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RADIOACTIVE WASTE MANAGEMENT AS APPROACHED BY NUCLEAR MATERIALS MANAGEMENT

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ABSTRACT

Nuclear Materials Management at EG&G Idaho, Inc., works energetically to maximize recovery of excessed nuclear fuel. This paper summarizes four fuel dispositions of nonroutine or odd lot fuels and supports the concept that recovery is the optimal disposal method. Specific packaging, recordkeeping, and timely disposal problems are described. The need for cooperative planning among nuclear materials and waste management personnel, contract personnel, and the program experimenters who use the fuel is stressed.

INTRODUCTION

Nuclear research and development work produces destructively examined, small quantity-per-experiment waste and excess fuel, both of which present a unique set of problems in fuel disposition. The Nuclear Materials Management section at EG&G Idaho, Inc., a prime operating contractor at the Idaho National Engineering Laboratory, directs routine and nonroutine returns of fuel. The section periodically is requested to dispose of odd lot waste and excess fuel. In this paper, the term "fuel disposition" means: (1) shipped to a reprocessor, (2) accepted for storage at the transuranic storage area, or (3) temporarily stored at a low-level waste-management facility. Materials Management has made an energetic commitment to see as much excess fuel reprocessed as possible. This paper summarizes four efforts to accomplish maximum fuel recovery rather than use a waste management facility. In one instance, reprocessing was not an option. This put that particular material in the waste category. The problems in all four cases--gaining fuel processing acceptance, budgeting, packaging, and scheduling throughout the disposition projects--were numerous but never insurmountable. These experiences and solutions support the concept that recovery is the optimal disposal method.

DISPOSITION PROJECTS

Driver Core Fuel

One experimental reactor driver core fuel that will require reprocessing when the reactor shuts down is a low enrichment (18.3%) ternary fuel with stainless steel cladding (see Fig. 1). Materials Management people have been assisting the program in formulating a plan of action for the already excessed rods from the driver core, and thus, a plan for the reprocessing of the remaining core fuel (131 kg U-235). Materials Management has worked in close cooperation with the Idaho Chemical Processing Plant (ICPP) to have dry well storage space allotted there for this fuel, so that it will be consolidated at the processing site and will eventually be reprocessed. Otherwise, small quantities of this fuel will be handled as waste for lack of a better full-scale plan. The fuel was chemically analyzed for reprocessing capability in 1964. A method of pulverization can be used to recover this fuel. After dissolution, a final volume (ml)-to-sample weight (g) ratio is only about 30. It will be difficult to reprocess because it is calcium stabilized zirconium stainless steel type fuel. However, Materials Management has taken the active approach to this problem although the fuel may not be available for reprocessing for 20 years. To date, the section formally submitted the required fuel receipt criteria document to ICPP, which resulted in a Department of Energy (DOE) directive for ICPP to prepare to receive all of the core fuel.

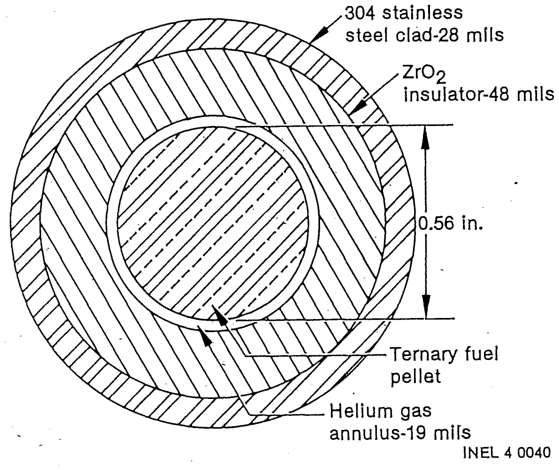

Fig. 1. Cross section of a driver core rod.

Canal Storage

The ongoing project of trying to remove excess fuel from canal storage is proving to be a lengthy task. Fortunately, the program that used this fuel is still in operation. The experimental fuel was cut into 3- to 6-in. pieces to obtain metallurgical mounts for examination. This low-enriched (10%), uranium dioxide, PWR- and BWR-type fuel is zircaloy clad and has impregnated epoxy. When the material was packaged for canal storage, it was primarily stored in stainless steel tubes and secondarily in aluminum canisters. Analyses of the rod pieces for reprocessing show that due to the zircaloy, stainless steel, aluminum, and epoxy combination, and the low enrichments, this material should not be considered for reprocessing.

