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FINAL REPORT

on

PACKAGING AND SHIPMENT OF IRRADIATED SPENT FUEL

to

EG&G Idaho, Inc.
and
U.S. Department of Energy
Idaho Operations Office

October 1988

by

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ABSTRACT

Irradiated spent fuel rods, rod sections, and other loose fuel were retrieved from various storage locations at the Battelle hot cells, packaged in stainless steel tubes, and inserted in a new basket assembly in preparation for shipment to EG&G Idaho. Fuel assemblies Connecticut Yankee S004 and Turkey Point B17 were also retrieved and prepared for shipment. All three fuel assemblies were loaded in shipping cask TN8-L and shipped to EG&G Idaho for storage.

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1. INTRODUCTION

As part of the U.S. Department of Energy (DOE) plans to relocate spent LWR commercial fuel from the Battelle Columbus Division, West Jefferson facility in Ohio to the Idaho National Engineering Laboratory (INEL) TAN-607 Hot Shop facility in Idaho, two complete fuel assemblies (B17 from the Turkey Point Reactor and S004 from the Connecticut Yankee Reactor) were to be relocated. In addition, several loose fuel rods and rod sections stored at Battelle's hot cells were also relocated by preparing and loading all of the fuel into a 3-assembly shipping cask at Battelle. The scope of work included the following specific tasks:

- o Retrieval, transfer and encapsulation of loose fuel, fuel rods and rod sections
- o Design, fabrication, and loading of the loose fuel rod shipping basket (LFRSB)
- o Final preparation of fuel assembly B17 for shipment

- o Final preparation of fuel assembly S004 for shipment
- o Loading of the 3-assembly shipping cask.

Descriptions of the activities on the individual tasks are given in the following sections.

2. RETRIEVAL, TRANSFER AND ENCAPSULATION OF LOOSE FUEL, FUEL RODS AND ROD SECTIONS

In this task, fuel rod sections remaining from destructive examination of B17 and S004 and all other remaining fuel rod sections were retrieved from various storage locations and transferred to the High Energy Cell (HEC) for encapsulation in individual stainless steel tubes.

2.1 Fuel Inventory

Since the loose fuel to be packaged was stored in several locations throughout the hot cell facility, a detailed inventory was performed to determine the total quantity and the physical form of the fuel stored in the hot cells. This information formed the basis for

- o Estimating the number of hot cell fuel transfers to be made
- o Selecting the size and quantity of the encapsulation tubes, since the fuel rod sections ranged from 0.950 cm to 1.43 cm OD
- o Determining the grid design of the LFRSB to accommodate all of the encapsulation tubes.

The fuel information records at the hot cell were reviewed in detail and the fuel inventory is given in Table 1. Close inspection of Table 1 showed that the fuel to be encapsulated was present as unclad bare fuel and as clad sections. There was also a relatively small amount of fuel present in unrecoverable form such as acid solution for burnup analyses. This fuel would not be included in the present shipment. In addition, there were several intact fuel rods which could be reinserted in either assembly B17 or S004.

The parent fuel rod sizes ranged from 0.950 cm to 1.43 cm OD, making it possible to encapsulate all of the fuel in four different tube sizes: 1.27 cm, 1.429 cm, 1.588 cm, and 1.905 cm OD. Also, a brief calculation revealed that all of the fuel could be accommodated in a total of 108 tubes of the above sizes. This was the number used in the design of the LFRSB as described in Section 3.

