

NEAC Fuel Cycle Technologies Subcommittee Report

Presentation to the
Nuclear Energy Advisory Committee
Washington, D.C.
December 11, 2015

Al Sattelberger

Fuel Cycle Technologies Subcommittee Members

- Carol Burns
- Margaret Chu
- Raymond Juzaitis
- Chris Kouts
- Sekazi Mtingwa
- Ron Omberg
- Joy Rempe
- Dominique Warin
- Al Sattelberger (Chair)



Fuel Cycle Technologies Subcommittee

- One day meeting on October 22, 2015
- Highlights:
 - Aqueous Separations Research
 - MELCOR Overview and Applicability to ATF Response
 - Fuels Product Line: Update on BISON and MARMOT Development
 - Advanced Reactor Program
 - Nuclear Fuel Storage and Transportation Program Update
 - Joint EM-NE-SC International Study of Glass Behavior over Geologic Time Scales



Aqueous Separations Research

General Comments/Observations:

- The overarching goal of the Materials Recovery and Waste Form Development (WRWFD) is a closed fuel cycle
- R&D on both aqueous and non-aqueous processes is appropriate to achieve the goal and the level of investment seems reasonable
- The aqueous separations program has been undergoing a transition to include work on process development (flowsheets)
- The educational/university pipeline was highlighted, but the number and breadth of projects in aqueous separations was not as extensive as we might have expected
- There are positive international exchanges and collaborations

Recommendations:

- Cost estimates of various materials recovery schemes are lacking; we would also like to hear more about the metrics that are used to prioritize the aqueous separations work
- Engage more top-tier university faculty and couple them with Lab research programs



MELCOR Overview and Applicability to ATF Response

General Comments/Observations:

- MELCOR is a NRC-sponsored simulation code for analysis of accidents in nuclear power plants; it's a fully integrated, engineering-level code, covering
 - Thermal hydraulic response in the reactor coolant system, reactor cavity, containment and confinement buildings
 - Core heat-up, degradation and relocation
 - Core-concrete attack
 - H₂ production, transport and combustion
 - Fission product release and transport behavior
- MELCOR is now being used to assess Accident Tolerant Fuels (Brad Merrill, et al., 2015 and K. Robb, 2015). Some identified modeling challenges include:
 - Initial heatup and H₂ generation that could be mitigated by a specific ATF design
 - How does ATF respond to the Emergency Core Cooling System?
 - How does the ATF respond to higher temperatures in steam and air?



MELCOR Overview (continued)

Recommendations:

- Expand the MELCOR evaluation effort
- Future calculations should use the production version of MELCOR that allows only fuel cladding changes to be evaluated
- Enhanced MELCOR evaluations should include all available high temperature material property data for proposed cladding materials, including data from irradiated samples if available.
- A detailed technical peer-review should be performed on the MELCOR analysis effort to increase confidence in inputs used for the down-selection process of the ATF program



The Fuels Product Line

General Comments/Observations:

- Fuel performance models, either those that have been developed by fuel vendors for regulatory evaluations or those developed by the regulator, are semi-empirical – they are limited to the range and domain over which validation data exist
- In contrast, the models being developed by the NEAMS program consider atomistic-, meso-, and engineering-scales with the goal of being capable for use outside the limited range of available engineering scale data
- The NEAMS toolkit strives to obtain a 3-D “Pellet-to-Plant” simulation capability useful for predicting performance and safety for a broad range of nuclear reactor power systems
- The NEAMS development team acknowledged that funding limitations will preclude them from obtaining all of the data required to validate their models

Recommendations:

- The proposed approach for assessing FPL tools is reasonable, but its limitations must be recognized



Advanced Reactor Program

General Comments/Observations:

- The Advanced Reactor Program (ARP) is a broad-based research and development program with a top-level, long-term goal of developing a safe and economical advanced reactor
- An advanced reactor has not been designed and built in the U.S. since the FFTF, which was designed in the 1970s, operated in the 1980s, and was shut down in 1992
- The ARP has a number of subprograms that span advanced reactor technology space
- The overall program engages in international collaborations to avoid duplication and to ensure that developments in other programs are not overlooked
- Funding in the FY15 Omnibus Spending Bill (\$7M) is only sufficient to assess the need for a test/demo reactor

Recommendations:

- The need for a test/demo reactor capable of supplying fast neutrons with high flux is compelling



Nuclear Fuel Storage and Transportation Program

General Comments/Observations:

- The Department continues to pursue a variety of activities related to the implementation of spent fuel interim storage, along with related transportation activities. These activities are being undertaken in anticipation of new authorizing legislation.
- The Department indicated it is continuing to pursue a canister-based storage facility concept and will give priority to the receipt of canistered spent fuel from shut down reactors.
- A Topical Safety Analysis Report (TSAR) is being prepared which can facilitate future licensing, assuming that the site parameters of a selected site fall within the boundary conditions of the generic design within the TSAR.

Recommendations:

- The Department should develop a list of assumptions under which it is developing its interim storage and transportation activities
- The Department should avoid referencing NWPA sections in its presentations, since they are not legally applicable to its ongoing activities.



Joint EM-NE-SC International Study of Glass Behavior

General Comments/Observations:

- This presentation described an international study, based on an evaluation of an 1800 year-old glass samples in which a set of test methods were employed to study composition, structure, and kinetics associated with glass corrosion to develop an improved understanding of the long-term behavior for glass waste forms.
- The characterization approach was then extended to evaluating glass ceramics as alternative waste forms with improved waste loading tolerance. R&D in this area is already leading to an improved mechanistic understanding.
- This is a challenging problem, and the conditions studied to date are limited.

Recommendations:

- The approach can and should be extended to look at additional families of waste forms, radiation loadings, and a wider variety of potential repository condition



**Thank you –
Questions**

