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MEMORANDUM

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NNWSI STRATEGY FOR REPOSITORY LICENSING

INTRODUCTION AND SUMMARY

The Nevada Nuclear Waste Storage Investigation (NNWSI) has developed a strategy to license a nuclear waste repository in tuff.[1] This strategy, which is currently circulating in draft form within the Department of Energy's Office of Civilian Radioactive Waste Management, has important implications for DWPF waste form qualification activities, design of the DWPF process, and DWPF operations.

In this report, the strategy and its implications for the DWPF are presented. The most important conclusions are:

- The NNWSI intends to take no credit for glass performance to meet NRC repository release requirements for anticipated events and processes. Thus, regulatory interest in DWPF glass properties would tend to be diminished.

- The NNWSI will rely on the DWPF to insure that there is no water within a sealed canister. This strategy would focus regulatory interest on the canister seal, particularly the temporary seal. Thus, any events which could introduce water into a filled canister should be identified as soon as possible, and steps taken to insure that they do not occur.

- The NNWSI has concluded that DWPF glass could, in fact, meet

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the NRC performance criteria (one part in 100,000 per year), if it had to. Thus, regulatory interest in DWPF glass properties would not be completely eliminated.

For unanticipated processes and events, the NNWSI will rely on SRL to assist in providing source term data for use in licensing. In particular, any models developed by SRL will need to be compatible with the EQ3/6 geochemical computer code.

BACKGROUND

DWPF glass will eventually go to a licensed geologic repository. Each of the three candidate geologies for the first repository (tuff, basalt, and salt) are currently developing strategies for licensing. DWPF waste form qualification and process design activities need to be performed in such a manner that properties important to repository licensing are optimized, and controlled during DWPF operation.

NNWSI ASSUMPTIONS

The Nevada Nuclear Waste Storage Investigation, which is responsible for tuff, is the first project to develop a licensing strategy. They have made the following assumptions in developing their strategy:

- The repository is above the water table in the unsaturated zone (mean degree of saturation = 65 %), in welded tuff. This implies that the repository will be at atmospheric pressure.

- There will be no water in the borehole before emplacement of the waste in the repository, and this condition will last through the period of repository closure.

- The amount of water passing through the repository will be < 1 mm/yr. This corresponds to 5X the maximum observed flow rate.

- Spent fuel and DWPF glass are co-mingled in the repository. Thus, the spent fuel will keep the glass hot for longer periods than if the glass were stored in isolation. The inventory of ten year old spent fuel is assumed, and the values in DP-1606, Rev. 1,[2] for DWPF glass are used.

- The canister closure will provide no barrier to fluid flow. However, the NNWSI also assumes that the canister remains substantially intact, and can accumulate water.

NNWSI CONCLUSIONS

Based on their preliminary analyses, the NNWSI comes to the following conclusions about the performance of DWPF glass in a repository in tuff:

• They anticipate that there will be no water in contact with DWPF glass for at least 10,000 years. This is a consequence of the high temperatures dehydrating the repository in the vicinity of the waste package, and the likelihood that any intruding water will tend to be sucked into the rock rather than attracted to the canister.

• Even if the latter conclusion is incorrect, the high temperatures lead to the conclusions that there will be no water in contact with DWPF glass for at least the first 300 years after repository closure. For the period 300-1000 years after closure, the amount of water will be < 5 L/(waste package)·yr. For the period 1000-10,000 years after closure, the amount of water will be < 20 L/(waste package)·yr.

• Based on the conservative heat loading, and assuming that an unanticipated intrusion of water occurs at 1 mm/yr (5X the maximum observed flow rate), at least 2000 years will be required for water to reach the glass. Only then would radioactivity be released into the repository rock.

• If glass leaching occurred, the dissolution rate of DWPF glass will be so low that release will be < 10^{-5}. An important part of the reasoning behind this conclusion is that the maximum rock / water interaction temperature is limited to 95°C, the boiling point of water in a tuff repository in the unsaturated zone.

