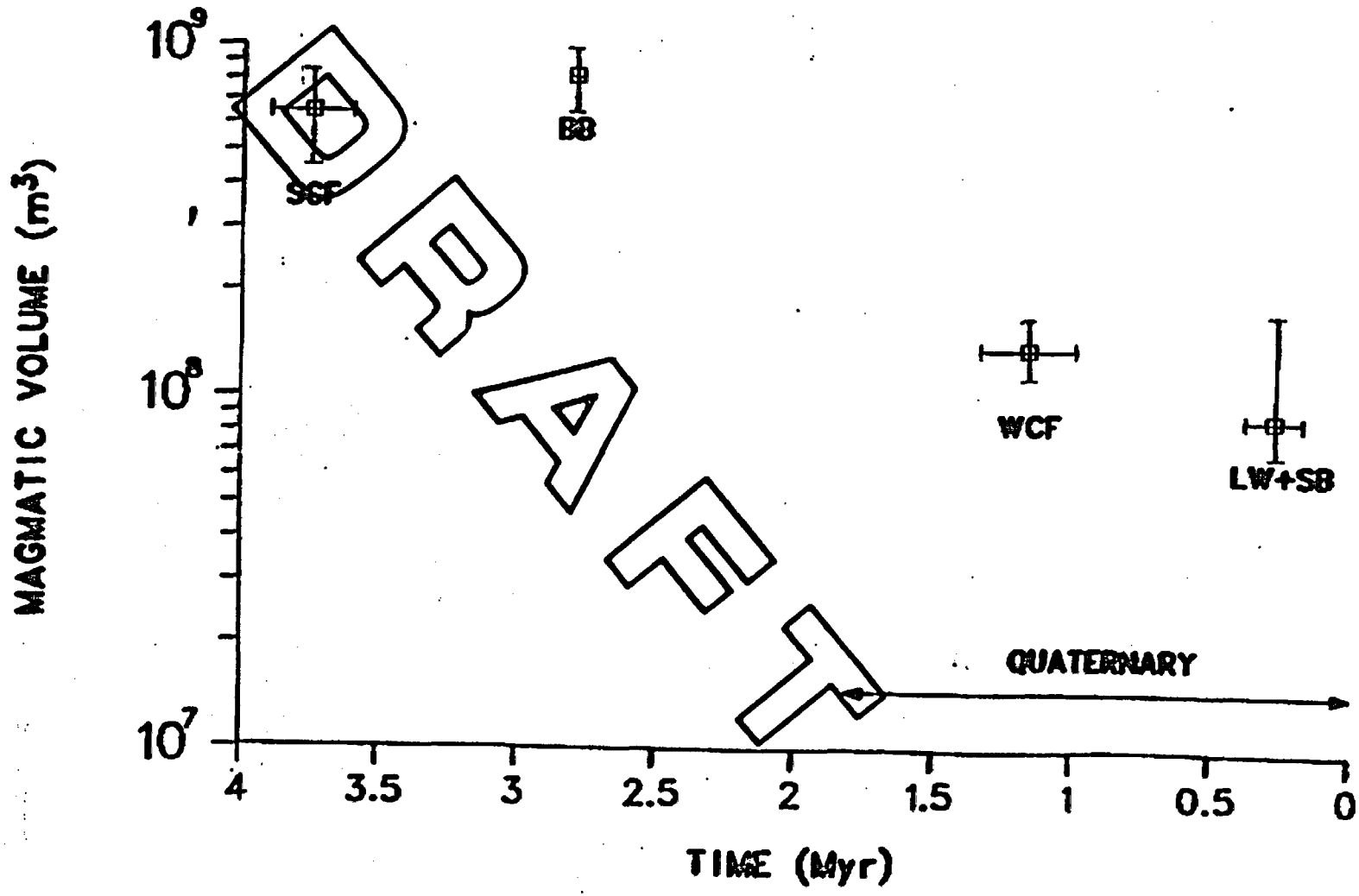
Fig 1


MAGMATIC VOLUME (m^3)
10^9
10^8
10^7
SGF
BB
WCF
LW+SB
QUATERNARY
4
3.5
3
2.5
2
1.5
1
0.5
0
TIME (Myr)

