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UNITED STATES GENERAL ACCOUNTING OFFICE
WASHINGTON, D.C. 20548

RESOURCES, COMMUNITY, AND ECONOMIC DEVELOPMENT DIVISION

DECEMBER 13, 1984

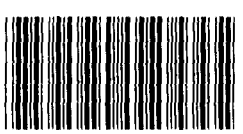
B-217124

The Honorable Richard L. Ottinger
Chairman, Subcommittee on Energy
Conservation and Power
Committee on Energy and Commerce
House of Representatives

Dear Mr. Chairman:

Subject: Return of Spent Nuclear Fuel from Foreign Research Reactors to the United States (GAO/RCED-85-47)

Your letter of June 12, 1984, requested that we examine whether the public's health and safety are adequately protected when spent nuclear fuel from foreign research reactors is returned to the Department of Energy (DOE) for reprocessing[1] and disposal. Discussions with your office indicated that you are specifically interested in determining (1) the amount of spent fuel that has been and is projected to be received from foreign countries, (2) who has title to the fuel and who is responsible for the fuel while it is in transit, (3) the organizations and agencies responsible for ensuring that public health and safety are adequately protected, and what inspections are performed, (4) if the federal government and/or states have planned to respond to an accident that might occur during a shipment of research reactor fuel, and (5) the final disposition of the spent fuel.



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[1]Reprocessing of spent research reactor fuel is a chemical process that separates and extracts the unused enriched uranium for subsequent reuse from the irradiated or spent fuel.

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OVERVIEW

Since the mid-1950's, the United States has been exporting highly enriched uranium (HEU)[2] to foreign countries for use in research reactors. Exports are only made to countries which have entered into formal international agreements for nuclear cooperation with the United States. While these agreements are generally tailored to meet the needs of the parties involved, certain controls in the agreements are designed to assure the United States that the HEU will be used for authorized purposes only, will be properly safeguarded, and will not be retransferred except as allowed by the agreement. The United States permits these countries, at their option, to return their research reactor used or spent fuel to the United States for reprocessing and disposal. If the fuel is not returned, it most often is stored at the reactor site. It could also be transferred to a foreign reprocessing facility, if allowed under the agreement.

Foreign research reactor spent fuel is returned to the United States in a metal form in casks that are designed to safely protect the environment from the spent fuel's radioactivity and to meet the specifications promulgated by the International Atomic Energy Agency (IAEA), the Department of Transportation (DOT), and the Nuclear Regulatory Commission (NRC). The United States Coast Guard (part of DOT) inspects the spent fuel casks upon arrival at a U.S. port, and DOE inspects them at their destination--either DOE's Idaho National Engineering Laboratory or its Savannah River Plant in South Carolina. Commercial carriers, licensed by NRC, truck the spent fuel from the port of entry to the DOE facility. The DOE contract governing reprocessing provides that, unless otherwise agreed to in writing, title to the fuel remains with the foreign owner while in transit. The owner, his agent, or the contracted carrier is responsible for the fuel's safe transportation to the DOE facility where title is assumed by DOE.

DOE reprocesses the spent fuel to extract the unused enriched uranium at either the Idaho National Engineering Laboratory or the Savannah River Plant in South Carolina. The waste generated during reprocessing operations contains high-level radioactive products and is stored in large tanks by DOE. After reprocessing, the recovered uranium, which is then in a powder or liquid form, is shipped to a DOE facility in Oak Ridge, Tennessee, where it is comingled with similar material and converted into a metal form. The metal is then shipped to the Savannah River Plant where it is fabricated into nuclear fuel. This fuel, called driver fuel, is

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[2]HEU is uranium that has typically been "enriched" to contain 93 percent of the isotope U-235. (Natural uranium contains about 0.7 percent of the U-235 isotope while uranium used in commercial power reactors has typically been enriched to 3 to 5 percent.)

used in Savannah River's production reactors to irradiate other materials that are converted into defense-related products, including plutonium and tritium. (The uranium recovered from the spent fuel becomes a small percentage--less than 1 percent--of the driver fuel.) Enclosure II presents a block diagram of the life cycle of research reactor fuel sold to foreign countries by the United States that is subsequently returned for reprocessing and disposal.

The following sections address the specific questions you raised. The objectives, scope, and methodology for our review are contained in enclosure I.