TABLE 1. INVENTORY OF SPENT FUEL AT THE BATTELLE HOT CELL

Reactor	Fuel Rod OD (cm)	Number of Fuel Rods		Bare Fuel
		Intact*	Sectioned	
Turkey Point (B17, D01, D04)	1.072	10	22	Yes
Shippingport	1.072	--	8	Yes
Connecticut Yankee (S004)	1.072	--	4	Yes
Oyster Creek	1.43	--	14	Yes
Monticello	1.25-1.43	--	12	No
Surry	0.95	--	12	No
Zion	1.072	--	17	Yes
Brunswick	1.43	--	7	Yes
Quad Cities	1.43	--	5	Yes
Calvert Cliffs	1.072	--	1	Yes
H. B. Robinson	1.072		12	Yes
Oconee	1.102		14	Yes
Maine Yankee	1.072	--	10	Yes
WEPCO	1.072	--	1	No
Ginna	1.072	--	1	No

* Reinserted in fuel assembly.

2.2 Fuel Transfers

Based on the fuel inventory and its physical location in the hot cells, it became quickly evident that a large number of intercell transfers would have to be made to place all of the fuel in the HEC for subsequent encapsulation.

The strategy for encapsulating the fuel was to load, as far as possible, all of the fuel sections from a rod in one suitably sized tube. Since the length of the fuel column in any one rod was a maximum of 365.76 cm (144 in.), this would leave approximately 12.7 cm of available space within the tube to be filled with additional fuel. Hence, it was decided to load an additional fuel section from the same reactor to completely fill the tube. In order to implement this encapsulation strategy, it was necessary to sort and separate the fuel according to reactor and fuel rod. Each fuel section was retrieved from its storage location, uniquely identified from the hot cell records, sorted by fuel rod, and placed in a marked aluminum vial for final transfer to the HEC. A batch of fuel sections from approximately five fuel rods was transferred at one time to the HEC to minimize radiation exposure to the hot cell personnel. In all, a total of 31 intercell transfers were made to place all of the fuel in the HEC.

2.3 Encapsulation Tube Design and Fabrication

As noted above, four different tube sizes were selected to encapsulate all of the spent fuel. Top and bottom end plugs were designed to fit the tubes and to permit relatively uncomplicated in-cell welding of the top end plug. The maximum length of the tubes including top and bottom end plugs was 381.32 cm (150.125 in). Since the plugs were relatively short, it allowed each tube to be filled to within 378.46 cm with fuel. Each encapsulation tube had identification numbers on the bottom end plug. The design of the encapsulation tubes and plugs (Ref: Drawing BCD-WJ-0001, Rev. 1) was reviewed and approved by EG&G prior to fabrication and encapsulation.

Following design approval by EG&G, fabrication of the encapsulation tubes and the end plugs was started. Type 304 stainless steel (ss) tubing of appropriate diameter and wall thickness (0.089 cm) and 304SS bar stock were obtained for fabrication of the tubes and plugs. The end plugs were machined to size, the tubes were cut to the correct lengths, and the ends were deburred to allow for easy insertion and welding of the plugs. An identification number was stamped on each bottom end plug which was then welded to the corresponding tube using well-qualified out-of-cell welding parameters. The welding parameters for both out-of-cell and in-cell welding were established by performing up to five qualification welds which were then subjected to nondestructive (visual, helium leak test, and radiography) and destructive (metallography) examinations to ensure the integrity of the welds.

After welding the bottom end plugs, the tubes were individually cleaned with acetone, dried, and helium leak tested (Ref: BCD Procedure HL-PP-80.1, Rev. 1). No leaks were found and the tubes were approved for fuel loading. Table 2 lists the number, size, and identification numbers of the fuel encapsulation tubes.

TABLE 2. IDENTIFICATION OF THE FUEL ENCAPSULATION TUBES

Tube OD (cm)	Number of Tubes	ID Numbers
1.27	12	L5, L8, L9, M1 to M9
1.429	40	G3 to G9; H1 to H9; J1 to J9; K1 to K9; L1 to L6
1.588	20	E1 to E9; F1 to F9; G1, G2
1.905	36	A1 to A9; B1 to B9; C1 to C9; D1 to D9

2.4 Encapsulation Tube Fuel Loading

As noted before, the spent fuel was in two physical forms, bare and clad, each of which required a different loading procedure (Ref: Procedure HL-PP-76.9, Rev. 1).

