THE DEFENSE WASTE PROCESSING FACILITY: THE FINAL PROCESSING STEP FOR DEFENSE HIGH-LEVEL WASTE DISPOSAL

S. P. Cowan
R. D. Walton
Office of Defense Waste and Byproducts Management
W. M. Sprecher
Office of Policy, Planning and Analysis
U. S. Department of Energy
Washington, DC 20545

ABSTRACT

The policy of the U.S. Department of Energy is to pursue an aggressive and credible waste management program that advocates final disposal of government generated (defense) high-level nuclear wastes in a manner consistent with environmental, health, and safety responsibilities and requirements. The Defense Waste Processing Facility (DWPF) is an essential component of the Department's program. It is the first project undertaken in the United States to immobilize government generated high-level nuclear waste for geologic disposal.

The DWPF will be built at the Department's Savannah River Plant near Aiken, South Carolina. When construction is complete in 1989, the DWPF will begin processing the high-level waste at the Savannah River Plant into a borosilicate glass form, a highly insoluble and non-dispersable product, in easily handled canisters. The immobilized waste will be stored on site followed by transportation to and disposal in a Federal repository.

The focus of this paper is on the DWPF. The paper discusses issues which justify the project, summarizes its technical attributes, analyzes relevant environmental and institutional factors, describes the management approach followed in transforming technical and other concepts into concrete and steel, and concludes with observations about the future role of the facility.

INTRODUCTION

The U.S. government began generating high-level radioactive waste in 1944 when operations began at the Hanford Works to produce plutonium for the national defense. Since then, the U.S. Atomic Energy Commission (AEC), and subsequently the U.S. Department of Energy have continued the production of nuclear materials as well as research, development, production and testing activities associated with nuclear weapons, naval propulsion reactors, and nuclear R&D. These activities continue to generate radioactive waste. Because of its potential hazard, this waste material must be carefully managed and disposed of properly.

High-level radioactive waste results from chemically processing nuclear reactor fuel and target assemblies to recover valuable materials. The high-level waste is generated as a liquid which contains essentially all of the fission products and a small amount of unrecovered transuranic isotopes. High-level waste creates special management problems because in addition to its radioactivity the waste material is chemically corrosive and generates heat from radioactive decay.

The Department's defense complex has produced over 80 million gallons of high-level radioactive waste since the early 1940's. The waste has been temporarily stored pending the selection of final disposal methods. Final disposal has been deferred because the interim storage methods have posed no significant hazard to man or the environment. However, the large volume of defense high-level waste that is stored in temporary facilities requires extensive and costly surveillance and maintenance efforts. The storage tanks are old and many must be replaced. This requires periodic construction of expensive new tanks and the transfer of waste from one tank to another. Defense related nuclear operations will continue to generate high-level waste that must be managed. The need for permanent disposal rather than just interim storage is clear. The safety of interim storage depends on continuing human controls; disposal will minimize this need. It is time for the government to demonstrate the ability to handle high-level waste by properly preparing it for disposal rather than continuing to store the increasing inventories in tanks that require active surveillance and periodic replacement.

It is, therefore, the policy of the Department of Energy (DOE) to pursue an aggressive waste management program that advocates final disposal of defense high-level waste in a manner consistent with environmental regulations and the Department's responsibilities.

Within DOE, the Office of Defense Waste and Byproducts Management under the Assistant Secretary for Defense Programs, administers DOE's defense waste management program. Reflecting Departmental policy, the program objectives are:

- Provide for either the safe interim storage or utilization of waste materials until disposal options are selected.
- Develop technologies, processes, and systems for disposal of waste.
- Process waste into forms suitable for permanent disposal.
- Develop a research and development facility to demonstrate geologic disposal of defense waste (WIPP).

