Working Group 4

New Technologies for On-Site and Surface Storage and Permanent Disposal of Nuclear Waste

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Introduction

Workshop Guidelines:

- Group was to address the underlying science related to radioactive waste issues realizing that there may still be large gaps between the science and the technology requirements
- Group should not emphasize one methodology to address a specific radioactive waste issues over another
- Entire group would identify all relevant issues and then breakup into smaller group to address each specific issue in a prescribed format

Analysis Format

1. Provide a written description of the subtopic
2. Identify barriers and challenges related to the subtopic
3. Provide a current status on the subtopic
4. Identify new R&D needs and potential opportunities related to the subtopic

Rad Waste Subtopic Listing

- Interim Storage / Transportation
- Transmutation
- Beneficial Uses / Separations
- Geologic Disposal and Alternatives
- Waste Forms

Interim Storage

1. Temporary storage of HLW for periods greater than 50 years and for periods greater than 100 years
2. Challenge is to protect the public and convince both the regulatory bodies and the public that the materials are stored in a safe, technically sound manner

   Ensure that the interim storage does not become a defacto permanent repository
3. Current technical understanding and regulatory approval is acceptable for periods up to 50 years for storage of solid materials including spent nuclear fuel

Interim Storage

4. Solid material (other than spent fuel)
   - What does irradiation do to the solid material?
   - What are the corrosion issues between all interface issues?
   - What are the fundamental design parameters of the storage facility?

   Spent fuel:
   - What are the corrosion issues?
   - What are the appropriate short term test and how do we extend to needed storage life?
   - How and what parameters are monitored?
   - What are the design parameters of the storage facility?
   - What are the container design issues?

Transportation

1. How to improve or optimize the safe transportation of spent fuel or other solid radioactive waste materials

2. Challenge is to safely and efficiently transport high level waste in solid forms acceptable to the public and the regulatory bodies

3. Radioactive materials have been safely transported in many countries over several decades

Transportation

4. R&D Need and Opportunities:
   - What are the issues to be studied for burn-up credits?
   - What are the new shielding materials to enhance the transport of high level waste?
   - What are the issues for cask weeping?
   - What is the characterization of the spent fuel/solid material after 100 years of storage?
   - Will overpack containers be necessary?

Transmutation

1. The conversion, via a nuclear reaction, of long-lived radioactive waste isotopes to either stable or shorter lived isotopes to reduce national security threat and improve safety
2. Challenges include:
   - Current U.S. policy on reprocessing may exclude use of this technology
   - Insufficient data exist on economic and environmental, health and safety impact of such a process
   - Process may not be economically viable

Transmutation

3. The technology has a number of science issues associated with both the target and the source
4. R&D Needs and Opportunities:
   - What are the existing analysis and data portfolio?
   - How convincing is it for demonstrating feasibility of and discriminate between existing conflicts (i.e., sources and targets)?

Separations/Beneficial Uses

1. New methodologies are needed for separations to allow better handling of hazardous constituents in spent civilian reactor fuel and/or recovery of components with economic value

   New uses are needed for depleted uranium

2. Challenges include:
   - The presence of certain long lived radioactive constituents in spent civilian reactor fuel presents problems for permanent geological disposal

Separations/Beneficial Uses

2. Challenges (con’t):
   - If permanent geological disposal of intact spent fuel elements is found to be unacceptable, an alternative will be needed.
   - The potential for recovery of constituents of economic value from spent civilian reactor fuel should be enforced
   - New uses are needed for consumption of depleted uranium to reduce disposal costs

Separations/Beneficial Uses

3. The current strategy for disposal of spent civilian reactor fuel is encapsulation of intact fuel elements and followed by geological disposal

   Large amounts of depleted uranium exist for which there are no current applications

4. R&D Needs and Opportunities:
   – Development of proliferation resistant separations of spent civilian reactor fuel as a source of useful constituents or for removal of long-lived radioactive components which represent special hazards for long-term disposal