2.4.1 Bare Fuel

All of the bare fuel was loaded in 1.905 and 1.588 cm tubes by placing a tube in the vertical position in the HEC. Bare fuel from an identified storage canister was removed and weighed. Using a wide funnel attached to the top end of the tube, it was filled with bare fuel to a height of 378.46 cm from the bottom end. The fuel remaining in the canister was weighed to obtain the net weight of fuel contained in that tube. This procedure was repeated until all of the bare fuel was encapsulated. The tubes were placed in storage for subsequent top end plug welding.

2.4.2 Clad Fuel Sections

From the fuel inventory records, it was determined that the clad fuel sections had to be encapsulated in all four tube sizes. Each section was uniquely identified, making it possible to track its physical location in the tubes. Loading was performed by placing an appropriate size tube in a horizontal position in the HEC. Sections from one fuel rod were identified and inserted one at a time in the tube until the tube was filled to a length of 378.46 cm. The tube was closed at the top end and transferred to a storage location for welding. These steps were repeated for all remaining fuel rods.

Table 3 lists the physical form and reactor source of the fuel encapsulation tubes. A total of 106 tubes were required to encapsulate all of the spent fuel.

TABLE 3. PHYSICAL FORM AND SOURCE OF FUEL IN THE ENCAPSULATION TUBES

Tube ID	Source of Fuel*	Physical Form
A1 to A4	Oconee	Bare Fuel
A5, A7	Oconee, HBR	Bare Fuel
A6	HBR	Bare Fuel
A8	Oconee, TP	Bare Fuel
A9, F9	TP	Bare Fuel
B1	TP, SP, OC, CY, HBR	Bare Fuel
B2	CY, HBR, CEMY	Bare Fuel
B3	CEMY, Zion	Bare Fuel
B4	CEMY	Bare Fuel
B5	CEMY, Brunswick	Bare Fuel
B6 to B9 C1 to C4 D1 to D4 E7 and E8	OC	Clad Fuel
C5 to C8	Brunswick	Bare Fuel
C9	Surry, Brunswick, TP, OC, CY, CEMY, HBR, Zion	Bare Fuel
D5 to D8	Quad Cities	Clad Fuel
D9	Quad Cities, SP, TP, CEMY, CC, HBR, CY, Zion	Clad Fuel
E1 to E6, E9 E1 to F4	Monticello	Clad Fuel
F5	Monticello, Oconee, TP	Clad Fuel
F6	HBR, TP, Quad Cities	Clad Fuel
F7, F8	TP, SP, HBR, Zion	Bare Fuel

TABLE 3. (Continued)

Tube ID	Source of Fuel*	Physical Form
G2	Zion, Surry, OC	Clad Fuel
G3 to G5	TP, Oconee	Clad Fuel
G6, G7	CY, HBR	Clad Fuel
G8, G9	CEMY	Clad Fuel
H1, L6	CEMY, TP	Clad Fuel
H2 to H6	Zion, HBR	Clad Fuel
H7	TP, HBR	Clad Fuel
H8 and H9 J2 and J3 K8 and K9 L1 to L3	TP	Clad Fuel
J1	CC	Clad Fuel
J4	TP, Zion	Clad Fuel
J5 to J7, J9 K1 to K6	Zion	Clad Fuel
J8	Zion, Ginna	Clad Fuel
K7	Zion, SP, TP	Clad Fuel
L5	WEPCO	Clad Fuel
L7 to L9 M1 to M8	Surry	Clad Fuel
M9	Surry, TP	Clad Fuel

* HBR = H. B. Robinson; TP = Turkey Point; SP = Shippingport; OC = Oyster Creek; CY = Connecticut Yankee; CEMY = Maine Yankee; CC = Calvert Cliffs.