After several years of strengthening the program's technology base the Department is moving forward to design, build, and operate waste processing and disposal facilities. One of the major efforts in DOE's defense waste program is the construction and operation, by 1988, of the Waste Isolation Pilot Plant (WIPP). The WIPP was authorized by Public Law 96-164 as an unlicensed research and development facility to demonstrate the safe disposal of defense waste. This includes disposal of transuranic (TRU) waste and disposal experiments with high-level waste. Another high priority project is the Defense Waste Processing Facility (DWPF), which will immobilize for disposal the substantial quantities of defense high-level waste stored at DOE's Savannah River Plant (SRP), located near Aiken, South Carolina.

THE DEFENSE WASTE PROCESSING FACILITY--ITS PURPOSE, ORIGIN, AND PROGRAM CONTEXT

The objective of the DWPF program is to design, construct, and operate facilities for the routine immobilization of defense high-level waste at the Savannah River Plant for temporary onsite storage, followed by transportation to and disposal in a Federal repository. To dispose of Savannah River Plant high-level waste in a geologic repository, the waste must be processed into a form that meets disposal criteria. The DWPF will provide this final processing step for Savannah River defense high-level waste.

The Department's decision to proceed with the DWPF project at Savannah River is the result of a program extending back to the early 1970's. High-level waste disposal strategies and processing alternatives were evaluated for the three DOE sites which produce and store defense high-level waste: the Hanford Site in Washington, the Idaho National Engineering Laboratory near Idaho Falls, Idaho, and the Savannah River Plant. Systems integration studies focusing on waste immobilization technologies, waste packaging techniques, transportation systems, waste storage methods, and disposal facilities were conducted. It was decided to proceed sequentially with waste processing for disposal. This strategy will allow the experience developed at the first site to benefit the long-term waste management programs at the other sites and result in cost savings and more level budgets.

Selection of the Savannah River Plant as the First Site for High-Level Waste Immobilization

The Savannah River Plant was selected as the first site for implementation of a high-level waste immobilization program for the following reasons:

- The defense high-level waste stored at the SRP represents about 35% of the total volume of defense waste and contains over 70% of the radioactivity stored in underground tanks. Significantly more high-level waste will be generated in the next 10 to 15 years at SRP than at the other sites. Based on the projected generation rates, up to 25 new storage tanks, each costing about $15 million, would be needed by the end of the century to store the SRP waste. Processing the waste for disposal will avoid the need to build these additional storage tanks.
- The SRP is located in a humid climate and the storage tanks are at or near the water table. The consequences of a tank failure at SRP would be greater than at the other DOE sites.
- The technology to remove and immobilize the SRP high-level waste has been demonstrated on both a laboratory scale (radioactive) and a pilot scale (non-radioactive). The process is ready for full-scale application. There are no significant issues with the strategy to remove the waste from the tanks, process it to an immobilized form, store the immobilized waste temporarily on site, then ship the waste off site for disposal in a federal repository.
- Both the Hanford and Idaho sites are located in dry climates in contrast to the SRP location. The liquid portion of the Hanford high-level waste is being transferred from the older tanks to new ones, thereby reducing the risk of environmental damage that could result from a tank failure. The high-level waste at Idaho is being converted to dry granular calcine and stored in stainless steel bins which can provide safe storage for hundreds of years.

Relationship to DOE's Waste Management Program

The DWPF will provide technology, design, construction, and operational experience that will benefit the Department's program to solidify the high-level waste at the other DOE sites. While not all aspects of the immobilization process may be applicable to commercial high-level waste, the construction and operating experience gained from DWPF will be of benefit there also. The DWPF will provide immobilized defense high-level waste for experiments in the WIPP in 1990. No other source of immobilized defense waste will be available then.

The Department is pursuing a strategy of geologic disposal of the SRP high-level waste in a repository that meets the Nuclear Regulatory Commission's (NRC) licensing requirements. To insure that the product from the DWPF will meet the requirements for disposal in a licensed repository, the Department has established a Materials Characterization Organization to (1) establish and approve standard testing procedures and (2) to collate and approve data. The data will be used in obtaining NRC licensing approval for the repository and to assure that the DWPF waste packages comply with repository operator, NRC, and EPA requirements.