Materials Management and the responsible EG&G program personnel feel that these rod pieces should receive consideration for storage at the waste management complex. These cut-up rod pieces are not spent because they were subjected only to power bursts, are not raffinate since they are not the result of a process, and are not fuel assemblies because they are merely pieces of rods and not a group of rods. Table I is a sampling of the thermal output, the gram content, and the curie content of the canisters.

TABLE I

A Sample of the Information on the Canisters in the Canal, Calculated for a Potential July 1, 1984 Shipment

Given:

1. Thermal power in watts.
2. Concentrations in grams of actinides and fission products.
3. Radioactivity in curies of actinides and fission products.

Rod	Watts	Grams	Curies
1. Canister A1 Rods 800-1, 2, 3 from RIA ST-1-1, 2, 3			
800-1	1.363E-01	4.359E+02	6.963E-04
800-2	5.863E-06	4.360E+02	5.238E-04
800-3	5.863E-06	4.360E+02	5.238E-04
Canister Totals	1.363E-01	1.308E+03	1.744E-03
2. Canister B1 Rods 312-1, 3 345-1, 2 from LOFT LEAD			
312-1	1.710E-03	5.397E+02	1.168E-03
312-3	7.237E-04	5.397E+02	2.820E-01
345-1	1.115E-03	5.397E+02	5.880E-01
345-2	1.483E-03	5.397E+02	1.109E-03
Canister Totals	5.032E-03	2.159E+03	8.723E-01
3. Canister B2 Rods 312-2, 4 399-2 from LOFT LEAD			
312-2	2.129E-03	5.397E+02	8.342E-01
312-4	5.294E-04	5.397E+02	8.556E-04
399-2	4.977E-04	5.397E+02	8.461E-04
Canister Totals	3.147E-03	1.619E+03	8.359E-01
4. Canister 4 (I2) Rods GC1-001, 002 from GC 1-3			
001	1.225E-03	7.043E+02	4.734E-01
002	1.225E-03	7.043E+02	4.734E-01
Canister Totals	2.450E-03	1.408E+03	9.468E-01

Hot Cell Storage

The next two fuels discussed required different approaches to achieve the same end result: moving fuel from storage in hot cells to ICPP.

Defense Fuel

A Department of Defense (DOD) fuel stored in a cask in the hot cells for 12 years consisted of 847 g of 93.6% enriched U-235 fuel in UO_2-BeO pellets with Hastelloy X cladding. Various fuel documents gave inconsistent matrix values of 30 and 60% BeO. ICPP safety personnel were disturbed by this discrepancy. (Beryllium is a moderator, and calculations had to be accurate for appropriate storage.) The fuel was so old that reliable records had been destroyed, however, we located other documents by tracking original project personnel who had data. We discovered that the conflict was because of the use of weight percent and volume percent in various official and unofficial documents that failed to specify what percentage was used. The pellets contained 60 volume% (30 weight%) BeO. After the discrepancy was resolved, ICPP accepted the fuel.

The recanning of this fuel and the fuel in the next example had to be in canisters acceptable for storage at the ICPP storage basin. These containers were owned by other companies who when asked, kindly donated the necessary canisters.

Breeder Fuel

For ten years, 839 grams of 51.9% enriched uranium-235 in chips and powder from the Experimental Breeder Reactor (EBR)-II also remained in hot cell storage (see Fig. 2). Because an associated can of EBR-I fuel created an explosive fire when opened for examination years earlier, ICPP chemists had reservations about accepting the can of chips and powder. The backup paperwork was not as specific as they would have preferred. Unlike these chips and powder, the original EBR-I fuel had sodium and potassium, a likely source of the problem. Because of insufficient documentation, the chips and powder were unloaded in the hot cells and tested for any sodium content by reacting the fuel with a small amounts with water. The results were negative, so ICPP accepted the fuel.