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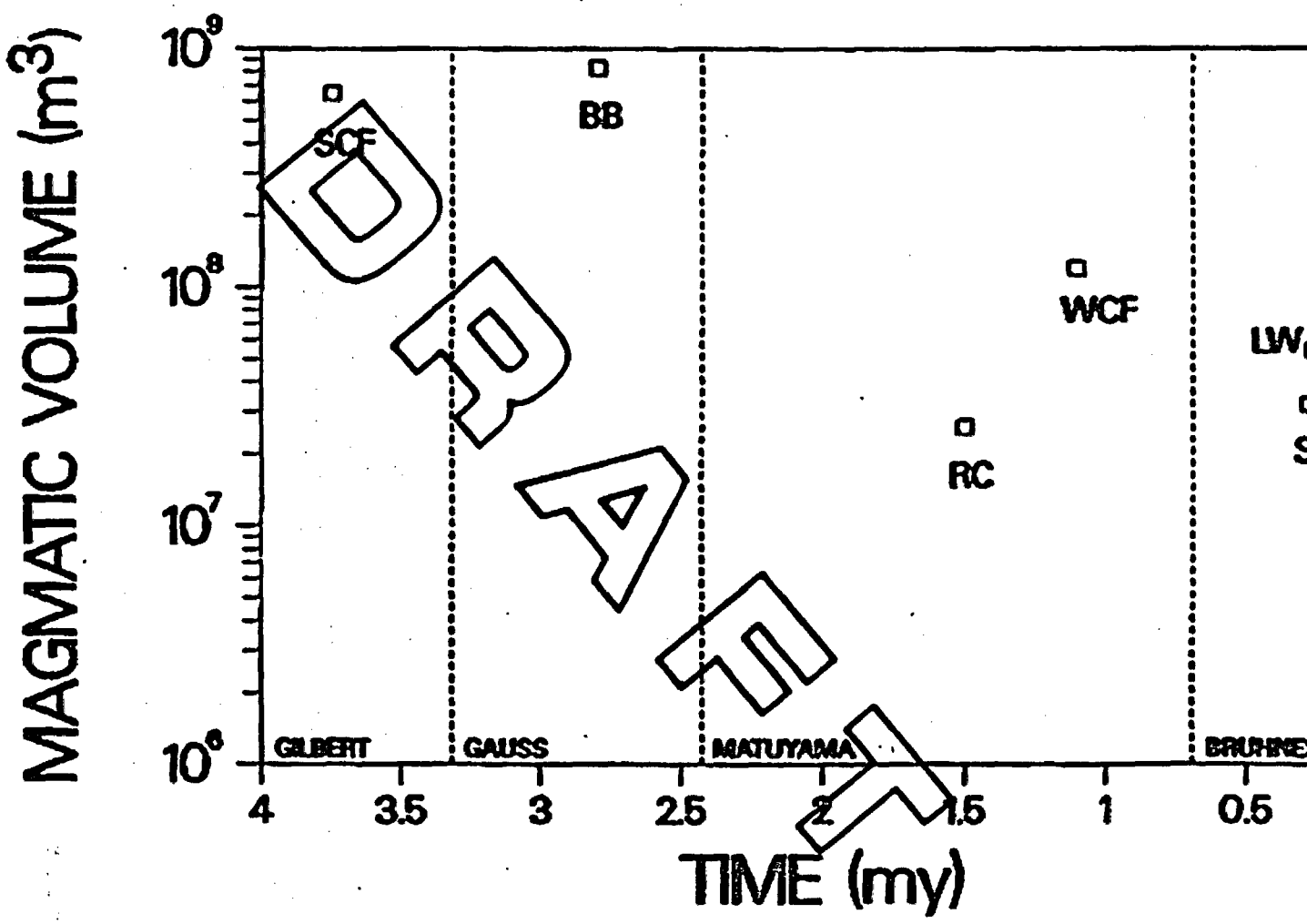
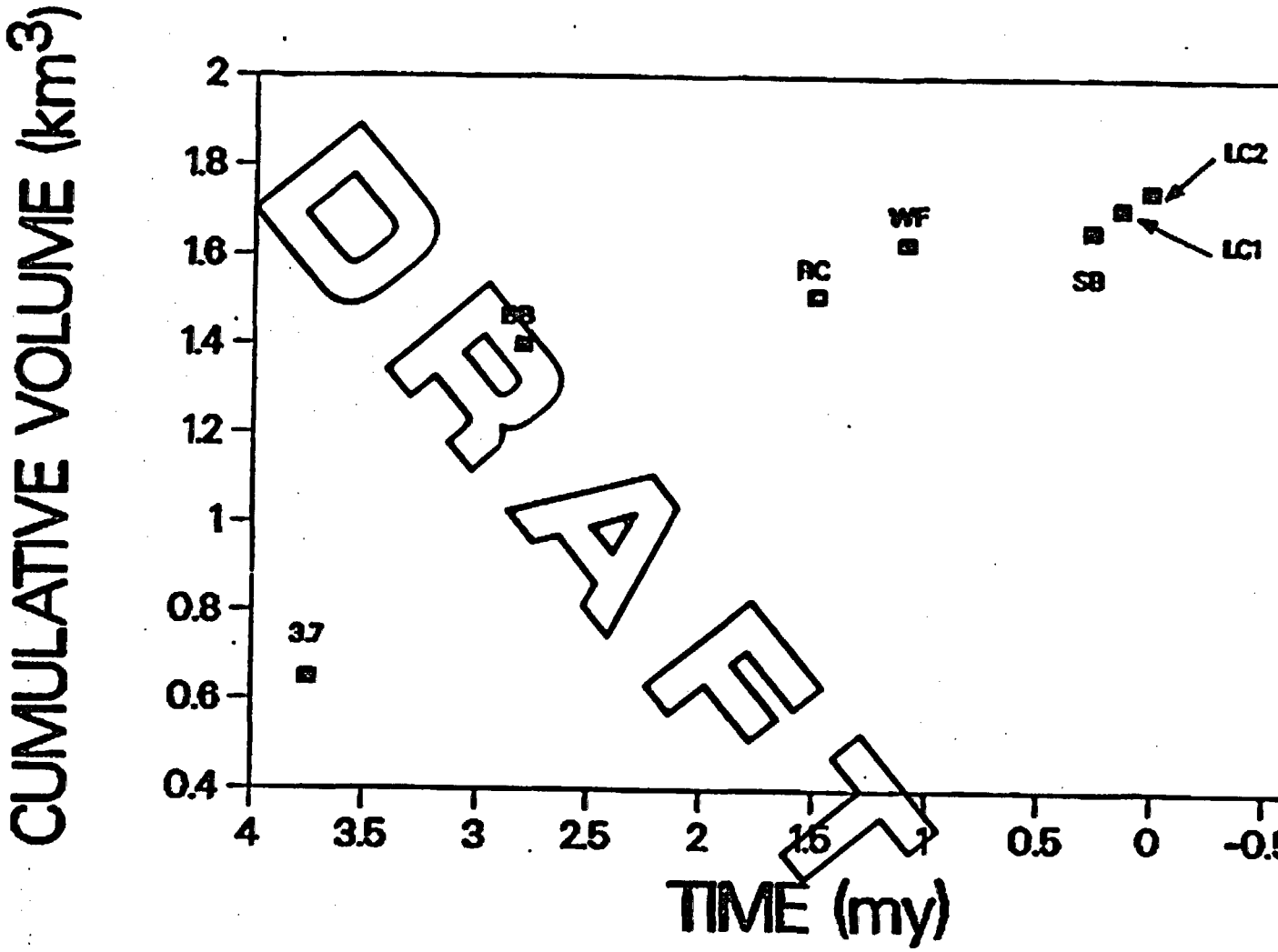

