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MANAGEMENT OF HFIR SPENT FUEL

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ABSTRACT

The High Flux Isotope Reactor (HFIR) at Oak Ridge National Laboratory (ORNL) has been unable to ship its spent fuel off-site for reprocessing since 1985. The HFIR storage pools are expected to fill up by the end of 1994. If a management alternative to existing HFIR pool storage is not identified and implemented by that time, the HFIR will be forced to shut down.

This study identified and investigated five alternatives to managing the HFIR spent fuel, to determine the feasibility of implementing each in time to prevent shutdown of the HFIR:

1. increasing HFIR pool storage capacity,
2. storing the spent fuel at another ORNL pool,
3. storing the spent fuel in one or more hot cells at ORNL,
4. shipping the spent fuel off-site for reprocessing or storage elsewhere, and
5. installing a dedicated dry storage facility at ORNL.

Of the alternatives investigated, only two could prevent the shutdown of the HFIR in the near term: increasing HFIR pool storage capacity or shipping the spent fuel off-site. Both options have been vigorously pursued because neither is assured of success, and at least one of the options must be successfully implemented if the HFIR is to continue operation. In addition, a third option was selected for implementation as an intermediate-term storage solution: installing a dedicated dry storage facility for the HFIR. An intermediate-term storage solution is needed because neither of the short-term solutions could ensure long-term continued operation of the HFIR.

I. INTRODUCTION

Until recently, spent fuel from the U.S. Department of Energy (DOE) research reactors was shipped to designated DOE sites for reprocessing. A decision by DOE management to stop these spent fuel reprocessing activities has left the operators of DOE research reactors without a means to disposition their spent fuels. As existing storage capacity at the research reactors is filled, the reactors will be forced to shut down unless alternatives are identified for dispositioning the reactor spent fuels. This paper addresses the actions taken by staff at one of these research reactors, the HFIR, to identify and implement a means for dispositioning the HFIR spent fuel so that continued, long-term operation of the HFIR can be ensured.

The HFIR discharges a full core of spent fuel approximately every month. Until 1985, HFIR spent fuel was shipped to the Savannah River Site (SRS) for reprocessing following an initial cooling down of the fuel in the HFIR storage pools. In 1985, shipments to SRS were suspended because of the loss of certification of the HFIR spent fuel shipping container. Efforts to obtain a new certified shipping container were begun immediately, but these efforts had not yet been successful when DOE management decided to stop DOE reprocessing operations. This decision has forced the HFIR staff to pursue other means for managing the HFIR spent fuel. At this time, the fuel needing to be dispositioned consists of the spent fuel accumulated in the HFIR pools since

1985 as well as the spent fuel that continues to be generated each month.

The pool storage array at HFIR has been expanded several times using the existing storage-rack design, thereby keeping the HFIR in operation. However, by about the end of 1994, the array will be completely full. If by that time no alternative to the existing pool storage has been identified and implemented, the HFIR will be forced to shut down.

An investigation of HFIR spent fuel management alternatives was performed.[1] Of five options investigated, the study identified two near-term options that might prove feasible as temporary measures and an intermediate-term solution that could possibly be used to keep the HFIR functioning throughout its expected operating life.

II. DESCRIPTION OF WORK

The first step of the investigation was to identify spent fuel management alternatives that had a possibility of extending HFIR operation. Five alternatives were identified:

1. increasing HFIR pool storage capacity by clearing the HFIR pools of miscellaneous materials and equipment and either close-packing or stacking the spent fuel assemblies,
2. storing the spent fuel at another ORNL pool,
3. storing the spent fuel in one or more hot cells at ORNL,
4. shipping the spent fuel off-site for reprocessing or storage elsewhere, and
5. installing a dedicated dry storage facility at ORNL.

The goal was then to study these alternatives to determine which, if any, could be implemented in time to prevent the HFIR from being shut down.

To determine the feasibility of each alternative, the following regulatory and other requirements affecting these options were identified and investigated:

1. DOE Order 5632.2A, which establishes safeguards and security requirements for special nuclear materials (SNM);
2. National Environmental Policy Act of 1984 (NEPA), which requires analysis, documentation, and approval of the environmental impacts of a proposed action before the proposed action may proceed;
3. Resource Conservation and Recovery Act (RCRA) of 1976, which establishes requirements pertaining to storage facilities for hazardous wastes;
4. U.S. Department of Transportation (DOT) regulations, which establish requirements for transporting hazardous and radioactive materials off-site;
5. DOE Orders 5481.1B and 5480.23, which establish safety documentation requirements for nonnuclear and nuclear facilities, respectively; and
6. ORNL Health Physics Manual, which requires any handling of fissionable materials to be analyzed and reviewed for nuclear criticality concerns.

For each option that appeared feasible, the amount of HFIR spent fuel that could be dispositioned with that option was also explored.

