

ATYPICAL, HIGHLY RADIOACTIVE GOVERNMENT-OWNED MATERIALS
THAT MAY REQUIRE GEOLOGIC DISPOSAL

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ABSTRACT

According to the Nuclear Waste Policy Act of 1982, the government must pay a waste fee for all government-owned "atypical" highly radioactive materials (AHRM). A search for such materials, utilizing the Nuclear Materials Management and Safeguards System data base, was completed. The results of this search provide a preliminary inventory and a description of the government-owned AHRM stored as of December 31, 1985, as well as an estimate of future accumulation.

INTRODUCTION

According to the Nuclear Waste Policy Act of 1982 (1), all government agencies are required by Section 3402(b)(4) to pay for disposal of nondefense high level wastes, fees that are equivalent to those paid by utilities under the standard disposal contract for spent fuel. A one-time charge is imposed on all spent fuel and/or high-level waste created prior to April 7, 1983. "High-level radioactive waste" is categorized, by definition, as highly radioactive material resulting from the reprocessing of spent nuclear fuel and other "atypical" highly radioactive materials (AHRM) for which no reprocessing is planned, but which have been determined by the Nuclear Regulatory Commission (NRC) to require permanent isolation.

Consequently, the Integrated Data Base Program (IDBP), jointly sponsored by the Department of Energy's (DOE's) Office of Civilian Radioactive Waste Management, Office of the Assistant Secretary for Defense Programs, and Office of the Assistant Secretary for Nuclear Energy was requested, in 1985, to undertake the project of compiling an inventory of these "atypical" government-owned materials (2). Examples of such AHRM include: intact, irradiated fuel elements which cannot be reprocessed or are uneconomic to reprocess; damaged, irradiated fuel elements; and solid pieces remaining after various experimental examinations of irradiated fuel elements.

SEARCH PROCEDURE

The search for AHRM began with the Nuclear Materials Management and Safeguards System (NMSS) data base maintained by the DOE and the NRC (3). Information from all facilities having inventories of accountable nuclear materials is reported to the NMSS, based on DOE and NRC reporting requirements. Information reported for each type of accountable nuclear material includes the location, chemical or physical form, total weight, ownership, country of

origin, enrichment, reactor reprocessing, import/export licenses, and financial/contractual obligations placed on the material.

Even though the NMSS does not request reporting of AHRM data as a separate category, the IDBP was requested by DOE to determine whether the NMSS data base could be utilized in inventorying the government-owned AHRM. One of the features of the NMSS data base is categorization of all the reported materials according to ~300 composition codes. An examination of these codes indicated that almost all of the AHRM owned by the government would be included in only 3 categories (listed in Table I). Our initial request for a printout of NMSS data in these categories enabled us to identify 22 contractor sites possessing more than 1 kg of potential AHRM. This amount was chosen as the minimum mass to be included in our inventory tables. The AHRM candidate materials listed in the NMSS data base include depleted uranium, enriched uranium, normal uranium, uranium-233, plutonium, and thorium.

Two separate sets of letters were distributed requesting assistance in assembling an AHRM inventory and including a description of all materials classifiable as AHRM. The first set was issued by DOE's Oak Ridge Operations Office to all other DOE operating offices. Each of the offices was asked to determine whether any of the contractor sites within their jurisdiction held any AHRM and to encourage their cooperation with the IDBP in building an inventory list. The second set of letters was sent by the IDBP to the 22 contractor sites identified through the NMSS analysis as having more than 1 kg of potential AHRM. Each letter packet contained a copy of the information provided in the NMSS printout concerning potential AHRM at that site. Each contractor was asked to verify possession of the items listed and to provide a detailed description of each. In addition, each site was asked to list any other accountable nuclear material held at that site which could be classifiable as AHRM but which had not been included in the NMSS printout.

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TABLE I

NMMSS Nuclear Material Composition Codes and Descriptions

| Composition code | Description |
|------------------|---|
| 392 | Includes irradiated fuels and target material for which the processing scheme is undefined. |
| 774 | Includes experimental fuel capsules, elements, and pins not reported elsewhere. |
| 790 | Includes irradiated materials stored for fuel element examination. |

RESULTS

Responses from the DOE field offices and contractor sites are summarized in Tables II and III, respectively. Our analysis of the descriptions of potential AHRM held at these sites revealed that only 10 of the 22 sites actually held such materials. The highly radioactive materials reported at the remaining 12 sites belong in some other waste category. The sites identified as having AHRM, as well as an inventory of those materials, are listed in Table IV.

