PACKAGING CRITERIA FOR SPENT FUEL AND HIGH LEVEL WASTE: AN OVERVIEW

J. Haley
Chairman, Nuclear Waste Management Group
Advanced Power Systems Divisions
Westinghouse Electric Corporation

INTRODUCTION

Packaging of commercial spent fuel and high level waste (HLW) is an activity not expected to start until the 1990's. However, it is an activity which requires continued development during the 1980's. Packaging may be required for long-term storage of spent fuel assemblies in the event reprocessing and repository schedules continue to slip. Packaging will be required for geologic disposal of HLW. This paper describes progress on current Department of Energy technology programs and defines what still remains to be done. It will emphasize the need for a stepwise development of realistic packaging criteria and regulations.

CURRENT PROGRAMS

As shown in Table I, Westinghouse is participating in waste management programs involving disposal, storage and institutional activities. Two of the programs, being conducted for the Department of Energy, are concerned with packaging technology for spent fuel and HLW. Both of these, the Commercial Waste and Spent Fuel Packaging Program, and the Dry Storage Technology Program, are being conducted at the Nevada Test Site. The programs use the Engine Maintenance, Assembly and Disassembly (E-MAD) facility, which Westinghouse has operated for the government since 1965. The E-MAD facility has extensive capability for handling large radioactive components. Its hot bay is 140 feet long, 66 feet wide, and 74 feet high. There are also a number of hot cells of

varying sizes. The hot bay has master-slave manipulators, traveling wall-mounted handling devices, an overhead positioning system, a traveling bridge crane, and railroad tracks running the length of the hot bay. E-MAD can package pressurized water reactor (PWR) and boiling water reactor (BWR) spent fuel assemblies and solidified HLW, leak test the completed packages, provide process storage within the hot bay, and emplace the packages into dry storage configurations outside the building.

Commercial Waste and Spent Fuel Packaging Program

The Commercial Waste and Spent Fuel Packaging Program started in 1978. Initial progress was reported during last year's Waste Management 1979 Symposium[1]. The objective of this DOE program is to develop and test the capability to satisfactorily package spent fuel assemblies and commercial HLW. The program also develops dry storage technology to support interim storage requirements at future repositories. During 1978-79 the technology to package spent fuel assemblies (or equivalent glassified HLW logs) in canisters was demonstrated. Sixteen packages were welded, back-filled with helium and satisfactorily leak checked. A typical seal welded canister is designed to contain either one PWR fuel assembly or two BWR fuel assemblies. The latest-design canister fits into standard spent fuel shipping casks. The canister materials tested to date consist of carbon steel and stainless steel. This material is satisfactory for storage applications; materials suitability for geologic disposal will depend on forthcoming regulatory criteria. The seal welded canister containing the fuel assembly is suspended from a shield plug filled with concrete.

Outside the E-MAD building are two dry storage configurations--drywells and storage casks. There are four drywells constructed, nominally 25 feet apart. For each drywell, a carbon steel liner (1.5 feet diameter, 23 feet long) is grouted into a shallow hole drilled in the soil. For drywell emplacement, the packaged spent fuel assembly is first loaded into a shielded transfer vehicle. The vehicle is moved along railroad tracks from inside the E-MAD hot bay, until the shield is directly over the drywell. The canister is then transferred to the drywell. Two PWR spent fuel packages have been stored in drywells since early 1979. (It should be noted that drywell-type storage units have been used for HTGR spent fuel in Idaho since 1971.)

The other dry storage configuration is located above ground and is called a Sealed Storage Cask. The reinforced concrete silo is about 8.5 feet diameter and 21 feet high. In 1978, a PWR spent fuel package was loaded into one of the two silos located outside the E-MAD building. (It should be noted that concrete storage casks have been used for CANDU spent fuel at Whiteshell, Canada, since 1975.)

Dry Storage Technology Program

The packaging program (described above) is also developing dry storage technology to support interim storage requirements at future repository sites. However, data developed to date also indicates that both dry storage configurations could be applicable to Away From Reactor (AFR) storage of spent fuel. It indicates that more than 70 packaged spent fuel assemblies could be stored per acre of soil similar to that at Nevada Test Site. This is based on storing spent fuel with decay heat levels of about 2 kw/assembly. Spent fuel assemblies with even greater decay heat levels could be stored in concrete silos. (It should be noted that West Germany is planning to use air-cooled, storage/transport casks for their AFR storage facilities.)

DISPOSAL/PACKAGING CRITERIA AND STANDARDS

A 20 year Pert-type schedule (Fig. 1) was prepared covering the overall U.S. nuclear waste management program. Figure 1 is a best-estimate schedule, based on latest DOE and NRC program plans. Although this schedule focuses on commercial HLW and spent fuel, selective use was made of applicable defense waste programs. Current ground rules were assumed to determine licensing time requirements.

Figure 1 includes the key activities leading to the first geologic repository for disposal of HLW, including prerequisite storage and packaging activities. An assumed reprocessing schedule is provided to show the applicable interfaces with storage and disposal activities. Figure 1 is consistent with President Carter's recently announced policy to characterize four or five sites before one will be selected for development as a licensed repository. Recent congressional testimony by DOE and NRC indicates that the Fig. 1 schedule will slip another 2 or 3