2.5 Encapsulation Tube Welding and Leak Testing

The top end plugs were welded in the HEC to seal each of the fuel encapsulation tubes. The proprietary technique for in-cell welding of end plugs on tubes was developed at Battelle. A detailed procedure HL-PP-80.3, Rev. 2 was used for welding the top end plugs on each of the tubes. Each welded tube was subsequently helium leak tested in accordance with procedure HL-PP-80.2, Rev. 1 and no leaks were found. The tubes were stored in the HEC until ready for insertion in the LFRSB.

3. DESIGN, FABRICATION, AND LOADING OF THE LOOSE FUEL ROD SHIPPING BASKET (LFRSB)

This task included design and fabrication of the LFRSB to hold the encapsulated rod sections. The basket was transferred to the HEC and the encapsulated rods and rod sections were loaded into the basket. The top nozzle was installed and the loaded basket was transferred to the Battelle storage pool for loading in the shipping cask.

3.1 LFRSB Design

The LFRSB design was based on several major considerations.

- o The basket will accommodate 108 tubes of the four different sizes given in Table 2.
- o The basket will have the same envelope dimensions as a standard 15 x 15 Westinghouse PWR fuel assembly (21.59 cm (8.5 in.) square and 408.94 cm (161 in.) long) with a top end fitting that is compatible with the TAN 607 Hot Shop Westinghouse fuel assembly grapple. In addition, the basket top nozzle will have an identification number stamped on one corner and visible from above in a vertical storage position in a storage pool. The identification number will be used for orientation of the basket to permit

identification of individual encapsulation tube positions located on a basket loading diagram.

- o The basket will be designed to drain water and permit easy drying of the inner spaces.

Following these considerations, the LFRSB was designed as a square truss assembly within which were welded five spacer plates each containing 108 holes located symmetrically over the spacer plates. A solid plate in the bottom nozzle with water drain holes prevented the tubes from falling through the bottom of the LFRSB in the vertical position. Similarly, a solid plate in the top nozzle prevented the tubes from sliding out the top of the LFRSB during handling and transport. The top nozzle attachment to the main truss consisted of four corner bolts, while the bottom end fitting was welded to the truss assembly. Detailed design drawings of each component of the LFRSB were prepared (Ref: Drawings BCD-WJ-0002 to BCD-WJ-0005) and were provided for review and approval to EG&G together with a stress analysis of the basket design.

3.2 LFRSB Fabrication and Inspection

The above drawings were used for fabrication of the LFRSB. All components were fabricated from certified Type 304 SS plate, sheet, or bar stock. The spacer plates were drilled in a computer-controlled machine and trimmed to size. The four sides of the truss assembly were cut by a wire EDM method and also trimmed to size. The bottom nozzle was fabricated from sheet material and all of the sections were welded together. Welds were made every 76 cm along the length of the basket. Throughout the fabrication and welding operations, the components were clamped together in a holding fixture to prevent excessive buckling and distortion.

The top nozzle was machined to size and the four attaching bolts were fabricated. The whole basket was then assembled on the shop floor for final inspection. The inspection consisted of:

- o Basket length and cross-section measurements
- o Squareness and flatness measurements of the LFRSB

- o Visual examination of the welds
- o Dye penetrant examination of the welds.

The results of the inspection showed that all basket dimensions were within the specified tolerances, including those for flatness and squareness. Also, all of the welds were sound.

The as-fabricated basket was subjected to a proof load test prior to insertion in the HEC for tube loading. The LFRSB was proof loaded to 1.54 times its loaded weight (proof load = 1057.8 kg; weight of fully loaded basket = 688.5 kg). The load was applied for 40 minutes while the basket was suspended from a calibrated scale. Following the proof loading the welds were examined with a dye penetrant and no flaws were observed. The basket was approved for tube loading and shipment.

