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7/7/87

FORMAT VOLCANICS

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MEMORANDUM FOR: John J. Linehan, Acting Chief
Operations Branch
Division of High Level Waste Management

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

SUBJECT: VOLCANISM AT NNWSI

The March 27, 1987, memorandum from Paul T. Prestholt, Senior NRC On-site Representative, NNWSI, to Robert E. Browning, Director, Division of Waste Management, transmitted the briefing package presented by Los Alamos National Laboratories during the March 25, 1987, NNWSI TPO meeting. This briefing package contained information suggesting the possibility that volcanism in the area of NNWSI may have occurred as recently as approximately 20,000 years before the present. The Geologic staff of the Technical Review Branch has begun reevaluating the various studies used to support Section 6.3.1.7.6. of the NNWSI Environmental Assessment (EA) and has identified two main areas of concern:

1. If the 20,000 years before present or younger date for latest volcanism in the area of NNWSI is correct, the probability of volcanism at NNWSI may be greater than the values presented on page 6-279 in the EA.
2. The DOE presented incorrect release values for comparison with the EPA standard. No matter what probability value for volcanism is finally agreed upon, the estimated release of radionuclides due to volcanic intrusion into the repository is likely to be several orders of magnitude higher than the values presented in the EA.

The bases for these statements are presented in the attachment.

The Technical Review Branch recommends that the concerns presented in this memorandum be brought to the attention of DOE, not only to aid the DOE in planning site characterization studies to evaluate volcanism, but also to allow the DOE to evaluate the validity of other similar calculations presented elsewhere related to the EPA standard. If there are any questions regarding this memorandum, please contact John Trapp at Ext. 74545.

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

Attachment:
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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. 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, as to the way the work of Link, et. al. (1982), was presented in the EA with respect to the determination of compliance with the EPA standard.

The EPA standard is a cumulative distribution function which sums all releases of radionuclides to the accessible environment as a function of the probability of release. In simplest terms, the probability of an event is plotted against its release and when all events and releases have been determined and summed, the resultant curve is compared to the EPA standard. If the sum of the ratios of all radionuclides released exceeds 1, the standard is violated when the probability of occurrence is greater than one chance in 10 in 10,000 years. The standard is also violated if the sum of the ratios of all radionuclides released exceeds 10 when the probability of occurrence is between one chance in 10 and one chance in 1000 per 10,000 years.

The geologic staff is concerned by the way in which the release estimates of Link, et. al., were used in the EA. In the EA, Section 6.3.1.7.6. discusses the probabilities presented by Crow 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, to come to the conclusion that volcanism is of no major concern. 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 2.9×10^8 years, 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.

As the EPA standard is a plot of release values versus probability the EA would have been more correct if it had reported 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 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 low probability limit of the EPA standard.

Additional concerns as to the method of reporting relate to the fact that Link et. al., assumed a repository that was smaller in both size and total radionuclide inventory than has been assumed in the FEA, and assumed an effective dike width of zero. As the calculational methodology of Link et. al., is sensitive to these parameters, a straight line extrapolation of values would increase the probability of intersection of the repository by volcanism, because both a larger "target" and volcanic source would be available. In addition, while the EPA ratio may not increase the total release to the accessible environment would increase. In addition, 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 could increase the release by several orders of magnitude.

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 10^{-7} to 10^{-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.

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

JUL 07 1987

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MEMORANDUM FOR: John J. Linehan, Acting Chief
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FROM: Ronald L. Ballard, Chief
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SUBJECT: VOLCANISM AT NNWSI

DATE: 87/06/

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7/4-87 8:25

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orig. mailed 7/28