UNITED STATES OF AMERICA

BEFORE THE NUCLEAR REGULATORY COMMISSION

In the Matter of

PROPOSED RULEMAKING ON THE STORAGE AND DISPOSAL OF NUCLEAR WASTE

Docket No. PR-50-51

COMMENTS ON STATEMENT OF POSITION OF THE UNITED STATES DEPARTMENT OF ENERGY IN THE MATTER OF PROPOSED RULEMAKING ON THE STORAGE AND DISPOSAL OF NUCLEAR WASTE (WASTE CONFIDENCE RULEMAKING) DOE/NE-0007 (15 APRIL 1980) BY DR. M. G. MUDREY, WISCONSIN GEOLOGICAL AND NATURAL HISTORY SURVEY.

Although the brief by the U.S. Department of Energy summarizes the state-of-art of the DOE approach to radioactive waste disposal issues, certain technical facts have not been adequately addressed or have been improperly interpreted. Because of this, certain aspects of the DOE "defense in depth" approach may not be as strong as their position paper purports.

Sensititivy Analysis

One major factor that has not been assessed to any great extent, and which could make these comments and many of the DOE concerns of minor importance (or conversely of major concern) is the sensitivity of any particular waste system (waste form, container, host medium) to natural processes and disturbances. For instance, how critical is the thermo—mechanical parameters of the various host media to repository design? Because this sensitivity analysis has not generally been performed, it can be assumed that the technical weaknesses that are discussed below have a similar level of impact and concern, and thus argue for improved research and quantification.

Quantitative Modeling

The paramount underlying philosophy in repository development is that quantitative simulations or geological models can be made, tested, and run for a particular repository configuration, waste form, etc., and a predictive scenario can be developed that will adequately represent present and future events in the respository, and will thus permit a risk-safety analysis. Should a reliable model calculate an unacceptable scenario, presumably the respository design (siting, rock type, engineered configurations) would be modified or be dropped from further consideration, and other "banked" configurations assessed.

Implicit in such modeling is that appropriate measured and assumed technical variables are accurate, and that those variables do in fact entirely describe the repository system to a high degree of certainty. It is felt that the basic data input into models is probably not possible to determine on a generic basis, and may in fact be exceedingly difficult to acquire at any particular site.

Stress-Strain

The stress-strain environment of a repository has been extensively developed. This kind of analysis permits construction of a repository, but changes in the stress regime through realistic geologic and engineered processes suggest that continued work remains to be done to adequately identify the relationships between stress and fracture hydrology.

With improvements in technology, better in situ stress measurements can be made. With this data, a repository can be effectively designed. However, excavation, additional surface loading near the repository (mine waste pile, water entering joints, backfill) will add or subtract from the measured stress orientations. What calculations and model identify this reorientation of stress? This is particularly important because a closed, or tight joint system (under maximum compressive stress), could be placed in a less compressive stress field and even an extensional field, and thus become of some hydrologic significance.

A large body of data, including leaching characteristics does exist for the waste canisters. Although the host medium will probably be fairly rigid, and not flow significantly during the active stages of the repository, some amount of closure will result, thus tightly locking in any canisters that are emplaced. What are the compressive strengths of the waste form and canister system, and does the design provide sufficient strength during triaxial compression? What plans are underway for retrieval should minor amounts of closure occur on the waste system that might be locked into the host medium?

Overpack and Backfill

An additional major area of concern is overpack and backfill in the repository workings. Based on the depth of the repository, thermal regime and the general nature of smectite clay minerals, it can be concluded that there is great uncertainty about the sorptive and mechanical capacity of the backfill, particularly at elevated temperatures and pressures to be found in a decommissioned repository. At temperatures above 130-150°C, smectite clays begin to degrade (in some cases irreversibly). For some of the repository thermal loadings that have been presented, this temperature is exceeded immediately adjacent to the waste canisters, suggesting that sorptive material will not be immediately adjacent to the waste. Upon closing of the repository, the tunnels and chambers will be backfilld, and the access shafts backfilled in some manner. What sorptive studies on clay-like material have been undertaken at the pressure and temperature that will prevail with a one kilometer lithostatic load in the shaft and tunnels? Geothermal gradients will probably be between 15 and 30°C/km, which will be an added thermal burden on the backfill in addition to the heat generated from the waste canisters. At these elevated temperatures and pressures, solubility, and recrystallization of the clay minerals will be enhanced.