Two other DOE reactor projects have been found which have generated potential AHRM. These, the Shippingport Atomic Power Station in Shippingport, Pennsylvania, and the Three Mile Island Reactor (Unit 2), in Middletown, Pennsylvania, would be included in Table IV, but they are currently being dismantled, and their inventories are not yet available. A fairly accurate estimate of the quantity of potential AHRM generated at each of these projects can be made, based on an analysis of the initial mass of fuel loaded into each unit (4, 5). Table V summarizes this information.

DISCUSSION

The responses received from the DOE operating offices and contractor sites to our letters of request indicated that the use of the NMMSS data base to locate AHRM worked well. Those sites that did not reply to our request likely do not have any AHRM, since no such material was reported for them in the NMMSS data base. For these reasons we believe that the data reported in Tables IV and V represent an adequate preliminary estimate of the total inventory of AHRM.

As of December 31, 1985, 65% of the government-owned AHRM was stored at the Idaho National Engineering Laboratory (INEL), 21% was stored at the Savannah River Plant (SRP), and the remainder was located at 8 additional contractor sites. In the future, the AHRM stored at INEL is expected to increase. In May of 1986, the fuel assemblies stored at the Nevada Test Site were transferred to INEL, and current plans call for the remaining AHRM from Shippingport and all of the AHRM at Three Mile Island to be stored at INEL. When these transfers are completed, INEL will have ~86% of the government-owned AHRM and SRP will have ~11%. Some of the fuel at the Idaho Chemical Processing Plant (ICPP) has a lower uranium content than that of most normally processed fuels. For economic reasons, these fuels have not been reprocessed, but they could be

reprocessed in a special campaign, if required. None of the fuel at SRP is reprocessable in their existing facilities.

Most responses to our inventory request letters included descriptions of the AHRM being stored. As of December 31, 1985, the materials could be categorized as the five distinct types listed in Table VI. More than 55% of the AHRM inventory mass is composed of intact, irradiated fuel elements; ~38% is damaged fuel elements resulting from the Three Mile Island (Unit 2) reactor accident; 5% is scrap left from various experimental examinations of irradiated fuel elements; 0.6% is various materials containing U-233 stockpiled at Oak Ridge National Laboratory; and the remainder is uncategorized materials.

SUMMARY

Our procedure utilizing the NMMSS data base to locate government-owned AHRM worked quite well. With our follow-up letter requests, we identified 10 DOE contractor sites storing AHRM and obtained descriptions of this material. We believe the data gathered in this project form a reliable, preliminary inventory of AHRM, but an annual effort will be required to update and extend this inventory.

Responses to our survey indicate that, as of December 31, 1985, a total of 109,228 kg of government-owned AHRM was being held at 10 sites. Of this total, ~65% was stored at INEL, 21% was stored at SRP, and the remainder was held at 8 other DOE contractor sites.

When all currently planned transfers are completed, ~214,100 kg of AHRM will be held in storage, 86% at INEL, 11% at SRP, and the remainder at 7 other contractor sites.

As of December 31, 1985, ~55% of the accountable heavy metal mass of the AHRM in storage was in the form of intact, irradiated reactor fuel elements; ~5% was scrap from various experimental examinations of irradiated fuel elements; and 0.6% was fuel materials containing U-233 that are stockpiled at ORNL. The remaining ~38% is mostly damaged fuel elements that are now being removed from the Three Mile Island (Unit 2) reactor facility.

The inventory compiled as a result of this study should allow DOE to include provisions for final disposal of AHRM materials in its plans for a repository and assist in an accurate determination of its waste fee liability.