MAGMATIC VOLUME (m3)
10^9
10^8
10^7
10^6
SCF
BB
WCF
RC
GILBERT
GAUSS
MATUYAMA
4
3.5
3
2.5
2
1.5
1
0.5
TIME (my)


CUMULATIVE VOLUME (km3)
2
1.8
1.6
1.4
1.2
1
0.8
0.6
0.4
4
3.5
3
2.5
2
1.5
1
0.5
0
-0.5
TIME (my)
3.7
BB
RC
WF
SB
LC2
LC1
DRAFT

Shaw, 1987

island (~10^6 yr in duration) are unavailable because of the masking effects of younger lava in undissected edifices. Thus, we are dealing with several discontinuous and widely different scale ratios when comparisons are made between data sets describing Hawaiian volcanism in a context that includes both the historical and Pacific-plate records.

Cumulative volumes of lava extruded from Kilauea and Mauna Loa are shown in figure 51.4, together with inferred volumes of the largest deflation episodes of Kilauea (those associated with earthquake activity), as compiled by Klein (1982) from HVO records. The latest data points terminating the records represent estimates for the cumulative eruptive volumes of the 1983–85 east-rift activity and the 1984 Mauna Loa eruption. The approximate mean trends are indicated by dashed lines of slope 0.025 km^3/yr drawn subjectively through the data; reference slopes of 0.1 and 0.01 km^3/yr are shown for comparison.

The following points of interest are noted in the historical rate behavior of Kilauea and Mauna Loa, as shown in figure 51.4. (1) There is an episodic variation between rates (slopes) of about 0.01 and 0.1 km^3/yr for both Kilauea and Mauna Loa. (2) These rate episodes tend to be steplike at intervals of about 10–40 yr rather than scattered uniformly about the mean trend. (3) The mean extrusion rate on the 100-yr scale is near 0.025 km^3/yr at both volcanoes (the overall magma-supply rates will be discussed later). (4) The eruption frequency is higher for Kilauea than for Mauna Loa despite similar average rates, underscoring the typically larger eruptions and longer repose times at Mauna Loa (see Klein, 1982). (5) The steplike episodicity of rates resembles the variations in Hawaiian-Emperor rates in figure 51.1*A*, and the similarity in mean eruptive rates for Kilauea and Mauna Loa parallels the long-term similarity of slopes between loci 1 and 2 in figure 51.1*B* (the "Kea" and "Loa" lines of Dana, 1849; see Jackson and others, 1972; Jackson and Shaw, 1975). (6) The intrusive volumes, which are based on the larger deflation episodes listed by Klein (1982, table 1), have episodic trends similar to the eruptive trends, and they have about the same mean slope near 0.025 km^3/yr. (7) The slope of the major cumulative intrusive-volume events since about 1960 is less than the slope of eruptive volumes over that time interval, so that eruptive rates intermittently exceed rates of major intrusive volumes: hence, (8) there are decade-long delays in renewed intrusive storage compensating eruptions, and (or) there are components of magma supply that are not recorded by the major intrusive events (evidence described below suggests that the latter factor, acting somewhat like a continually leaking valve, is exceedingly important in the 100-yr scale balances of intrusive and extrusive episodes).

Volumetric variations for Kilauea between 1956 and 1983 are shown in figure 51.5 in more detail, as compiled and interpreted by Dzurisin and others (1984) in terms of magma-supply rates. I intentionally show these data in their units and format to facilitate comparisons of the two discussions and to avoid errors of transcription of the complicated history. This introduces an unavoidable difference in the convention for the orientation of the time axes compared with earlier figures, which were drawn to be compatible with the discussions of time-distance relations given by Shaw and others (1980). Their best estimate of average supply rate during this