WHAT AMOUNTS OF SPENT FUEL HAVE BEEN RETURNED TO THE UNITED STATES, AND WHERE HAS IT BEEN SENT FOR REPROCESSING? WHAT ARE FUTURE PROJECTIONS?

In the mid-1950's the United States began exporting HEU to foreign countries to fuel research reactors. The reactors are used for conducting scientific research in agricultural, medical, industrial, and other scientific areas. HEU is only exported to those countries that have signed international agreements for nuclear cooperation with the United States. According to DOE records, the United States signed nuclear cooperation agreements with 43 countries between 1954 and mid-1984, and had exported about 16,700 kilograms of HEU.

While the agreements do not require that the spent fuel used in research reactors be returned to the United States, DOE has permitted countries to return the fuel for reprocessing and disposal at their discretion. DOE officials told us that countries return the spent fuel because they do not have adequate storage or they cannot find more economical reprocessing services. To return fuel, DOE requires that a country sign a contract. Pursuant to the terms of the contract, the countries are required to transport the fuel to a DOE reprocessing facility and to reimburse the United States for reprocessing and disposal costs. The countries are given a credit, equal to the value of the uranium extracted from the returned spent fuel during reprocessing, on their next purchase of highly enriched uranium.

Since the beginning of the program in the late 1950's through December 1983, about 1,500 kilograms of spent research reactor fuel had been returned to the United States. The following table shows the amounts of HEU that individual countries have returned to the United States for reprocessing.

Country	Kilograms of HEU Returned			
	Prior to 1982	1982	1983	Total
	----------(calendar year)----------			
Austria	2.3	0	3.6	5.9
Belgium	63.2	19.1	0	82.3
Canada	268.9	34.0	0	302.9
Denmark	25.9	3.3	3.3	32.5
France	324.6	101.8	25.1	451.5
Italy	9.6	12.7	0	22.3
Japan	61.8	29.8	17.9	109.5
Mexico	.4	0	0	.4
Netherlands	80.4	24.6	32.2	137.2
South Africa	14.3	11.9	0	26.2
Sweden	153.8	13.6	12.5	179.9
Switzerland	0	6.8	0	6.8
United Kingdom	.3	0	0	.3
West Germany	93.5	31.1	14.2	138.8
Total	1,099.0	288.7	108.8	1,496.5

Source: Compiled from DOE records and information collected at the Savannah River Plant and the Idaho National Engineering Laboratory during our review.

Prior to 1982, most of the spent fuel returned to the United States entered the country at an East-coast port and was then shipped to the Savannah River Plant for reprocessing. Beginning in 1982, however, because of a shortage of krypton in this country, the United States began shipping returned spent fuel to the Idaho National Engineering Laboratory, which has the capability to extract krypton. (Krypton is a radioactive gas used primarily for leak or penetration testing of electronic assemblies.) During 1983, the Savannah River Plant received only 1 shipment of spent fuel, which contained approximately 25 kilograms of HEU, while DOE's Idaho facility received 11 shipments of spent fuel, which contained approximately 84 kilograms of HEU.

DOE officials were unable to predict the number and size of future shipments, saying only that they depend to a large extent on the availability of economical commercial reprocessing facilities in foreign countries.

WHO HAS TITLE TO THE FUEL WHILE IT IS IN TRANSIT TO A DOE REPROCESSING FACILITY? WHO IS RESPONSIBLE FOR TRANSIT ACCIDENTS?

According to DOE officials, contracts between DOE and the foreign owner of spent fuel stipulate that title to the spent fuel remains with the foreign owner--the country's government or its atomic energy agency--while it is enroute. Responsibility for the spent fuel while in transit, including liability for any accidents, generally lies with the owner. The owner's agent and/or the contract carrier shipping the fuel could also be liable depending on the circumstances. Title is transferred to the U.S. Government when the shipment is received and accepted by DOE at the Idaho National Engineering Laboratory or the Savannah River Plant.