PROJECT STRATEGY

Project Facilities

The DWPF project will provide facilities which will perform the following operations remotely:

- Transfer the treated high-level waste from waste storage tanks to feed tanks in the main processing building.
- Process the waste to produce canisters of waste immobilized in borosilicate glass.
- Store the sealed canisters in a near-surface vault pending transfer to a waste repository.

The DWPF will meet DOE criteria and standards for nuclear facilities. The main process building will be seismic and tornado resistant. It will include remotely operated and maintained process cells containing the process vessels and equipment.

The concrete walls of the process cell will provide shielding against the highly radioactive waste solutions and solids. Cold feed chemicals and service systems, e.g., instrument connections, cooling water, steam, electrical power, etc., will be provided from adjacent areas to facilitate maintenance and reduce exposure to personnel. Ventilation air will be filtered before final monitoring and discharge to the atmosphere. Maintenance shops and areas, control rooms and similar services will be included. New facilities and supporting services such as electrical substations, water wells, sanitary sewer systems, roads, shops and auxiliary buildings will be constructed as needed.

A near-surface, air cooled, concrete storage vault will be built near the main processing building to provide lag storage for immobilized waste. It will be cooled by natural convection and require minimum surveillance. This vault will contain about 1,000 canisters of vitrified high-level waste (approximately 2 years production). Although it is intended for only short-term use, there is no technically imposed time limit for this mode of storage. Additional storage space can be added as needed.

Waste Form and Process

Borosilicate glass has been selected as the waste form for Savannah River high-level waste because of its stability, resistance to leaching under anticipated repository conditions, ability to accomodate a wide range of waste compositions, and its suitability for large-scale production operations in a remotely operated radioactive environment.

DOE began a program to evaluate alternative waste forms for the DWPF in 1979. With borosilicate glass as the reference waste form, sixteen other forms were evaluated for process complexity, cost, performance, development status and compliance with criteria. By a rigorous selection process, the waste form choices were narrowed to the reference borosilicate glass and a crystalline ceramic form, SYNROC-D, in 1981. The environmental impacts of selecting the waste form for the DWPF were evaluated in an Environmental Assessment issued for public review in July 1982. The data available was sufficient to select the waste form for the DWPF. It was desirable to make this selection in order to increase efficiency by concentrating the development effort on a single form and to reduce the uncertainty in the DWPF project. The environmental analysis and the comments received, and consideration of both waste form performance and cost, confirmed the selection of the reference borosilicate glass form.

In the DWPF immobilization process, the high-level waste sludge (containing most of the strontium-90 and actinides) will be washed in the tank farm and fed to the DWPF as a slurry. This material will be mixed with glass forming material (frit) and fed directly into a joule-heated ceramic melter where the waste will be fused, at approximately 1150°C, with the glass frit. Off-gas will be removed, cooled, filtered, and treated before being released. The immobilization equipment will operate at a rate of about 100 kgs of glass per hour. The molten glass waste will be poured into steel canisters measuring about 3.0 meters long and 0.6 meters in diameter. Cooled canisters, containing about 1480 kgs of glass, will be plugged and welded. The canisters will then be leak tested, decontaminated and transferred to the air-cooled storage vault for later shipment to a geologic repository. All of these operations will be done remotely. The soluble salt fraction of the high-level waste will be decontaminated in the tank farm. The separated radionuclides, primarily cesium, can either be immobilized in the DWPF or processed into another form for beneficial use. The decontaminated salt solution will be disposed on site.

The DWPF will produce about 500 canisters annually. Approximately 15 years of processing will be required to reduce the high-level waste inventory to normal operational levels. This capacity was chosen to optimize costs, efficiency, the rate at which the backlog can be reduced, and plant utilization during normal operation.

Compliance With Environmental and Other Regulations

The DWPF project complies with the requirements of National Environmental Policy Act (NEPA) and applicable Federal, State and local regulations.