3.3 LFRSB Loading

The LFRSB was transferred into the HEC in preparation for tube loading in accordance with procedure HL-PP-76.6, Rev. 0. In the HEC, the top nozzle was removed and the basket was placed in a horizontal position for loading. Starting with one corner hole, appropriately-sized tubes were inserted one at a time into the basket until all grid positions had been filled. The position of each tube was marked in a basket loading diagram as the tube was inserted in the basket. After all 106 fuel tubes had been inserted in the basket, the two empty remaining positions were filled with Type 304 SS rods. The top nozzle was attached and the bolts were torqued down. The basket was given a final visual inspection and then transferred to the storage pool until ready for loading in the shipping cask. Figure 1 shows the LFRSB loading diagram.

FIGURE 1. LFRSB FUEL TUBE LOADING DIAGRAM

4. FINAL PREPARATION OF FUEL ASSEMBLY B17 FOR SHIPMENT

Fuel assembly B17 was transferred into the HEC for final preparation prior to shipment. Ten intact whole rods from Turkey Point Fuel Assemblies B17 and D04 were returned to empty positions in the assembly. The remaining eleven positions from which fuel rods had been removed for destructive examination were filled with stainless steel solid rods. An appropriately sized modified cover plate (Ref: Drawing BCD-WJ-0015, Rev. 0) was attached to the top nozzle of the assembly to close the holes drilled previously in the nozzle for removal of fuel rods. The size of the cover plate was such that it would not interfere with the operation of the TAN 607 Hot Shop Westinghouse fuel assembly grapple.

The assembly was subjected to a final inspection and transferred to the storage pool for loading in the shipping cask. All operations for preparation of assembly B17 were performed according to procedure HL-PP-76.8, Rev. 0.

5. FINAL PREPARATION OF FUEL ASSEMBLY S004 FOR SHIPMENT

Fuel assembly S004 was also transferred into the HEC for final preparation prior to shipment. Since four rods from the S004 assembly that were destructively examined were encapsulated, the original positions occupied by these rods in the assembly were filled with solid stainless steel rods. The existing top nozzle was attached to the assembly according to the following procedure. The guide tubes were cut just above the welded end plugs located in the bottom of the guide tubes. Since the plugs have a bayonet extension which is welded to the bottom nozzle, cutting released the entire bottom nozzle from the fuel assembly, leaving the guide tubes open. A new bottom end fitting, adapted to meet INEL fuel configuration requirements, was designed and fabricated from Type 304 SS according to approved drawing BCD-WJ-0010, Rev. 0. Since assembly S004 is approximately 58 cm shorter than a standard Westinghouse 15 x 15 PWR fuel assembly, the new bottom end fitting was made to increase the overall length of S004 to compare with the length of

assembly 817. Stainless steel nuts were welded in a symmetrical pattern on the outside of the new bottom end fitting to accept the eight full-length attaching bolts. The number and pattern of the attaching bolts were determined on the basis of a detailed stress analysis of the design of the assembly modifications.

The new bottom end fitting and the existing top nozzle were attached to the assembly by means of the eight full-length bolts which pass through the guide tubes and are screwed into the nuts. The bolts were torqued down, the assembly was subjected to a final inspection and then transferred to the storage pool for loading in the shipping cask. All hot cell operations for preparation of assembly S004 were carried out in accordance with procedure HL-PP-76.7, Rev. 0.

6. LOADING OF THE 3-ASSEMBLY SHIPPING CASK

EG&G provided a Transnuclear (TN), NRC-licensed TN-8L shipping cask for shipment of the two fuel assemblies and the LFRSB. All standard cask ancillary handling and operating equipment was also provided at the Battelle Hot Cell Facility by TN. Since the TN-8L cask had not been handled previously at Battelle, TN performed a presite survey to determine the needs and requirements of the facility for TN-8L cask operations.