Waste Form, Canister and Groundwater

Definitely within several hundred years or less, the immediate disposal area in a repository will probably be within groundwater (LBL-7096, p. 147, second paragraph, DOE reference 249). The lack of a firmly established waste form (spent fuel or reprocessed material) and canister, do not presently permit quantitative evaluation of leaching under repository conditions. Waters presently associated with granitic rocks may well not be the composition of water that might attack the waste. A model must be developed that describes the source, composition and history of any waters that might come in contact with the waste. This is discussed further below.

Reclamation (p. III-61)

Reclamation, particularly of the surface disturbances, generally is not discussed. In particular, p. III-61, the reclamation of an abandoned exploratory shaft does not address what happens if a shaft is sunk and the site later abandoned. Similarly, the volume of waste rock from the repository is not addressed, nor is the potential for leaching of the waste pile and subsequent environmental effects. Locating a site to accommodate the mine waste in the upper midwest may be difficult. Ideally, clay-lined waste basins would be used to handle the mine waste. However, such material is scarce because of the nature of the glacial materials overlying bedrock. In a similar fashion, wetlands are extensive in the upper midwest, and their degradation and use is severely restricted by statute and code. How will the major land-use decision of repository siting be made with respect to the above discussed problems? Will these land-use, technological factors be included along with repository factors in the final site selection?

Sorption (p. II-74)

The "distribution coefficient K_d" is not thermodynamically defined, and its calculation and use do not permit an accurate understanding of solute/solvent interactions. This conclusion was also reached in LBL-7096, p. 159-ff (DOE reference 249), which strongly recommended (emphasis in original, p. 161):

> "We recommend that all laboratory water-rock interaction studies, not just those on exchange and sorption phenomena, be designed so their results will be useful in rigorous thermodynamic calculations."

This is particularly important in that the sorptive reactions called for by the repository medium and backfill are exchange reactions, and may or may not be reversible. A particular example would be the "sorptive" capacity of an ion exchange resin, such as used in domestic water supplies to provide soft water. In use, the resin removes calcium. At reasonably frequent intervals, the resin is recharged by flushing it with sasaline solution, displacing the adsorbed calcium and replacing calcium with sodium. With adequate thermodynamic data, it will be possible to determine whether or not ions can be <u>released</u> if the chemistry of the water in the repository should change in composition, say by reaction with the various minerals present in the host rock, backfill, etc. With K_d defined on p. II-74, such calculations are impossible to make.

<u>Geophysics as Characterization Tools</u> (p. II-92-94)

Electromagnetic methods are an effective tool to characterize and locate many features of geological/hydrological interest. These techniques are particularly effective in locating and quantifying <u>some</u> electrical conductors, such as fractures that might contain water. These systems generally do <u>not</u> work well where a shallow, horizontal clay layer is found (subhorizontal conductors) such as in much of the upper midwest. In addition, hydrologically significant conductors, because of their fine scale, may not be resolvable by EM systems. Similarly closed fractures that are not presently conductors will not give geophysical signatures. Upon reorientation of the stress regime by stress reorientation during excavation, and perhaps by loading, these fractures may open and become hydrologically significant.

<u>Catastrophic Events</u> (Meteorite Impact, p. II-225)

Statistics for meteorite impact are incorrect. Probability, in the radwaste time frame of one trillion years (as stated in the paragraph beginning "It is possible...") is much grater than 1. One need only to examine the extensive body of lunar impact research, or look at the surface of the moon and other bodies to see the pock-marked surfaces. Over a long enough timeframe, the surface of the planet will be affected by several impacts, and the entire surface remade several times.

Realistically, should such an impact occur, rupturing the repository to a depth of one kilometer, the devastation related directly to the impact would probably be much greater than the damage of the potentially released nuclides. The advancing shock front would completely melt and homogenize the repository on the order of microseconds.

Hydraulic Conductivity of Granite (p. II-226, paragraph beginning "The site...")

This paragraph and the supporting reference are clearly in error. A significant body of data has evolved from study of uranium mineralization in Wyoming by Jon Rosholt and John Stuckless of the U.S. Geological Survey. Recent formal publications include papers by John Stuckless, U.S. Geological Survey (Journal of Research, v. 5, p. 61, 1977). Through study of isotopic systematics of recovered drill core, Stuckless and his colleagues have clearly demonstrated significant leaching of uranium from apparently intact granite. This uranium, in turn, was precipitated and is one of the sources of uranium in the Tertiary basins of Wyoming. In particular, a sample from 357 meters in drill hole GM-1, lost approximately 70 percent of its uranium (Stuckless and

Nkomo). To my knowledge, Stuckless has not pursued the details of the loss mechanism, nor the degree of fracturing that might have contributed to such loss. Apparently, however, this loss occurred under low temperatures related to uplift and weathering.

