J. L. McElroy, Chairman

## Introduction

The workshop on solidification was intended to identify major problem areas and factors affecting high level waste (HLW) solidification, identify the R&D needs required to successfully design and operate a solidification plant, and to assure that we have the technology to safely handle, solidify, and store HLW. To accomplish this purpose invited speakers gave prepared presentations which led to very open discussions and a sharing of experiences. There was no goal of deriving a long-range plan for solidification. The prepared presentations and speakers were:

Workshop Introduction

- Jack McElroy, Battelle-Northwest

R&D Presentations

- Bill Dickey, Idaho National Engineering Laboratory
  Fluidized Bed Calcination, Post Treatment
- Bill Bonner, Battelle Northwest
  Calcination, Melting/Glass Making, Alternatives
- Dick Schwoebel, Sandia Laboratories
  Inorganic Ion Exchange Solidification Process

Industry Presentations

- Bob Barnes, General Electric, Midwest Fuels Reprocessing Plant
  Critique of MFRP HLW Solidification System
- Gary Bray, Allied General Nuclear Services
  Major Factors Affecting AGNS Solidification Plans
- Jim Duckworth, Nuclear Fuel Services
  Other Factors: ILW and Other Wastes
- Frank Shrade, Nuclear Services Corporation
  An Architect Engineer's or Designer's Needs

ERDA Programs and Plans

- Warren Eister, Energy Research & Development Administration

Following these presentations the meeting minutes were organized and the workshop speakers agreed on presenting the following material as a consensus opinion regarding the status and future of solidification.

## Consensus Opinion

- On the part of the reprocessors the following general attitude prevails. "Tell us what we have to do and we'll do it". This opinion is primarily related to providing regulations on required waste from criteria. This direction would also benefit those doing solidification R&D work which is aimed at supporting the reprocessors.

- It is believed that technology is available for high level waste solidification. In fact, any one of several processes can be made to do the job.
- The primary needs that remain include placing more emphasis on equipment maintainability to assure that the high level waste processes are both reliable and remotely maintainable. A second major problem involves the need to provide waste form requirements for intermediate level waste (ILW). While ILW is different from high level waste in terms of composition, its radiotoxicity is about the same as high level waste.

(Although other types of waste exist that require solidification, we chose to limit our discussion to high and intermediate level waste.)

Need for Waste Criteria/Regulation

The current regulation for solidified high level waste is obsolete. It was written for disposal of waste in a salt mine at Lyons, Kansas. At that time it was planned that the solidified waste would be taken directly from the reprocessors to disposal. The present plan is to store the solidified high level waste in a retrievable surface storage facility. This near surface storage has resulted in a change in emphasis on waste form requirements and it has been indicated that a low dispersability monolithic form will be required. Thus far, this intention has only been informally verbally communicated to the reprocessors and more formal understanding is required. This could perhaps be achieved by means of a timely written communication from the appropriate agency.

In order to implement the intended plan for requiring a low dispersible form, it is necessary to make a decision as to whether calcine, which was intended for salt mine disposal, is acceptable. If not, then the intended regulation should be enacted immediately. It should be noted that there is growing concern about the suitability of calcine due to potential instability as a result of residual nitrate and water.

If a new regulation is enacted, some definition of how to measure criteria should be provided. The regulation should emphasize licensing of the process, as a means of controlling the waste form rather than strict quality assurance of the waste form. A reference material, most likely glass, should be identified that meets the requirements of the regulation.

Reprocessor's Status - Present

There are currently no reprocessing plants in operation. The next plant

to be operating will be the AGNS plant at Barnwell, South Carolina. The high level waste from each of the anticipated reprocessing plants is expected to be chemically different and as such the solidification process requirements are different. For example, General Electric's MFRP waste contained large quantities of alumina, the NFS waste contains iron and the AGNS waste contains gadolinium.