Foreign countries returning spent fuel to the United States obtain the services of one of two firms licensed by NRC to act on a country's behalf as an agent--Transnuclear, Inc., of White Plains, New York, or Edlow International Company of Washington, D.C. The agent makes all of the arrangements for shipping, including making sure that the packaging and transportation of the spent fuel are in compliance with NRC, DOT, and IAEA requirements. In addition, the agent assures compliance with applicable state or local regulations. If the agent does not transport the fuel from the port of entry in the United States to its final destination, it contracts with a licensed commercial carrier. The contract carrier is responsible for complying with DOT's hazardous material transportation regulations.

WHAT AGENCIES HAVE OVERSIGHT RESPONSIBILITY FOR THE SPENT FUEL WHILE IT IS BEING TRANSPORTED IN THE UNITED STATES? WHAT INSPECTIONS ARE PERFORMED TO ENSURE COMPLIANCE WITH THE AGENCIES' REGULATIONS AND GUIDELINES?

NRC and DOT have primary responsibility for promulgating regulations and guidelines designed to ensure the safe transportation of the spent fuel within the United States. Basically, NRC is responsible for the safety of the casks in which radioactive materials are transported, while DOT establishes criteria for the safe transport of the casks on the highways. However, in the case of foreign research reactor spent fuel, DOT, under NRC guidance, is involved in reviewing cask design. For example, although all casks used to transport radioactive materials within the United States are licensed by NRC, casks originating in foreign countries and used to bring radioactive materials into the United States, such as those used to transport foreign spent fuel, must have an IAEA Certificate of Competent Authority revalidated by DOT before they can be brought into the United States. Basically, this document certifies that the cask was designed in accordance with

the guidelines issued by IAEA and that it was tested in accordance with IAEA guidelines in the country of origin.

A prerequisite for NRC's licensing of a cask or DOT's issuance of a certificate is proof that the cask complies with NRC, DOT, and IAEA regulations for packaging and transport. The cask must be designed so that under both normal operation and severe accident conditions (such as a collision or fire), no release of radioactivity will occur, the shielding will remain intact, and there will be no risk of explosion.

Foreign spent fuel packages are inspected twice by federal officials; once by Coast Guard officials upon arrival at a U.S. port and again by DOE officials upon arrival at its DOE destination. Coast Guard officials at two ports which receive foreign reactor fuel--Portsmouth, Virginia, and Portland, Oregon--inspect the fuel shipment upon its arrival in the harbor.[3] The Coast Guard boards the ship upon its arrival at either port and checks the cargo for compliance with DOT's Hazardous Material Regulations. Radiological readings are measured against established DOT criteria, and the exterior of the casks are inspected for damage or noncompliance. Our review of Coast Guard records at both ports showed that they are receiving advance notices of shipments. Moreover, the Coast Guard officials told us that no deficiencies involving the release of radiation have ever been disclosed by the inspections. On rare occasions, a loose cask bolt or cask tie down have been discovered by the inspections.

Upon arrival at its DOE destination, DOE officials inspect the shipping cask and transport vehicle. The inspection procedure includes radiological readings. After the cask is unloaded, the inside of the cask and the fuel are also inspected. DOE officials at Savannah River and Idaho told us that their inspections have never revealed any deficiencies other than minor packing violations involving casks from one country. We reviewed 11 inspection reports involving that country and found only minor problems or none at all.

NRC does not presently inspect casks containing spent fuel coming into the United States although such inspections were conducted routinely several years ago. NRC officials told us that the requirement was discontinued in 1980 because the inspections had disclosed no problems.

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[3]Portsmouth usually receives shipments from European countries while Portland receives those from Japan. In 1982 and 1983, 29 of 35 shipments came through Portsmouth.

We visited the seven states through which the spent fuel most frequently travels on its way to the DOE reprocessing facilities.[4] Of the seven states we visited, only Oregon conducts any kind of inspection on a regular basis. As previously noted, when spent fuel arrives in port at Portland, Oregon, it is inspected by the Coast Guard. After it has been unloaded from the ship and loaded onto a truck, it is inspected by Oregon state officials. They perform an inspection similar to that of the Coast Guard, but they also inspect the truck and the driver for fitness. State officials told us that these inspections have disclosed no deficiencies. Although several other states that we visited had conducted inspections on spent fuel shipments in the past, they discontinued the practice when no problems were identified.

We also asked officials of the seven states and the two port authorities we visited whether they were also receiving proper advance notice of the shipments. All the officials with whom we talked said that notices were received in a timely manner and that they had no problems with any other aspect of the agents' or the carriers' performance. Generally, the state and port officials were complimentary of the performance of the agents and the carriers.