It is strongly suggested that this reseach be pursued, both from the point of uranium resource studies, and from the point of waste management.

Limits to Modeling (p. II-77, last half, first complete paragraph, and p. II-239-240)

As discussed above with reference to Quantitative Modeling and on the limits thereto, two major criteria must be met -- the mathematical and physical model must satisfy actuality, and the input data must be of sufficient accuracy and density, that the solution of the model will, in fact, predict actual cases. Figure II-27 on p. II-240 is touted on p. II-239 as the "results verify the model within the limits of its assumptions." Assumptions are discussed in paragraphs above this quote. Cursory examination of Figure II-27 clearly discloses the failure of the model to adequately describe the system ... Theoretical (dashed lines) and actual (solid lines) values for 90 Sr are off by an order of magnitude. Notice a groundwater flow plume trending southwestward from the disposal well. This can be interpreted as a hydrologically significant fracture system trending northeast to southwest. This fracture system was not identified by field study, and thus not factored into the hydrologic modeling. Is this the rule ... if you cannot explain the data -- ignore it?

The important conclusion is, that even in an area presumably as well studied as the National Reactor Testing Station, the groundwater hydrology cannot be adequately modeled. How then can a repository be studied remotely to adequately provide data for realistic and accuate hydrologic modeling?

Transportation and Volumetric Considerations (p. II-295, last paragraph... "The anticipated volume of materials moving to or from the site and the size of the daily work force are not expected to place excessive demands upon existing transportation systems.")

Reference this to p. VI-10 and 11 (and discussion of those pages below). Present transportation capacity is 511 MTU/yr., consisting of the capability of 207 individual shipments by existing equipment. Scaling this times 12 to account for the 6,000 MTU/yr. projected for the 6th and ensuring years at the respository (p. VI-11), suggests 2,484 shipments/yr., or 10 shipments/day, or one every 45 minutes (daylight working day). These shipments are to be escorted, and will generally be traveling slowly. Depending upon the exact location and roadway, this shipment rate could affect local transportation, which is contrary to p. II-295.

(p. VI-11, item 3)

Does 90 percent of the material being transported by rail reflect the declining role of railroads for transportation? Will siting be constricted by availability of the rail-network? What plans are underway to acquire right-of-ways if the site chosen should not be located close enough to an operating railroad spur? Has the quality of the national railroad beds been evaluated, particularly as major derailments do occur, and many sections of track have significantly reduced speeds imposed because of track problems?

<u>Nuclear Growth Decommissioning and Volume Constraints</u> (p. V-4)

It is assumed for purposes of discussion that the projected growth of the nuclear industry, availability of transportation casks, and capacity of respositories is in agreement (although this reviewer has not performed such calculations from the various tables). Although the growth projections on Table V-1 are in significant disagreement with ONWI-24 (Assumptions and Ground Rules Used in Nuclear Waste Projections and Source Term Data), and a lesser capacity of repository systems may be required, the major problem on volume calculations is the lack of discussion of disposal of decommissioned and decontaminated civilian power reactors. Does this mean that entombment will be the preferred method? In the event that DOE, NRC, EPA, or Congress require complete dismantling of power reactors that have reached or exceeded their design lives, does capacity exist for adequate disposal for the contaminated and activation materials? What is the volume of material from a 1,200 megawatt reactor that will require high-level disposal? How will this material be phased into the repository system? Will waste packaging and repository design be compatible?

Short Items

p. II-59-61, liters total or liters per what?

p. II-364, references no. 760 and 761. My copy of DOE/TIC-11033 (Draft), April 1980, does not contain these pages nor does it contain these reference.

p. II-339, reference no. 431. My copy does not contain this section nor page number.

p. II-169, last sentence. Reference 28 makes no sense in this context.

p. II-141, last complete paragraph beginning "Preliminary..."

The question is not whether or not spent fuel is a durable waste form, but whether or not the material that is leached can be retained, and if not, whether or not there is high toxicity. At least one paper (DOE reference no. 333) reports 100 percent of Cesium being leached (Table 1 of cited report).

p. II-146, Carbon

A body of data suggests that plutonium and possibly other nuclides are mobilized in organic system, arguing very strongly that no carbon-based materials should become involved with the waste (DOE reference no. 249, p. 155-ff).

p. II-300, item 4

Even if characteristics are identified, can we adequately quantify and predict responses? See particularly discussion of p. II-240. We concur that the successful disposal system can be summarized and characterized, but can such characterization be adequately quantified so as to predict response to designed and accidental actions?

p. II-302, item 4.4

This statement clearly says that waste packages do not presently exist, thus making many, if not most, of the engineering and geotechnical discussions less firm than this document proports.