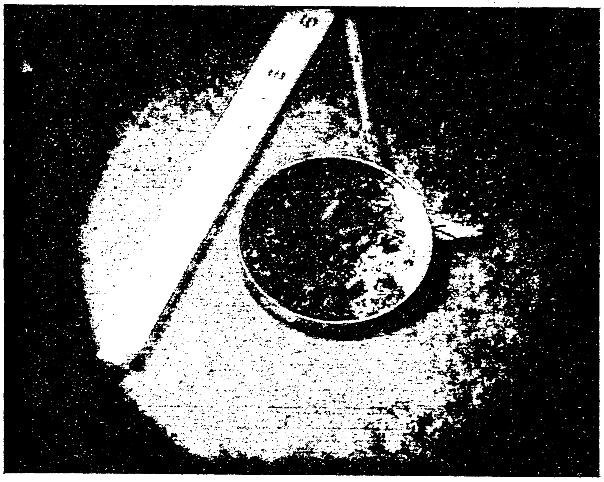

Fig. 2. A photograph of the EBR-II fuel emphasizes the insignificant quantity of material.

After the fuel was accepted, the next step was to remotely load the chips and powder into the required small-diameter (1/4 in.) tubes, a tedious and costly task that required several attempts (44 hot cell manhours) before a workable procedure was developed.

The only technically feasible transport plan available to move both the DOD and EBR-II fuels required going from the hot cells, into a canal, and to ICPP. Incorporating the necessary changes into the documents for handling these odd lot fuels was quite costly. Because of inadequate funding, hot cell, canal, and processing personnel had to be recruited to donate their efforts to a good cause. Using two different casks and scheduling the operation through three facilities was difficult, but by persistence and careful negotiation with four companies, DOE, DOD, and several internal organizations, the project was completed.

Gaining acceptance of small quantities of material at a reprocessing facility is not economically feasible or justifiable. One kg U-235 quantities require the same procedure and processing method as 100 kg U-235 quantities. However, research and development projects continue to produce numerous small quantities of fuels, some of which will have to be disposed of despite the costs. One disposition effort for the UO_2-BeO pellets required 2000 manhours from eight people. This was a small project, but the expense was not.

SUGGESTIONS AND SOLUTIONS

One way to reduce the costs of nonroutine fuel disposition and increase the chances of reprocessing is with nuclear materials management involvement at the contract proposal stage and with continued close contact with each program. Many fuels are being developed without a reprocessing method established, but if fuels are produced in large enough quantities, developing the technical capabilities to reprocess these fuels may be within reason. Waste management participation with nuclear materials management can be beneficial, because each program and its fuels need to be monitored throughout the lifetime of the program with the final disposition in mind.

Good records of the extraneous nonaccountable materials in each container are vital information for reprocessing. This problem seems to be disappearing slowly with the current demands for detailed records but without an understanding of the importance of these packaging details, a nuclear material packager may remain nonspecific in his observations and descriptions. Knowing reprocessing problems, the packagers can become more aware of the importance of minimizing material types in a container to increase the chances of recovery. With a large batch of routine fuel, these problems in packaging simply do not occur. With research and development test material that is destructively assayed, these packaging problems occur.

Timely disposal of irradiated fuels after an acceptable cooling down period will definitely affect the ease of the disposition project. Archive samples will remain, but the other previous methods to reduce costs apply to archive samples. Timely disposal can counteract problems with lost or destroyed information and lack of funds for disposal. A lengthy time lapse could lead to the inability to reprocess fuel because historical documentation is lacking.

CONCLUSIONS

The problems in all four cases cited here--gaining fuel processing acceptance, budgeting, packaging, and scheduling throughout the disposition projects--were numerous but never insurmountable. These experiences and solutions support the concept that recovery is the optimal disposal method.

The fuel disposition issue needs to be addressed early in the planning process. Early cooperation among waste management, nuclear materials management, contract personnel, and programs personnel encourages the proper persons to address disposition issues now, instead of leaving the issues for future generations. Some programs seem to be prepared, which is helpful, but maximum planning and coordination of all persons who need to be involved is necessary to accomplish the most effective, most environmentally beneficial, and most economical means of fuel disposition with the nonroutine research and development fuels.

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