HAVE THE FEDERAL GOVERNMENT AND/OR THE STATES PLANNED FOR AN ACCIDENT THAT MIGHT OCCUR DURING A SHIPMENT OF RESEARCH REACTOR SPENT FUEL? SHOULD AN ACCIDENT OCCUR, HOW SERIOUS MIGHT IT BE?

Both the Savannah River Plant and the Idaho National Engineering Laboratory have emergency response teams available at all times. The primary objective of these teams is to respond to nuclear emergencies at their respective facilities. According to DOE officials at both sites, the teams are prepared to and will respond to nuclear emergencies off the facility if they are requested to do so by state or local officials. From 1958 through 1982, the Idaho laboratory radiological response team responded to a total of 155 radiological assistance requests in at least five different states. DOE officials said none of the assistance requests at either site involved foreign spent fuel.

Officials in six of the seven states we visited were confident that they were prepared to adequately respond to a nuclear incident such as a highway accident involving a spent fuel cask. Each of these states had radiological response teams, communications systems, and plans to deal with a radiological accident. We

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[4]Spent research reactor fuel may pass through 18 different states depending upon the shipment route. The seven states we visited were Idaho, North Carolina, Oregon, South Carolina, Utah, Virginia, and Wyoming.

did not evaluate or test how effective or complete the federal or state emergency response plans are.[5]

One state, Wyoming, did not have a radiological response team or a radiological defense officer trained to deal with such an emergency. A Wyoming official told us that should such an emergency occur, they would immediately call NRC, which also has response teams, or DOE, to provide assistance. The official also said that his state was presently attempting to recruit a radiological defense officer who will subsequently establish a radiological response team.

Foreign research reactor spent fuel, like commercial reactor spent fuel, is considered highly radioactive and can be lethal, depending on the volume of material and length of exposure to it. However, according to the Chief, Radioactive Branch, Office of Hazardous Materials Regulation, Department of Transportation, the potential impact of an accident involving the two types of fuels is different. If a commercial spent fuel cask was breached, there would be a greater chance of a harmful release of radioactivity because the level of radioactivity in commercial spent fuel assemblies is very high because of the presence of numerous fission products such as plutonium. Foreign research reactor spent fuel does not contain as many high-level radioactive fission products, and is not as radioactive.

WHAT HAPPENS TO THE FOREIGN SPENT FUEL ONCE IT ARRIVES AT A DOE REPROCESSING FACILITY? DOES IT END UP CONTRIBUTING TO DEFENSE PROGRAMS?

The DOE Director of the Process and Weapons Division at Savannah River told us that when foreign research reactor spent fuel is reprocessed at the plant, two streams emerge. One stream is the HEU that is extracted from the fuel. The other stream is high-level waste, which is subsequently stored in underground tanks.

The HEU emerges from the reprocessing action in a liquid solution. This solution is shipped to a DOE facility in Oak Ridge in casks similar to those used to bring the spent fuel into the country. According to DOE officials, the possibility of a serious radioactive incident during the shipment of the HEU is less than the possibility of such an incident during the transportation of the research reactor spent fuel because most of the high-level radioactive materials have been removed and are

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[5]For more information on state plans to respond to nuclear emergencies, see report Further Actions Needed to Improve Emergency Preparedness Around Nuclear Power Plants (GAO/RCED-84-43, Aug. 1, 1984).

contained in the waste generated during reprocessing. According to these officials, however, DOE maintains extensive safeguards on these shipments because of security concerns.[6] At Oak Ridge, the fuel loses its identity as it is combined with other quantities of similar material and converted into a metal. The metal is then returned to the Savannah River Plant for fabrication into fuel assemblies, called driver fuel, for use in the plant's reactors. The uranium recovered from the spent fuel is less than 1 percent of the driver fuel.

Driver fuel provides the radiation in the Savannah River Plant's reactors that is directed at other materials. As a result of their exposure to the radiation, these materials are converted into defense-related products such as plutonium or tritium. Thus, no plutonium or tritium is produced from the reprocessed spent fuel itself; rather, the fuel is consumed during the fission process that irradiates other material to produce defense-related products.