TABLE II

Summary of responses from DOE field offices to AHRM information request

| DOE operations office/contractors | Requested | Responded | Potential AHRM |
|---|-----------|-----------|----------------|
| Albuquerque | Yes | Yes | |
| Lovelace Inhalation/Toxicology Research Institute, Albuquerque, New Mexico | | | No |
| Sandia National Laboratory, Albuquerque, New Mexico | | | No |
| Sandia National Laboratory, Livermore, California | | | No |
| Allied Corporation-Bendix, Kansas City, Missouri | | | No |
| Rockwell International-Rocky Flats Plant, Golden, Colorado | | | No |
| Los Alamos National Laboratory Los Alamos, New Mexico | | | Yes |
| Monsanto-Mound Plant Miamisburg, Ohio | | | No |
| Mason & Hanger-Pantex Plant, Amarillo, Texas | | | No |
| General Electric Co.- Pinellas Plant, Largo, Florida | | | No |
| Chicago | Yes | Yes | |
| Argonne National Laboratory-West Idaho Falls, Idaho | | | Yes |
| Idaho | Yes | Yes | |
| West Valley Nuclear Services West Valley, New York | | | No |
| Nevada | Yes | Yes | |
| EG&G, Inc., Las Vegas, Nevada | | | No |
| Holmes & Narver, Inc., Las Vegas, Nevada | | | No |
| Reynolds Electrical & Engineering Co., Las Vegas, Nevada | | | No |
| Halliburton | | | No |
| Dresser-Atlas | | | No |
| Nevada Test Site, Mercury, Nevada | | | Yes |
| Oak Ridge | No | No | |
| Pittsburgh Naval Reactors | Yes | No | |
| Richland | Yes | No | |
| San Francisco | Yes | Yes | |
| Rockwell International-Santa Susana Canoga Park, California | | | No |
| Lawrence Livermore National Laboratory, Livermore, California | | | No |
| Stanford Linear Accelerator Laboratory, Palo Alto, California | | | No |
| Lawrence Berkeley Laboratory Berkeley, California | | | No |
| Savannah River duPont-SRP, Aiken, South Carolina | Yes | Yes | Yes |
| Schenectady Naval Reactors Knolls Atomic Power Laboratory Schenectady, New York | Yes | Yes | No |

TABLE III

Summary of responses from contractor sites to AHRM information request

| Contractor site | Requested | Responded | Potential AHRM |
|--|-----------|-----------|-----------------|
| Argonne National Laboratory-West | Yes | Yes | Yes |
| Argonne National Laboratory-East | Yes | No | ND ^a |
| Babcock & Wilcox, Lynchburg, Labs | Yes | Yes | Yes |
| Battelle Memorial Institute Columbus Labs | Yes | Yes | Yes |
| Battelle Memorial Institute Pacific Northwest Laboratories | Yes | Yes | Yes |
| EG&G Idaho, Inc. (ARA, LOFT, PFB, TAN) | Yes | Yes | Yes |
| EG&G Idaho, Inc. (TRA) | Yes | Yes | Yes |
| Hanford Engineering Development Laboratory | Yes | Yes | Yes |
| Los Alamos National Laboratory | Yes | Yes | Yes |
| Lawrence Livermore National Laboratory | Yes | Yes | No |
| Oak Ridge National Laboratory | Yes | Yes | Yes |
| Princeton Plasma Physics Lab | Yes | Yes | No |
| Rockwell International - Rocketdyne | Yes | Yes | No |
| Rockwell International - Rocky Flats Plant | Yes | Yes | No |
| Sandia National Laboratory | Yes | Yes | No |
| Savannah River Plant | Yes | Yes | Yes |
| Westinghouse - Bettis Atomic Power Laboratory | Yes | No | ND |
| Westinghouse - Bettis Atomic Power Laboratory, Naval Reactors Facility | Yes | No | ND |
| Westinghouse - Idaho Chemical Processing Plant | Yes | Yes | Yes |
| West Valley Nuclear Services | Yes | Yes | No |
| Martin Marietta Energy Systems, Inc., Y-12 Plant | Yes | No | ND |

^aND = not determined.

TABLE IV

Reported inventory, as of December 31, 1985, of AHRM that may require geologic disposal

| Storage site and location | Total candidate materials (kg) | Uranium content, kg | | | Total plutonium content (kg) | Total thorium content (kg) |
|--|---|---------------------|------------------|------------------|---------------------------------------|-------------------------------------|
| | | Total | ²³⁵ U | ²³³ U | | |
| Argonne National Lab.-West | 2,690.27 | 2,651.04 | 98.381 | 0.040 | 39.232 | |
| Babcock & Wilcox | 53.85 | 53.47 | 1.162 | | 0.377 | |
| Battelle Memorial Institute Columbus Labs | 1,505.22 | 1,492.10 | 11.764 | | 13.123 | |
| Battelle Memorial Institute Pacific Northwest Laboratories | 2,249.5 | 2,216.0 | 17.8 | | 26.8 | 6.7 |
| Hanford Engineering Development Laboratory | 70.2 | 60.0 | 10.4 | | 10.2 | |
| Idaho National Engineering Lab. Idaho Chemical Processing Plant | 70,875.0 ^a | 41,395.8 | 1,082.06 | 481.98 | 9.217 | 29,470.0 |
| Los Alamos National Laboratory | 127.49 | 96.52 | 54.47 | 0.133 | 30.97 | |
| Nevada Test Site | 7,452.3 | 7,422.7 | 54.582 | | 29.614 | |
| Oak Ridge National Laboratory | 1,275.65 | 1,257.85 | 803.99 | 280.28 | 0.795 | 17.00 |
| Savannah River Plant | 22,929.0 | 14,236.54 | 1,743.927 | | 44.305 | 8,648.2 |
| | 109,228.5 | 70,882.0 | 3,878.5 | 762.43 | 204.6 | 38,141.9 |