A project specific environmental impact statement (DOE/EIS-0082) which evaluated alternatives for the DWPF was issued in March 1982. A Record of Decision documenting the Department's decision to construct and operate the DWPF was issued in June 1982. The environmental impacts of selecting the DWPF waste form were evaluated in an Environmental Assessment that was issued for public review in July 1982. A Finding of No Significant Impact (FONSI) for the selection of borosilicate glass as the DWPF waste form was issued in December 1982, completing the NEPA documentation for the project. Relatively few public comments were received on the various documents. Essentially all of the comments received were constructive in nature and support the Department's decisions to construct and operate the DWPF using borosilicate glass as the waste form.

The project complies with applicable environment, safety and health requirements. The

potential occupational hazards associated with construction and operation of the facility are being evaluated. Safety and quality assurance programs assure that public health will be protected and that occupational exposures are maintained as low as practicable. A preliminary safety analysis report has been prepared and the final safety analysis report will be completed before startup. The information and experience base thus developed will help address any public concerns about the project.

DWPF Project Cost and Schedule

The total estimated capital cost for the DWPF project is $910 million. The costs for project technical support, conceptual design, equipment development, coordination of development and design, inspection and testing, and startup are estimated to be $440 million. Funding will be provided through phased appropriations over the duration of the project. Firm design has been underway since FY 1981 and is approximately 15% complete. Major construction will begin in FY 1984 and be complete in FY 1989. "Hot" startup is planned for late FY 1989.

Management Approach

The Department has adopted an integrated, yet decentralized, approach to management. Policy is established by DOE Headquarters, and project execution is the responsibility of the DOE field office.

DOE's Office of Defense Waste and Byproducts Management (under the Assistant Secretary for Defense Programs) provides overall programmatic direction, guidance, assistance, and Headquarters coordination. This office, by closely monitoring pertinent activities, assures that the project's quality, cost and schedule objectives are being achieved. The Manager of DOE's Savannah River Operations Office is responsible for the project. He has established a special project office to manage the project. This office maintains project plans, authorizes expenditure of funds, controls the project's performance, and engages in other activities as described in a documented project charter.

E. I. duPont deNemours and Company, Inc. (DuPont), the operating contractor for the Savannah River Plant, is responsible for design, construction, and operation of the DWPF. DuPont subcontracts for certain services including, design, and construction of the main process building, the glass waste storage facility and support facilities. To the maximum extent possible, contracts and subcontracts will be awarded on a competitive basis. Small or disadvantaged businesses, and labor surplus areas will be given special consideration, consistent with DOE policy. DuPont uses an integrated, closed-loop management system that correlates technical, financial and scheduling baselines with actual performance to help control the project.

The Savannah River Operations Office has contracted with A. D. Little, Inc. to provide independent assessments of the DWPF program. Other contracts for independent analyses will be awarded, as necessary.

CONCLUSION

The DWPF will be the Nation's first production-scale facility for immobilizing high-level waste for disposal. It will demonstrate the Government's ability to handle high-level waste and will provide valuable operating experience for other nuclear waste situations.

Responsible management of defense nuclear waste requires disposal. Low-level waste disposal is in place. With the completion and operation of the WIPP, the disposal of transuranic waste will be demonstrated. And finally, with the completion and operation of the DWPF, DOE will be ready for the disposal of defense high-level waste as soon as a repository is available.

REFERENCES

1. Final Environmental Impact Statement, Defense Waste Processing Facility, Savannah River Plant, Aiken, S.C., DOE/EIS-0082, U.S. Department of Energy, February 1982.

2. "Defense Waste Processing Facility, Savannah River Plant, Aiken, S.C.,; Record of Decision" Federal Register, Volume 47. No. 105, U.S. Department of Energy, p. 23801, June 1, 1982.

3. Environmental Assessment, Waste Form Selection for SRP High-Level Waste, DOE/EA-0179, U.S. Department of Energy, July 1982.

4. R. D. Walton, W. B. Wilson, D. E. Gordon, "Department of Energy's Selection of High-Level Waste Forms," Proceedings of the ANS Topical Meeting on the Treatment and Handling of Radioactive Waste, Battelle Press, April 1982.