Although a similar process takes place with the spent fuel reprocessed at Idaho, there are some differences. At the Idaho facility, three streams emerge from the reprocessing action--HEU, krypton, and high-level waste. Krypton is extracted for testing purposes, and the high-level waste is put into storage tanks. The HEU, which emerges from the process in a liquid form, is converted into a powder and is then shipped to Oak Ridge where it is also processed into a metal form for use as a driver fuel in the Savannah River Plant's reactors. A DOE official at Oak Ridge told us that the only use DOE had for the driver fuel produced from previously burned highly enriched uranium fuels was in the Savannah River Plant's reactors.

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As you requested, we did not obtain official agency comments on this report. Copies of this report are being sent to the Director, Office of Management and Budget and other interested parties.

Sincerely yours,

J. Dexter Peach
Director

Enclosures - 2

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[6]Highly enriched uranium can be used in atomic weapons.

ENCLOSURE I

OBJECTIVES, SCOPE, AND METHODOLOGY

In a letter dated June 12, 1984, the Chairman, Subcommittee on Energy Conservation and Power, House Committee on Energy and Commerce, requested that we examine the measures taken to control the public's health and safety during the shipment of spent nuclear fuel from foreign research reactors to DOE facilities. Discussions with the Chairman's office revealed that the specific questions he was concerned about are:

--What amount of spent fuel has been received and projected to be returned to the United States by foreign owners?

--Who owns the spent fuel, and who is responsible for it while in transit?

--What organizations and federal agencies are responsible for ensuring the public's health and safety during transportation? What inspections are performed by these agencies?

--Have the federal government and/or the states planned to respond to an accident that might occur during a shipment of research reactor spent fuel?

--What is the final disposition of the spent fuel?

To determine the amount of spent fuel that has been and is projected to be returned to the United States and to gain an understanding of the spent fuel reprocessing cycle, we interviewed officials in DOE's Office of Materials Processing in Germantown, Maryland, and at the two DOE facilities responsible for reprocessing the spent fuel--the Savannah River Plant and the Idaho National Engineering Laboratory. We also reviewed pertinent records and reports at each location.

To determine who has title to the fuel and who is responsible for transit accidents, we spoke with knowledgeable DOE officials within its Office of Materials Processing. We also met with NRC officials within the Division of Fuel Cycle and Material Safety and spoke with officials of DOT's Hazardous Materials Division.

To determine the roles of the agencies responsible for the fuel in transit, we spoke with these same officials and also contacted Coast Guard officials in Portsmouth, Virginia, and Portland, Oregon, to determine their inspection procedures and to find out if they had encountered any problems. During the course of the review, we also reviewed Coast Guard inspection records to see if any problems had been encountered during their inspection. We also examined the inspection records at DOE's Savannah River and Idaho facilities. We did not evaluate how well these agencies handle their responsibilities because we found no evidence of any

release of radioactivity associated with the receipt and transportation of foreign research reactor spent fuel. In addition, we contacted Edlow International Company, one of the companies that acts as an agent for foreign countries, to obtain its views on the responsibilities it assumes while working as an agent for foreign shippers of spent research reactor fuel.

To determine how the federal government and the states have planned for an accident that might occur during the shipment of research reactor spent fuel, we contacted knowledgeable emergency response officials at Savannah River and the Idaho Laboratory. We also discussed the shipment of the spent fuel with officials from the seven states through which the material is most frequently transported. (Research reactor spent fuel passes through approximately 18 states.) The seven states we visited are Idaho, North Carolina, Oregon, South Carolina, Utah, Virginia, and Wyoming. We did not evaluate the adequacy of any of the federal or state emergency plans.

To determine the final disposition of the research reactor spent fuel, we spoke with knowledgeable officials at DOE headquarters and at its Savannah River and Idaho laboratory facilities.

We conducted our review between April and July 1984[7] in accordance with generally accepted government auditing standards except as noted by the above limitations on our review. Also, as requested by the Chairman of the House Subcommittee on Energy and Power's office, we did not obtain official agency comments. We did, however, informally provide DOE program officials a copy of this report and discussed it with them. On the basis of their comments, we made appropriate revisions.