- GE - MFRP's failure to start up was not due to the solidification system. In general, the performance of the fluidized bed calciner was satisfactory; an exception being the plugging of some of the calciner feed spray nozzles. Except for short lag storage holdup of the waste, no liquid storage was planned for the HLW.
- AGNS - Barnwell will store high level liquid waste for a period of one to three years. A high level waste solidification system has not been chosen; however, both the fluidized bed calciner and the French vitrification system are being evaluated. It is believed that solidification limitations presented by the retrievable surface storage facility are major overriding factors in solidification system design. The size of canister and quantity of heat at 10 years as determined by the RSSF will set many limits on the process.
- NFS - West Valley is currently shut down and plans are being made to expand the plant to approximately three metric tonnes per day. After the construction permit is approved, there will be 3 years of construction before the plant can restart. Currently, 600,000 gallons of high salt content waste is being stored as a liquid. This waste will be treated separately from the lower salt waste to be generated in the expanded plant.

Reprocessors - Future

All reprocessors, as a whole, feel an urgent need for regulations govering the solidification of both high and intermediate level waste.

- GE - MFRP's future is uncertain, but they would recommend that there be no HLW liquid storage and if a low dispersible nonlithic waste form is required, granular intermediate product such as produced by a fluidized bed calciner would not be produced. The MFRP processing plant and equipment would be designed to provide more flexibility by providing more remote maintenance capabilities.
- AGNS, Barnwell has an immediate need for waste form regulations and believes that this would aid them in selecting a process; this has to be done very soon.

Currently, AGNS plans to incorporate the ILW in with the HLW solidified product if it proves technically feasible. A high sodium content in the ILW could preclude this.

- NFS, West Valley plans to use 5 years liquid acid storage in their new design. This will give them time to select a solidification system. A major concern is how to handle ILW which contains very large amounts of sodium; mostly from sodium carbonate solvent washes.

R&D Status - Present

A two-step calcination/melting process is technologically developed to the point where the solidification process can be designed for installation in the nuclear fuel reprocessing plant. However, reliability and maintainability are still of concern and specific R&D needs exist for application of any process because of differences in each plant. For drying or calcining the waste, the fluidized bed calciner is currently the leading contender. A wiped film evaporator which concentrates the waste without calcination shows promise and could eventually eliminate the calciner. In-can melting, where melting is performed in the waste can and the french glass process are leading glass processes. Both processes produce acceptable borosilicate glasses. Such glasses are currently being made and characterized to assure their long term stability. As potential alternatives to glass, second generation processes and waste forms are being screened and lab scale R&D is being performed on some selected processes. These processes include:

- sintering with and without glass binders
- ion exchange to form mineral titanate ceramic forms.
- matrix isolation in metals, alloys, and glass.
- particles coated with carbides and metals.

R&D - Future

It is proposed that a single process be selected for a complete system demonstration. This demonstration should place emphasis on process operability, reliability and maintainability from the standpoint of remote operation.

Work should continue on glass development and characterization to assure that no surprises are found later on. Formulations which are unique to each plant hould be optimized and characterized. The glass characterization should include more tests where the glass incorporates actual high level waste in order to determine the behavior and effects of all the actual waste constituents. This characterization will also provide data for the reference waste form. While it is

believed that glass is an acceptable form, we should continue with advanced technology, looking for improvements in simplicity economy and safety.

Intermediate Level Waste

Most of the above discussion was devoted to high level waste. Intermediate level waste, while not having a heat generation problem, may be similar in radiotoxicity to the HLW. The fission product content is a factor of 10 to 100 lower than HLW, but the plutonium levels are equivalent. The ILW has a high sodium content and also contains iodine and mercury. These chemical factors make it substantially different from HLW so that it may not be possible to solidify the two wastes by the same technique. An accpetable final form needs to be developed for the ILW and regulations are required which define the requirements for the final waste form. Possible ILW waste forms include sodium nitrate, concrete or asphalt; however, the sodium nitrate form would be inconsistant with the current planning of having HLW in a low dispersible monolith. If it is possible to blend the ILW with the HLW to form a borosilicate glass, this would simplify the solidification systems since one process could serve two functions.

Summary

- Criteria or regulations, or formalized intentions to impose new regulations for the solidified high level waste form are required.
- Solidification R&D should place increased emphasis on equipment maintainability and reliability.
- Decisions are required on treating ILW (and a few selected other wastes).

We feel this workshop provided an opportunity for very open discussion and look forward to similar opportunities in the future. Perhaps this would lead to providing answers to some of the above questions.