The cask arrived at Battelle on October 20, 1987, two working days prior to the actual fuel loading date (October 22, 1987), so that a dry run and hands-on training could be performed by Battelle operations personnel. TN provided technical assistance for training, dry run, and loading. Based on the dry run and training, the standard TN cask handling procedure was modified and adapted to meet Battelle Hot Cell Facility requirements. A stepwise cask handling and loading procedure, HL-OP-48.6, Rev. 0, was prepared by Battelle and approved for use by TN. Following the dry run and operational training, the two fuel assemblies and the LFRSB were loaded into the TN-8L shipping cask in accordance with the operating procedure (Ref: Procedure HL-OP-48.6, Rev. 0). The cask was then prepared for final shipment and it left Battelle for EG&G Idaho on October 26, 1987.

7. QUALITY ASSURANCE

The present project was performed in accordance with established Battelle quality assurance systems to be implemented in nuclear-related programs. Quality assurance at Battelle is a planning, control, surveillance, and documentation program to assure that all work is conducted following the basic principles of scientific investigation. The basic document in establishing quality assurance system is the Battelle Nuclear Technology Quality Assurance Manual BCL-QA-HL-1. The manual is designed to be responsive to quality assurance requirements of Title 10 CFR, Part 50, Appendix B, Title 10 CFR, Part 71, Subpart H, and ANSI/ASME NQA-1.

Implementation of the quality assurance requirements include preparation of a quality assurance plan and the use of technical and quality assurance authorized procedures and data sheets to document all generated data, compliance with the procedures, and conformity to requirements of applicable specifications. A system of technical overchecks and independent quality assurance surveillance assures compliance with the procedures and the overall quality assurance program. All personnel are trained and certified in compliance with ANSI N45.2.6 as being technically qualified for the task being undertaken and are aware of the quality assurance requirements.

As specified in the manual, quality assurance controls are also maintained on other phases of the program, including shipping, receiving, procurement, storage, materials, and documents.

Upon completion of the program, the Battelle and EG&G Quality Assurance Managers verified that all requirements of quality assurance and applicable specifications had been met.

The following approved procedures and drawings were employed to meet the specific quality assurance requirements of this program. Copies of each of these documents together with the manual were provided to EG&G.

7.1 Program Plan

QAP No. 22, Rev. 1, Quality Assurance Program Planning for Packaging of Spent Fuel for Shipment Off-site.

7.2 Procedures

1. HL-OP-41, Rev. 0, Movement of Storage Pool Protective Lid
2. HL-OP-42, Rev. 1, Movement of Casks in Storage Pool
3. HL-OP-45, Rev. 1, Storage and Handling of Special Nuclear Materials in the Storage Pool
4. HL-OP-46, Rev. 0, Operation of Pool-HEC Transfer Basket
5. HL-OP-47, Rev. 0, Storage and Handling of Special Nuclear Materials in the Hot Cell
6. HL-OP-48.6, Rev. 0, Operational Procedure and Documentation Traveler for Receipt of an Empty TN-8L Shipping Cask and Loading of Fuel Assemblies for Shipment
7. HL-PP-76.6, Rev. 0, Procedure for Loading and Assembly of Loose Fuel Rod Shipping Basket
8. HL-PP-76.7, Rev. 0, Preparation of Fuel Assembly S004 for Shipment
9. HL-PP-76.8, Rev. 0, Preparation of Fuel Assembly B17 for Shipment
10. HL-PP-76.9, Rev. 1, Procedure for Loading of Fuel Rods, Fuel Rod Sections, and Bare Fuel Into Encapsulation Tubes, and Weld Sealing of the Encapsulated Tubes
11. HL-PP-80.2, Rev. 1, Fuel Rod Seal Weld Leak Testing
12. HL-PP-80.3, Rev. 2, Welding of End Plugs on Encapsulation Tubes for Storage of Fuel Rod Sections

7.3 Drawings

1. BCD-WJ-0001, Rev. 1, Stainless Steel Encapsulation Tube with End Plugs
2. BCD-WJ-0002, Rev. 0, Top Nozzle, Loose Fuel Rod Shipping Basket
3. BCD-WJ-0003, Rev. 0, Bottom Nozzle, Loose Fuel Rod Shipping Basket
4. BCD-WJ-0004, Rev. 0, Truss Assembly, Loose Fuel Rod Shipping Basket

5. BCD-WJ-0005, Rev. 0, Loose Fuel Rod Shipping Basket
6. BCD-WJ-0010, Rev. 0, Reconstitution of Fuel Assembly S004
7. BCD-WJ-0015, Rev. 0, Modification to Plug 000-515-004 for Fuel Assembly B17

8. PROJECT DOCUMENTATION

The following documentation was obtained during the performance of the project and was also provided to EG&G.