III. RESULTS

A. Safeguards and Security Requirements

The safeguards and security requirements of DOE Order 5632.2A place restrictions on the type and quantity of SNM that may be placed in various categories of facilities, with Category I facilities requiring the most stringent security measures and Category IV facilities requiring minimal security measures. Facility classification depends on both the attractiveness level and the quantity of SNM in the facility. Attractiveness levels pertain to the potential attractiveness of an SNM for use in a nuclear explosive device. They range from A to E, with E being the least attractive and, therefore, requiring the least stringent security measures. HFIR spent fuel is an attractiveness-level E material (a material that, unshielded, emits a radiation dose measured at 1 m that exceeds 100 rem/h), and will remain so for at least 50 years. Therefore, according to DOE Order 5632.2A, an unlimited amount of HFIR spent fuel could be stored in a Category IV (i.e., minimal safeguard) facility.

The quantity of HFIR spent fuel which could be stored in a facility is significantly limited when higher attractiveness-level SNMs are stored in the same facility. According to the DOE order, when more than one attractiveness level of SNM is present in a facility, the entire inventory of SNM must be treated as though it has the highest attractiveness level for which at least 1000 g of material is present. This requirement would place a significant safeguard and security burden on the ORNL Bulk Shielding Reactor (BSR) facility if the BSR pool were to be used for storage, unless SNM now stored in the BSR facility were relocated. Other existing facilities under consideration at ORNL are not affected by this restriction.

B. NEPA Requirements

DOE's NEPA Implementing Pocedures, 10 CFR Part 1021, provide guidelines for determining what NEPA documentation is required for various types of projects. An evaluation of these guidelines led to the following conclusions:

1. To increase HFIR pool storage capacity, it may be possible to obtain a Categorical Exclusion (CX) for pool reracking since HFIR spent fuel is already stored in the pool. A CX would mean that no further NEPA documentation would be required. A CX should be obtainable in a matter of months.
2. To use an existing ORNL facility not already being used to store HFIR spent fuel (e.g., a facility containing a storage pool or hot cells) would probably require preparation of an Environmental Assessment (EA) covering transport to the facility and storage in the facility. However, because this situation is not explicitly covered in 10 CFR Part 1021, a formal ruling from DOE would need to be obtained on what NEPA documentation would be required for such an action. To obtain a formal ruling, 6 months is typically required after submittal of an EA Determination. The review and concurrence process for an EA involves both DOE and the State of Tennessee and is expected to take 2 years or more.
3. Off-site transport of spent fuel is generally covered under NEPA only as it is related to a process covered by NEPA documentation. In the case of shipment of HFIR spent fuel to an off-site location (e.g., to SRS), NEPA documentation at the receiving site should cover these shipments. The shipments in and of themselves do not invoke NEPA documentation requirements.
4. Installation at ORNL of an interim dry storage facility for HFIR spent fuel is expected to require significant NEPA documentation, probably an EA and possibly an Environmental Impact Statement (EIS). Appendix C to Subpart D of 10 CFR Part 1021 describes classes of actions that normally require EAs. This appendix states that an EA is typically required for "Siting, construction (including modification to increase capacity), operation, and decommissioning of onsite storage facilities and/or packaging and unpackaging facilities (that may include characterization operations) for all waste other than high-level waste or spent nuclear fuel." Appendix D describes classes of actions that normally require EISs. According to this appendix, an EIS is typically required for "Siting, construction, operation, and decommissioning of major treatment, storage, and/or disposal facilities for high-level waste and/or spent nuclear fuel, such as spent fuel storage facilities and geologic repositories." The regulation does not provide guidance as to what is considered a "major" facility. Westinghouse Hanford Company is pursuing an EA for its planned dry storage facility, arguing that its proposed facility is not a "major" facility because (1) it will be only an interim facility having a finite life and (2) it will have a specified, limited capacity. The company has recently been informed by DOE that an EA is appropriate for its dry storage system; however, the EA process will sometimes still result in a decision that an EIS is needed. An EIS, if required, must be contracted out to an independent (in the case of HFIR, a non-ORNL) organization. Public hearings are part of the EIS review and approval process. ORNL does not yet have experience with this process; a guess is that an EIS would take 3 to 5 years (possibly more).

C. RCRA Requirements

RCRA regulations apply only to storage and disposal facilities for hazardous wastes. As long as the HFIR spent fuel storage facility does not contain any RCRA wastes, these regulations do not apply. It is currently believed that the HFIR spent fuel contains no RCRA wastes.

The cadmium shrouds used for criticality control during HFIR spent fuel storage could be included in the HFIR spent fuel storage facility as part of the facility (for criticality control) or could be declared wastes. If wastes, the shrouds would have to be shown to pass the toxicity characteristic leaching procedure test required by RCRA (40 CFR 261 Appendix II) to be excluded from RCRA requirements. It is recommended that the cadmium shrouds be used in the spent fuel storage facility for criticality control to avoid this problem.