^aIncludes 20,200 kg of AHRM from Shippingport Atomic Power Station.

TABLE V

Potential Government-Owned AHRM from Sites with Inventories
Not Yet Completely Available

| Reactor sites | Total candidate materials | Initial mass of fuel, kg | | | Total thorium content |
|---|---------------------------------|--------------------------|------------------|------------------|-----------------------------|
| | | Uranium content | | | |
| | | Total | ²³⁵ U | ²³³ U | |
| Three Mile Island (Unit 2) | 82,023 | 82,023 ^a | 2,064.4 | | |
| Shippingport Atomic Power Station PWR-2 (Seed 1 and 2) | 490 | 490 | 371 | | |
| LWBR | 42,560 ^b | 503.7 | 0.5 | 495.2 | 42,056 |
| Total | 125,073 | 83,017 | 2,436 | 495.2 | 42,056 |

^aIt is estimated that removal of the damaged fuel and structural materials from the reactor vessel will result in a mass of 140,000 kg. See Table 7.8 in U.S. Department of Energy, Integrated Data Base for 1986: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, Rev. 2, September 1986.

^bAs of December 31, 1985, 20,200 kg of this potential mass had been stored at INEL (see Table IV); the remaining potential AHRM was temporarily stored at the Westinghouse-Bettis Naval Reactors Facility, Idaho Falls, Idaho.

TABLE VI

Accountable mass for various types of AHRM located at contractor and reactor sites, as of December 31, 1985

| Contractor or reactor sites | AHRM mass, kg | | | | |
|---|----------------------------------|-----------------------------------|---|----------------------------|---------|
| | Intact, irradiated fuel elements | Damaged, irradiated fuel elements | Solid pieces remaining after examination ^a | ²³³ U stockpile | Unknown |
| Argonne National Laboratory | | | 312 | | 2,378 |
| Babcock & Wilcox | | | 54 | | |
| Battelle Memorial Institute Columbus Labs | 1,178 | | 327 | | |
| Battelle Memorial Institute Pacific Northwest Laboratories | 2,230 | | 20 | | |
| Hanford Engineering Development Laboratory | | | 70 | | |
| Idaho National Engineering Laboratory | 70,307 | | 568 | | |
| Los Alamos National Laboratory | | | 127 | | |
| Nevada Test Site | 7,452 | | | | |
| Oak Ridge National Laboratory | | | 30 | 1,246 | |
| Savannah River Plant | 14,434 | | 8,495 | | |
| Shippingport Atomic Power Station | 22,848 | | | | |
| Three Mile Island | | 82,023 | | | |
| | 118,449 | 82,023 | 10,003 | 1,246 | 2,378 |

^aScrap left from various experimental examinations of irradiated fuel elements.^bVarious materials containing ²³³U stockpiled at ORNL.

REFERENCES

1. U.S. CONGRESS, "Nuclear Policy Act of 1982," Public Law 97-425, January 7, 1983.
2. U.S. DEPARTMENT OF ENERGY, Integrated Data Base for 1986: Spent Fuel and Radioactive Waste Inventories, Projections, and Characteristics, DOE/RW-0006, Rev. 2, September 1986.
3. U.S. DEPARTMENT OF ENERGY AND U.S. NUCLEAR REGULATORY COMMISSION, Nuclear Materials Management and Safeguards System Reference Manual, Draft 10-84, October 1984.
4. D. R. CONNORS et al., Design of the Shippingport Light Water Breeder Reactor, WAPD-TM-1208, Bettis Atomic Power Laboratory (January 1979).
5. J. R. WORSHAM III, Methods and Procedures of Analysis for TMI-2 Criticality Calculations to Support Recovery Activities Through Head Removal, BAW-17318, Babcock & Wilcox (June 1982).