IMPORTANT QUESTIONS TO BE ANSWERED

In their strategy document, the NNWSI identified the following questions involving DWPF glass as being of such great importance that answers are needed before a license application is submitted. For each, they have indicated the actions they intend to pursue to attain those answers.

• What is the degradation rate of DWPF glass under conditions expected in a repository in tuff?

The NNWSI intends to satisfy this need by developing their own data on glass performance, and by making use of data obtained by SRL. Release from the glass under both unsaturated and standing water conditions will be evaluated. The NNWSI has already contacted SRL about performing both laboratory and large-scale tests of glass performance.

In addition, the NNWSI will evaluate the effects of their package design to insure that it is compatible with the glass. As part of this effort, they will determine the effects of dissolved groundwater components (e.g. PO_4^{3-}) on glass performance. They will then use all of the information gathered as input for geochemical modelling using the EQ3/6 geochemical code.

• Will the DWPF keep water out of the canister?

The absence of water is a key part of the NNWSI licensing strategy. Thus, they are keen on insuring that no water enters the repository as part of the waste form. NNWSI intends to answer this question by rigorous enforcement of the Waste Acceptance Preliminary Specification which excludes free liquids, and are likely to make this a key point in audits of DWPF quality assurance.

• How much activity will be available for release from the repository?

The NNWSI intends to satisfy this by ascertaining the inventory at time of emplacement to within ± 20% for any species making up more than 5% of inventory at any time in first 10,000 years. This includes both spent fuel and DWPF glass.

SCHEDULE

The NNWSI will officially publish this strategy as part of their Site Characterization Plan, sometime this spring. In October, 1987, they will begin testing DWPF-type glasses in order to develop a data base for licensing. They intend to have completed sufficient testing to issue a summary report in October, 1989. This report is likely to play an important role in the formulation of NNWSI's response on the acceptability of DWPF glass. The tests started in 1987, and any additional testing carried out to confirm the findings of the initial tests, are to be completed by June, 1991, to allow time for submission of a license application sometime in 1992.

IMPLICATIONS FOR DWPF

The NNWSI strategy has much to recommend it from the standpoint of the DWPF. As indicated by the Nuclear Regulatory Commission staff in a recent public meeting, such a strategy will diminish (though not eliminate) the NRC's interest in the durability of the waste glass itself.

Further, the strategy would appear to reduce the rigor of the required knowledge of the inventory of radionuclides in DWPF glass. If NNWSI needs to know the total inventory of radionuclides only to within 20 %, and ~ 90 % of the total inventory is spent fuel, then the accuracy with which they would need to know the inventory of the radionuclides in the DWPF product should be much less. This point will be pursued, because it could have major significance for design, and the operation, of the DWPF analytical facilities.

Of equal importance is the added attention the NNWSI strategy will focus on the temporary seal of the DWPF canister. This feature was included in the canister design to prevent the intrusion of water into the canister during decontamination. The additional importance of the tightness of this seal indicates that SRL should re-evaluate the adequacy of the present design, and the reliability of the sealing process. Melter Systems Group has already been requested to perform this work.

Finally, as noted above, NNWSI has already indicated that they will be working with the waste form producers (i.e. DWPF and WVDP) to produce data and models for licensing purposes. SRL (Glass Technology Group) has already agreed to perform tests in support of these efforts. This means that SRL will have to perform these tests in a manner compatible with the quality assurance practices and procedures of the NNWSI.

The NNWSI will utilize the EQ3/6 geochemical code for modelling. Any work performed at SRL needs to be done with this in mind. Thus, both modelling and experimental work needs to be in a form compatible with this code whenever possible.

REFERENCES

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2. R. G. Baxter, **Description of Defense Waste Processing Facility Reference Waste Form and Canister**, USDOE Report DP-1606, Revision 1, E. I. DuPont de Nemours and Co., Inc., Savannah River Plant, Aiken, SC 19808 (1983).