D. DOT Regulations

DOT regulations apply only to off-site transport of the HFIR spent fuel. For off-site shipment, the spent fuel must be transported in a shipping container certified by the DOE and/or the U.S. Nuclear Regulatory Commission (NRC) to carry HFIR spent fuel. At this time, no shipping container is certified by either organization to transport HFIR spent fuel. Efforts are underway to obtain an NRC-approved shipping container.

E. Safety Documentation Requirements

Preparation of safety documentation is required both for construction of a new facility and for expanded use of an existing facility. The safety documentation process begins with preparation of a Safety Assessment (SA). The SA includes a hazard screening for the facility, which establishes the amount of additional safety documentation required. The hazard screening is based on the type and quantity of hazardous material to be present at the facility. It does not take into account any features of the facility that might mitigate the hazard. Although a formal hazard screening has not yet been performed, the HFIR spent fuel is expected to qualify as a moderate hazard.

Before a moderate hazard material may be placed into an existing facility, it is fairly certain that an approved Safety Analysis Report (SAR), including the moderate hazard material in its scope, would be required for the entire facility. The problem is that during the safety documentation process, the existing facility would be evaluated against modern safety standards for a moderate hazard facility. Older facilities either would require significant upgrades to meet current standards or would not be upgradeable at all. Even with extensive facility upgrades, there is no assurance that an approved SAR could be obtained for an older facility. The time for preparation and approval of an SAR is significant.

Of the existing facilities under consideration, the HFIR facility (which includes the HFIR storage pools) is the only existing facility that is close to having an approved SAR; this SAR could be expanded to incorporate the larger quantities of HFIR spent fuel without much difficulty.

F. Nuclear Criticality Concerns

According to ORNL requirements, any handling of fissionable material must be analyzed and reviewed for criticality concerns. At the time of this investigation, DOE did not review or approve the criticality review except as it involved a change to safety documentation approved by DOE.

G. Evaluation of Options

Of the five options studied, the second and third options (involving use of existing pools or hot cells at facilities other than the HFIR) were quickly eliminated. Both involved the use of older existing facilities lacking adequate safety documentation. These two options were deemed infeasible because of (1) the significant costs associated with facility upgrades, (2) the large amounts of time (several years at a minimum) required to upgrade facilities, and (3) the lack of certainty that approved safety documentation could be obtained even if all this work were completed.

This left the first, fourth, and fifth options. The first option (increasing HFIR pool storage capacity) appeared to be feasible as a near-term option. Work is underway to design, fabricate, and install a new compact pool storage array. The limitation of this option is that it cannot keep the HFIR open indefinitely because eventually the HFIR pool will run out of storage space. A long-term concern with pool storage is the possibility of significant corrosion of the aluminum-clad fuel. This is not expected to be a problem for many years because the water quality of the HFIR pool is rigidly controlled; nevertheless, a surveillance program will be implemented to identify any leaking spent fuel assemblies early on before they become a problem.

The fourth option (shipping the spent fuel assemblies off-site) has two limitations. First, a place is needed to which the spent fuel assemblies may be sent. Second, a certified shipping container is required by DOT regulations. SRS staff have indicated that they have storage capacity for 20 more HFIR spent fuel assemblies. Shipment of 20 spent fuel assemblies to SRS would enable the operation of the HFIR to be extended for about 20 months. Because of the urgency of the situation at the HFIR and the lack of certainty that either option will be successful in time to keep the HFIR operating, this option is being pursued along with the first option as a near-term alternative. Efforts to procure a shipping container that is certified by the NRC are proceeding on an accelerated schedule.

The fifth option (installation of a dry storage system) is the only option that can be designed to keep HFIR operating throughout its expected life. However, this option cannot be implemented in time to make near-term alternatives unnecessary. Extensive effort has gone into an evaluation of dry storage systems for the HFIR spent fuel, and current plans are to install dry storage as soon as feasible.

IV. CONCLUSIONS

Two near-term alternatives were identified that may keep HFIR in operation for a short period of time: (1) reracking of the HFIR pool to increase storage capacity and (2) shipment off-site of some of the HFIR spent fuel. Both these options are being aggressively pursued. However, neither of these options can keep the HFIR in operation indefinitely.

One intermediate-term alternative has been identified which could, if necessary, provide for storage of all HFIR spent fuel produced through the shutdown of the HFIR. This option (dry storage), although still being investigated, is at this time the planned course of action for the intermediate term.

V. ACKNOWLEDGEMENTS

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VI. REFERENCE

1. J. M. Begovich, V. M. Green, L. B. Shappert, and A. L. Lotts, *HFIR Spent Fuel Management Alternatives*, ORNL/M-2377, Martin Marietta Energy Systems, Inc., Oak Ridge National Laboratory, Oak Ridge, Tennessee (1992).

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