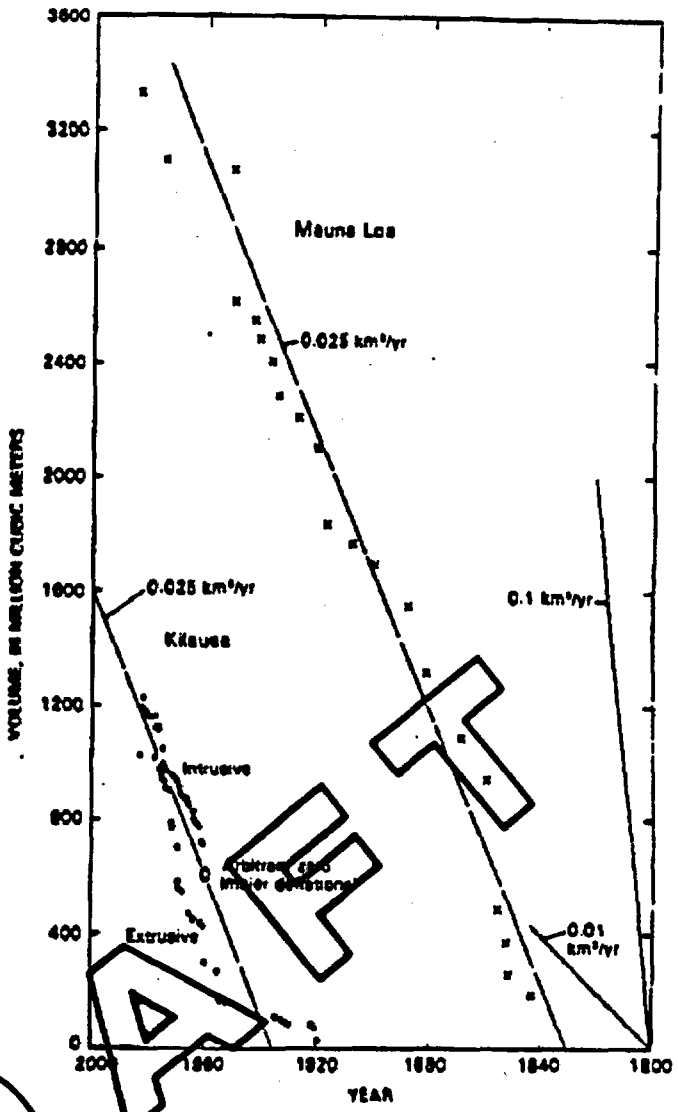


FIGURE 51.4.—Cumulative volumes of erupted lava for Kilauea and Mauna Loa and volumes of major Kilauea intrusive events from Klein (1982, tables 1 and 2); data for Kilauea also given in Dzurisin and others (1984). Intrusive volumes plotted relative to arbitrary initial point on mean trend beginning about 1960. Trend lines (dashed) with slope of 0.025 km^3/yr are drawn to indicate rough parallel between average Kilauea and Mauna Loa eruption rates; reference slopes (light solid lines) of 0.1 and 0.01 km^3/yr also shown. Although average slopes are not rigorously defined; trends suggest that both Kilauea and Mauna Loa may be expected to continue high eruptive activity (see Wadge, 1982, for comparison of steady-state volcanism in other systems). Mean supply rate for Kilauea is about three times larger than mean eruption rate (Dzurisin and others, 1984); similarity of trends suggests that same relation may also hold for Mauna Loa. Data after 1981 supplied from HVO records: Kilauea (George Ulrich, written commun., 1984); Mauna Loa (Robert Decker, written commun., 1984).

time (adjusted for vesicle porosity) is about 0.086 km^3/yr (7.2×10^6 m^3/mo), with episodic deviations over an approximate order of magnitude (uppermost curve in fig. 51.5*A*). They also concluded that, during 1956–83, only 35 percent of the magma supply was extruded and 65 percent was stored in Kilauea's rift zones: 55

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Mr. Mitchell Kunich, Acting Director
Waste Management Project Office
US Department of Energy
Nevada Operations Office
P.O. Box 14100
Las Vegas, NV 89114-4105

Dear Mr. Kunich:

Enclosed for your consideration is a Nuclear Regulatory Commission staff report specifying concerns related to the potential for volcanic intrusion into the proposed repository at Yucca Mountain. We recommend that the points raised therein be taken into account in your plans and activities related to site characterization.

If you have any questions concerning the contents of this document, please contact John Trapp (FTS 427-4545), Seth Coplan (FTS 427-4728) or King Stablein (FTS 427-4796) of my staff.