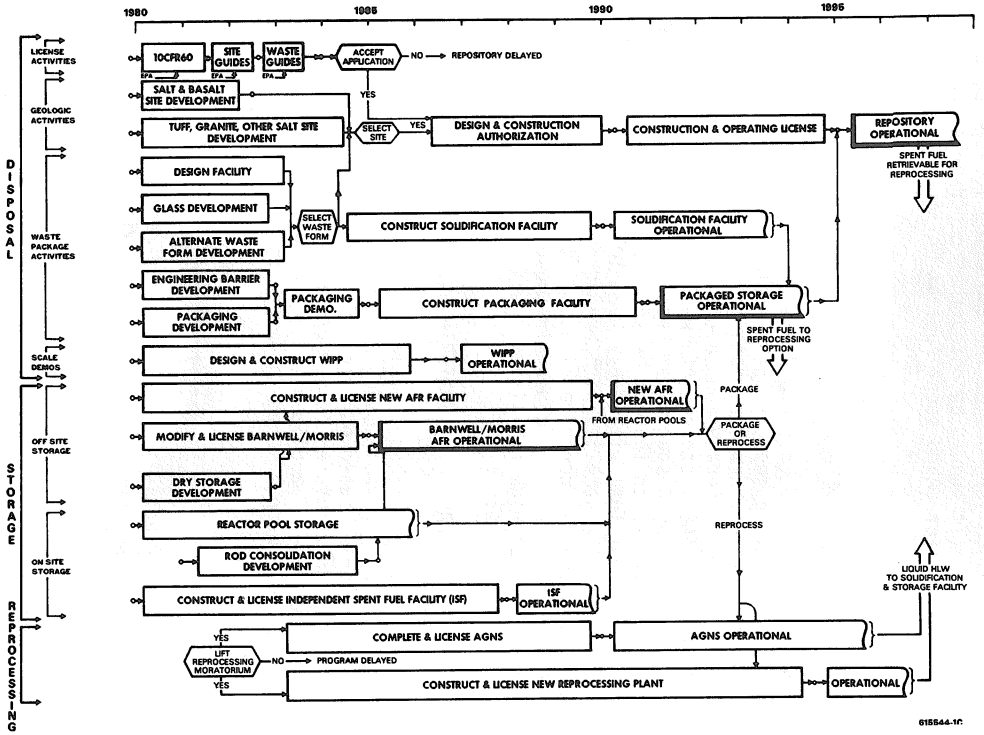

Fig. 1. U. S. Nuclear Waste Management Program (Commercial High Level Wastes & Spent Fuel).

years if exploratory shafts and testing at depth are required to characterize each and every one of these four or five sites. (The Fig. 1 schedule is based on exploratory shafts and testing at several sites.)

Figure 1 shows that the first HLW repository won't be operational before 1995. Nevertheless, we need to develop realistic packaging criteria and standards starting now. A stepwise evolution will be required so that both packaging regulations and packaging technology will be available as needed to support the first repository schedule.

TABLE I. Westinghouse Involvement Current Programs

Disposal

- **Commercial Waste & Spent Fuel Packaging**
- **National Waste Terminal Storage Program**
  - **Design Field Experiments**
  - **Granite Geologic Demonstration**
  - **Basalt Geologic Demonstration**
- **Waste Isolation Pilot Plant**
- **Westinghouse Hanford**

Storage

- **Dry Storage Technology**
- **Spent Fuel Racks**
- **Rod Consolidation**

Institutional Activities

Nuclear Waste Management (in this case, HLW packaging) is a process, not a problem requiring a perfect solution. It is a process, like Air Transport is a process. Safety standards and regulations for Air Transport have evolved in conjunction with development and evolution of the airplane, radar and other applicable systems. Many of us arrived at the Symposium by air, well aware there were certain acceptable risks involved. We also know that the safety standards and regulations for today's 747 aircraft have developed considerably from those specified for the first DC3.

Currently, the Environmental Protection Agency (EPA), the Nuclear Regulatory Commission (NRC) and the Office of Nuclear Waste Isolation (ONWI) are drafting packaging criteria and regulations for geologic disposal of high level waste[2,3,4]. There will be important public and peer group comments on these documents. In order to develop realistic packaging criteria and regulations, I would recommend the following key actions:

- The standards criteria and regulations should not be based on requiring perfect solutions. Instead, the need for a stepwise evolution of these documents should be recognized.

- Performance criteria for the overall repository disposal system should be established now. However, detailed design criteria should not be specified for the HLW package or other individual system components. A systems approach should be followed. The designer and regulators should examine potential combinations of waste packages, geologic media, and other barriers--natural and engineered--which meet the overall systems criteria.

- Most important of all, the HLW packaging criteria and regulations should evolve and develop during design, construction,and operation of several repository system demonstrations in the 1980's. (These demonstrations will also be required to address nuclear moratoriums and public acceptance issues.)

CONCLUSION

The technical feasibility for packaging spent fuel and solidified HLW has been demonstrated. However, additional packaging development activities are required for geologic disposal of HLW. NRC, EPA and DOE must follow a stepwise development of realistic packaging criteria and regulations. Evolution and development of the regulatory standards and criteria should take place during design, construction,and operation of repository system demonstrations which are needed in the 1980's. This is required so that both packaging regulations and packaging technology will be available as needed to support the schedule for the first HLW repository.

REFERENCES

1. M. S. Bensky et al, "Spent Fuel Storage and Isolation," Proceedings Waste Management 1979 Symposium, Tucson, Arizona, February 1979.

2. U.S. Nuclear Regulatory Commission, "Draft 10CFR60, Disposal of High-Level Radioactive Wastes in Geologic Repositories - Technical Criteria," Washington, D.C., March 1980.

3. Environmental Protection Agency, "Draft 40CFR191, Environmental Radiation Protection Standards for Management and Disposal of Spent Nuclear Fuel, High-Level and Transuranic Radioactive Wastes," Washington, D.C., March 1980.

4. Office of Nuclear Waste Isolation, "Draft ONWI-33(4), NWTS Criteria for the Geologic Disposal of Nuclear Wastes: Waste Package," Battelle-Columbus, Ohio, January 1980.