1. Copies of all applicable quality assurance procedures and as-built drawings of all fabricated components.
2. Records of all data generated such as tube weld qualification, material specifications, stress analysis, load test, helium leak test, and fuel accountability information.
3. Videographic record of the hot cell operations and cask loading activities.
4. Monthly technical progress reports and cost summaries.
5. Final report summarizing the highlights of the project activities.

9. ACCOUNTABILITY AND FISSILE MATERIAL QUANTITIES

The fissile material inventory in each encapsulation tube was calculated to satisfy the requirements of DOE Form 741, Nuclear Material Transaction Report. Since the net weight of the bare fuel or the total length of the rod sections in each tube was known, it was possible to accurately calculate the fissile material quantities in the tubes from the isotopic data in the accountability records. The calculations were performed according to procedure HL-PP-76.9, Rev. 1 and individual data sheets were completed for each tube.

Title to all of the non-DOE spent fuel at Battelle was transferred to the Department of Energy prior to shipment. This was authorized by DOE for

fuel from the Nuclear Regulatory Commission (NRC) research programs (Oconee, H. B. Robinson and Maine Yankee), Electric Power Research Institute (EPRI) fuel examinations (Quad Cities, Brunswick, and Calvert Cliffs), and the Rochester Gas and Electric Company rod consolidation program (R. E. Ginna), since the prorated incremental costs for disposal of this fuel with the remaining DOE fuel at Battelle were obtained from the cognizant organizations.

As noted earlier, a small amount of fuel was present in unrecoverable form in the hot cells and was not included in the shipment from Battelle. Since title to all of the fuel was transferred to DOE, this fuel still remaining at the hot cell will be disposed of as waste material. Table 4 lists the date of title transfer, the project number assigned to the spent fuel, and the fuel inventory shipped to INEL and the inventory still remaining at Battelle.

TABLE 4. SUMMARY OF FUEL SHIPMENT DATA

Reactor	Date of Title Transfer	Project Number	Fuel Quantity (gms)*	
			Shipped to INEL	Remaining at Battelle
Turkey Point B17	5/1/78	HDC300303F	431,084	59
Turkey Point D01	7/9/79	HDC300303F	10,978	22
Turkey Point D04	9/7/79	HDC300303F	14,831	169
Shippingport	6/13/80	DDC1013030	1,985	15
Connecticut Yankee	5/9/80	DDC1013030	388,079	8
Oyster Creek	6/82	HDC10000CF	49,263	47
Monticello	8/27/81	CAF201000C	16,000	--
	5/6/83	CGB0103000	17,000	--
Surry	4/21/83	CGB0103000	19,976	24
Zion	10/26/87	JDC1012010	35,086	52
		CAF101000H		
Brunswick	10/26/87	JDC1012010	20,562	--
Quad Cities	10/26/87	JDC1012010	15,000	--
Calvert Cliffs	10/26/87	JDC1012010	1,914	328
H. B. Robinson	4/18/77	J401001006	18,239	3341
Oconee (Cycles II, III)	3/21/78	JDC1012010	21,937	--
	6/21/79	JDC1012010	9,000	--
Maine Yankee	6/24/76	JDC1012010	21,070	--
WEPCO	10/25/86	JGD0500000	2,165	--
Ginna	10/26/87	JDC1012010	1,815	--

* Weights rounded off to nearest whole gram.