Separations/Beneficial Uses

4. R&D Needs and Opportunities (con't):
   - Development of proliferation-resistant separations methodologies for use in accelerator transmutation of waste
   - Development of new uses for depleted uranium

Geologic Disposal

1. Long term storage of high level waste
2. Challenges include:
   – Better characterization of behavior of actinides, fission products in the host rock
   – Better understanding of molecular load behavior
   – Lack of actual experimental data in lab and field
   – Limited confidence in long-range predictions
   – Allowable regulatory exposure has changed with time and may change further in the future
   – Long lived packaging
   – Continuity of effort and funding

Geologic Disposal

3. Yucca Mountain Project
4. R&D Needs and Opportunities:
   – Pursue microbiological research
   – Better prediction of chemical characteristics of waste and environment as a function of time
   – Selection of materials for waste package to convert waste to less hazardous states
   – Co-precipitation studies of Yucca Mountain Project

Geologic Disposal

4. R&D Needs and Opportunities (con't)
   - Post-emplacement monitoring devices for long term performance confirmation
   - Methods and approaches for demonstrating long-term performance of engineered barriers
   - Innovative materials or material treatment methods for long-lived engineered barriers

Waste Forms

1. A large variety of radioactive waste forms exists including those related to spent fuels, and nuclear weapons processing and related activities
2. Challenges include:
   - Long-term stability of the waste form verified by combination of testing , analysis, and computable modeling - Dose-time relationship
   - Processing variability/history can affect performance of waste forms

Waste Forms

2. Challenges (con't):
   - Confidence in Long-Term Behavior of Waste Form Engineered Barriers
   - Characterization of Chemical and Biological Environment
   - Long Term Monitoring and Performance Confirmation

3. N/C

Waste Forms

4. R&D Needs and Opportunities:
   - Addressing the integrity of stainless/carbon steel canisters
   - Development of a material design capable of encapsulating a wide spectrum of waste (i.e., variety of metals, acids, bases,and chelates)
   - Use of immobilization agents utilized in vitrification processes
   - Development of oxide passivation techniques

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RECOMMENDATIONS

Duplication of Existing Work

It is essential that a system be established to inventory work that has been completed or is currently underway both in the U.S. and in the international community to avoid needless duplication.

Peer Review Process

Insure that the work is peer reviewed by panels outside the DOE in order to avoid any appearance of conflict. There are a number of models by various agencies funding research grants that could serve as a model. The member should be external to DOE and be free of obvious bias.

Other Than HLW

Discussion has been confined to HLW to adhere to the change in the PCAST report. This does not imply any reduction in importance of low level waste, uranium mill tailings, or problems in dealing with previously disposed wastes. Research conducted on HLW will, in many instances, apply to these radioactive wastes as well. DOE may wish to consider recognition of proposed research with broader applications.

Achievements

Achievement of the technical goals stated at this workshop is unlikely to be sufficient to make nuclear energy viable in the near (or even far) future. If the intent of NERI is to address the obstacles to expansion of commercial nuclear power, then NERI should encourage participation of researchers not only from physical science and engineering disciplines but also from social and biological sciences and public health.

Conclusions

There is no end customer, no end product, no infrastructure, no program plan and no vision for the whole initiative. No theme integrates this as a package.

How do you go from fundamental R&D to achieving the three goals of NE R&D? How do you convince the Congress that you can make this step?

It appears that what we are developing is individual PI initiatives "1000 points of light" that don't have a common thread or vision for an integrated, coordinated program. I don't think this will sell well in Congress as is.

Conclusions (Cont’d)

There is no appropriate given slot/topic for considering the integrated or system-level view of the nuclear endeavor (e.g., the whole fuel cycle).

An over all “systems” analysis of U.S. energy policy focusing on nuclear energy’s current role and impediments to its growth/use is a necessary precursor to determining how NERI projects can further PCAST goals.