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

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'85 JAN 29 P3:14

JAN 28 1985

MEMORANDUM FOR: Hubert J. Miller, Chief
Repository Projects Branch
Division of Waste Management, NMSS

FROM: Frank A. Costanzi, Chief
Waste Management Branch
Division of Radiation Programs
and Earth Sciences, RES

SUBJECT: RADIOLYSIS OF GROUNDWATER AT SALT SITES

Dr. McNeil and I have discussed the note from Robert Johnson dated October 23, 1984 describing NMSS's present best estimates of important parameters in the salt repositories, and Dr. McNeil has also discussed this with Mr. Tokar. There seems to be a major unresolved problem, and we would be grateful if NMSS and DOE could examine carefully the question of radiation levels at the surface of the overpack.

Recent DOE figures on radiation in the immediate vicinity of the overpack have varied between 1 rad/hr and 10^3 rad/hr. An independent check by Dr. Sastre at BNL has suggested that for new waste a figure in the neighborhood of 600 rads might be appropriate. Mr. Tokar informed Dr. McNeil that the DOE responses to NRC concern about this ambiguity are first, that some calculations are done with ten year old waste and others with new waste; and second, that these numbers are all so small as to be insignificant. Both these assertions appear questionable. A detailed analysis by Dr. McNeil is attached. Please give this matter your attention.

Frank A. Costanzi, Chief
Waste Management Branch
Division of Radiation Programs
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cc: M. Tokar, NMSS

WM Record File 106

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POTENTIAL SIGNIFICANCE OF RADIOLYSIS AT SALT SITES

1. Effect of age of waste on radiation field:

The major sources of gamma radiation (the only form of radiation likely to penetrate 15 cm of steel) are Cs and Sr isotopes with half-lives in the 20-30 year period. For ten years of aging to change the flux by more than an order of magnitude would require the major sources of gamma radiation to have half lives of less than two years.

2. Significance of radiation field:

It is not clear that the radiation doses are negligibly small. To see this consider first peroxide production in groundwater. Obviously the dependence of corrosion rate on radiolytic peroxide depends on many factors, but since DOE does not claim that any of their brines will heavily oxygenated we might consider 10-3 molol H_2O_2 as a level at which any realistic treatment would have to consider the oxidizing tendency of the peroxide. We then ask how long it would take to generate this if the water were subject to doses of 1 r/hr. and 1000 r/hr.

The g-factor for H_2O_2 generation in pure water is .7 molecules/100ev. Such g-factors are generally higher in brines, but this will do for an engineering estimate, and this means that 1 rad/hr will produce 7x10-9 moles /kg hr of H_2O_2, 10^3rad/hr will produce 10-6 moles/kg hr of H_2O_2. To achieve 10-3 molal H_2O_2 (neglecting consumption by corrosion and other reactions) will take 16 years for 1 rad/hr and 6 days for 1000 rad/hr. It is clear that even in the case where this fairly substantial concentration of peroxide is concerned 1000 rad/hr. is not negligible. If the groundwater is regarded as very anoxic (an assumption I have no faith in), even 10-6 molal H_2O_2 would make a difference and these times are reduced by a factor of 10^3.

Judgements concerning the radiolysis of salt are difficult to make because DOE data collected in past years (all at higher dose rates than expected here) indicate that the lower the dose rate higher the amount of radiolysis per unit dose, and because very little is known about recombination reactions. Further ONWI tests show that $5x10^7$rad will give quite substantial damage even at much higher dose rates than are expected here. Significant damage is defined here as representing conversion of NaCl to Na and Cl_2 in percentages rather the parts per million and it is reasonable to expect say that $5x10^7$ rad will certainly, and 10^7 rad will quite possibly, cause significant damage. Thus at 10^3 r/hr. significant damage will be done in 1 year (total dose 10^7 rad), whereas at 1 r/hr, since the half lives of the important gamma emitters are of the order of 20 years, significant damage may never occur (total dose 10^5 rad).

3. Conclusion:

The point of these calculations is that discrepancies on the order of those which we are seeing in DOE/NPO documents are <u>not</u> trivial and <u>cannot</u> be dismissed as due to use of differing ages of waste, and we feel that a careful analysis is called for.