Sincerely,

Seth D. Coplan
for John J. Linehan, Acting Chief
Operations Branch
Division of High-Level Waste Management
Office of Nuclear Material Safety
and Safeguards

Enclosure:
As stated

cc: J. Knight (DOE-HQ)

8709040356

ACTION
CC: Kunich
CC: Blackhurst
CC: Szymanski
CC: Levich
CC:
CC:
CC:
RECD INFO 8/20/87

ACTION NMSS
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AMA
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ENCLOSURE 2

CONCERNS RELATED TO VOLCANIC INTRUSION INTO THE REPOSITORY AT NNWSI

Probability Concerns

The work of Crowe, et. al. (1982), is the main reference for the probability calculation presented in the EA for renewed volcanism at NNWSI. Crowe, et. al., utilized a variety of approaches to try to determine the rate of volcanic activity in the area of NNWSI including geochronological studies, variations in magma volume versus time and counting Quaternary volcanic centers. A briefing package presented by Los Alamos National Laboratories during the March 25, 1987 NNWSI TPO meeting contained information suggesting the possibility that volcanism in the area of NNWSI may have occurred as recently as 20,000 years before present. While the geologic staff has not yet done a complete reassessment of this study, if the 20,000 years before present or younger date for latest volcanism in the area of NNWSI is correct, rather than the 270,000 year value presented in the EA, the probability of volcanism intruding a repository at NNWSI, utilizing geochronological studies or studies which rely on the volume of magma produced versus time, may be greater than the values presented in the EA as these calculations are sensitive to the age data input.

Release Calculation Concerns

The geologic staff has a greater concern, however, with the way in which the release estimates of Link, et. al. (1982), were used in the EA. In the EA, Section 6.3.1.7.6. discusses the probabilities presented by Crowe and compares them to the "expected values" presented in table 8-4 of Link, et. al., as calculated in accordance with formula 8-2 of the referenced report. On that basis, the EA concludes that the EPA standard (40 CFR 191) would be met with a margin of several orders of magnitude if volcanism were to occur and intersect a repository at NNWSI. This comparison is not valid, however, as the expected value of .038 curies per 1000 MTHM reported in table 8-4 in Link, et. al., was obtained utilizing the following formula:

$$A_i = \sum_{n=1}^{N} C_i(n)\, R_i\, P_i\, \Delta t(n)$$

where

A_i= curies of radionuclide i released

c_i= curies of radionuclide i in inventory during time increment n

R_i= release fraction

P_i= probability of release occurrence and

Δt= increment of time, years.

As stated in Link et. al., this calculation produces the "expected release" due to volcanism by assuming that volcanism could occur in 3.4 X 10E+7 years (the reciprocal of 2.9 X 10E-8), determining the resulting release, and assigning the prorated share of release to a 10,000 year time frame. This is a way of reporting "risk" but is not the correct way to plot releases against the EPA standard.

The EPA standard is represented by a distribution function which relates the probability of exceeding a given cumulative release to the accessible environment over a 10,000 period to that release. Hunter et. al. (1987), presents an overview of methodology that the NRC staff considers appropriate for

implementing this standard. The methodology requires the use of cumulative release rather than a value representative of risk of release such as is obtained by the use of the above formula. The EA would have been more in line with this methodology if it had used Link's "expected release if volcanism occurred between 100 and 10,000 years after emplacement" as reported in table 8-6 of Link et. al., rather than Table 8-4. The values presented in table 8-6 are approximately 4 orders of magnitude higher than the values presented in table 8-4 and the EA. The value as presented in the EA of .038 curies per 1000 MTHM is an EPA ratio[1] of approximately .00025, much below the EPA standard, while a summation of the values from table 8-6 would give an EPA ratio of approximately .9, very close to the high probability limit of the EPA standard.