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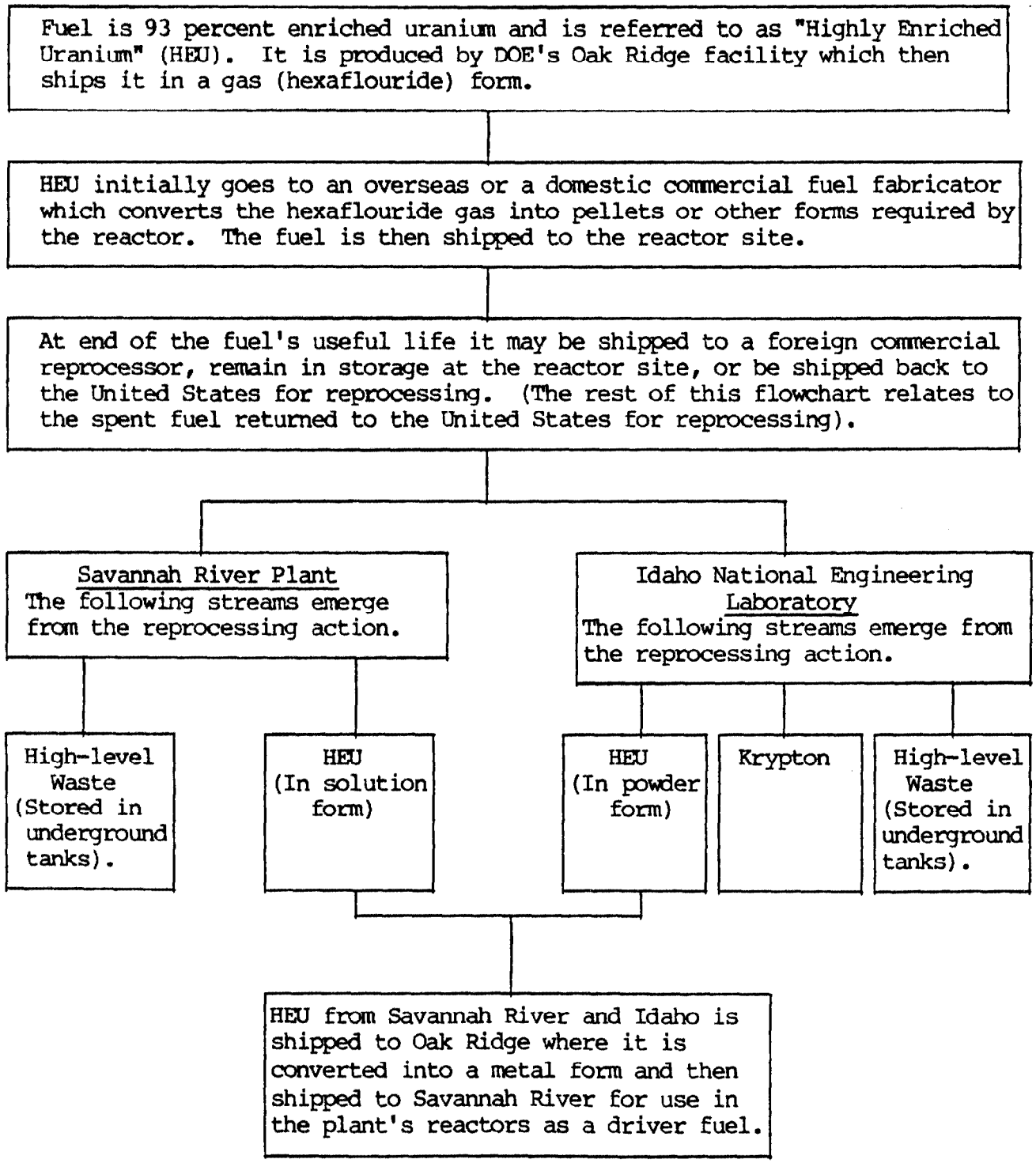
[7]We initiated audit work on the basis of discussions with the Chairman's office before he formally requested that we perform this work.

ENCLOSURE II

LIFE CYCLE OF HIGHLY ENRICHED URANIUM PROVIDED TO FOREIGN COUNTRIES FOR USE IN REASEARCH REACTORS THAT IS RETURNED TO THE UNITED STATES FOR REPROCESSING



Source: DOE's Office of Materials Processing, Germantown, Maryland.