Additional concerns

The values presented in tables 8-4 and 8-6 of Link et. al., assume random intersection of the repository by dikes. As shown in Link et. al., non-random intersections, such as might result from structural control of the dike emplacement, could increase the release by several orders of magnitude. Also, Link et. al. assumed a repository that was smaller in both size and total radionuclide inventory than has been assumed in the EA, and assumed an effective dike width of zero. Assuming a dike width of 1 meter and a repository of the size given in the EAs would increase the total amount of radionuclides released to the accessible environment. A new analysis would be needed to determine whether the EPA ratio would also change.

Significance of Concerns

It is the opinion of the NRC Geologic staff that neither the available information on volcanism, nor the analyses performed to date are sufficient to make a licensing determination with respect to the significance of volcanism to meeting the performance objectives of 10 CFR 60. To make this determination would require more reliable geologic data and a much more sophisticated analysis than presented by DOE in the EA. With the present data base, uncertainties in probability calculations can range 3 to 4 orders of magnitude. Link et. al., for example, quotes probabilities ranging from 10E-7 to 10E-10. Even calculations which utilize more accurate ages for the past volcanic activity in the area of NNWSI will probably not significantly reduce this probability range. If site characterization activities show that the centers of volcanism in the area of the site are structurally controlled, and the relationship of these structures to the site could be established, this information, together with more reliable age dates, would allow for an informed decision on the significance of the phenomena of volcanism to the performance objectives. The staff recommends that the DOE consider the concerns identified above in the plans for testing and analysis during site characterization.

1 In showing compliance with the EPA standard, cumulative releases to the accessible environment are expressed as ratios that are determined in accordance with the procedures in Appendix A to 40 CFR 191.

REFERENCES:

Crowe, B.M., M.E. Johnson, and R.J. Beckman, 1982. Calculation of the Probability of Volcanic Disruption of a High-Level Radioactive Waste Repository within Southern Nevada, USA, "Radioactive Waste Management and the Nuclear Fuel Cycle, Vol. 3, No. 2, pp 167-190.

Link, R.L., S.E. Logan, H.S. Ng, F.A. Rockenback, and K.J. Hong, 1982. Parametric Studies of Radioactive Consequences of Basaltic Volcanism, SAND81-2375, Sandia National Laboratories, Albuquerque, New Mexico

Hunter, R.L., R.M. Cranwell, and M.S.Y. Chu, 1987. Assessing Compliance With the EPA High-level waste Standard: An Overview, NUREG/CR-4510,SAND86-0121, Sandia National Laboratories, Albuquerque, New Mexico

A-3

DRAFT

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Repository Projects Branch

Division of Waste Management

U.S. Nuclear Regulatory Commission

Washington, DC 20555

RESPONSE TO NUCLEAR REGULATORY COMMISSION (NRC) CONCERNS RELATED TO VOLCANIC INTRUSION INTO THE REPOSITORY AT THE NEVADA NUCLEAR WASTE STORAGE INVESTIGATIONS (NNWSI) PROJECT

We have received your letter of August 13, 1987, specifying concerns related to the potential for volcanic intrusion into the proposed repository at Yucca Mountain, and have enclosed a response to that letter.

Please note that the statement on the second page of the NRC report that "It is the opinion of the NRC geologic staff that neither the available information on volcanism, nor the analyses performed to date are sufficient to make a licensing determination with respect to the significance of volcanism . . ." is somewhat confusing to the U.S. Department of Energy. The NRC's opinion with respect to a "licensing determination" using only information from the Environmental Assessment without the benefit of additional information being presented to the NRC through the Site Characterization Plan, pre-licensing topical reports, and the eventual License Application seems rather premature from our view. Nevertheless, we are naturally concerned with the implications of the NRC's report and believe that the enclosed response will help to clarify our current understanding about this topic.

ENCLOSURE 3

Please contact either Maxwell Blanchard at FTS 575-8939 of my office or Mary L. Brown at FTS 575-8658, if you have questions or comments regarding this letter or its enclosure.

Carl P. Gertz, Project Manager
Waste Management Project Office

WMPO:MBB-

Enclosure:
Ltr 8/13/87 John Linehan, NRC, to
Mitchell Kunich, NV

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cc w/o encl:

V. J. Cassella, HQ (RW-222) FORS

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