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Characterization of LWR Spent Fuel MCC-Approved Testing Material—ATM-101

June 1984

Prepared for the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
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CHARACTERIZATION OF LWR SPENT FUEL MCC-APPROVED TESTING MATERIAL - ATM-101

J. O. Barner

June 1984

Prepared for
the U.S. Department of Energy
under Contract DE-AC06-76RLO 1830

Pacific Northwest Laboratory
Richland, Washington 99352

NOTICE

This report is intended to be a "living document" with additional characterization data being included in subsequent revisions as the data becomes available. This planned recurrent publication will permit the maximum usage of the characterization data by the users of Spent Fuel ATM-101.

ABSTRACT

The characterization data, obtained to date, for Materials Characterization Center (MCC) Approved Testing Material (ATM)-101, spent fuel from H. B. Robinson, Unit 2, Assembly BO-5, are described. ATM-101 consists of 27 equal-length segments from nine fuel rods. Characterizations provided for ATM-101 include, 1) reactor, assembly, and fuel rod descriptions, 2) Assembly BO-5 irradiation history, 3) a description of unusual incidents that occurred to the rods, 4) fission gas release measurements, 5) results of ceramography/metallography examinations, 6) fuel burnup measurement results and correlations, 7) results of gamma scanning, 8) calculated values of the radionuclide inventory, and 9) results of a radionuclide chemical overcheck. Calculations for and measurement of radial distributions of selected radionuclides are planned. A description of pertinent results from other studies on sibling rods from Assembly BO-5 is also included. The distribution of ATM-101 to date is described along with characterization results on specially processed material.

It is intended that this report be revised and updated as additional characterization data become available.

SUMMARY

This report describes the characterization plan, methods, and results for light water reactor (LWR) Materials Characterization Center (MCC) spent fuel Approved Testing Material (ATM)-101. ATM-101 is spent fuel from the H. B. Robinson, Unit 2, Assembly B0-5, a moderate-burnup, pressurized water reactor (PWR) fuel that released very small quantities of fission products and fission gas from the fuel during commercial operation.

The characterization plan for the ATM-101 is described in Section 3.0 and includes discussions/sampling for 1) fuel rod, assembly and reactor descriptions, 2) irradiation and decay histories, 3) unusual incident description, 4) fission gas release, 5) transverse and longitudinal ceramography/metallography, 6) burnup distribution, 7) gross and spectral axial gamma scanning, 8) calculations of the axial radionuclide distribution, and 9) chemical overchecks of the axial radionuclide distributions. Calculation of the radial radionuclide distributions and measurement of radial radionuclide distributions are also planned.

Characterization data that are available to date for items 1 through 9 are presented in this original version of the characterization report. In addition, descriptions of the preparation and characterization of some special ATM-101 materials are discussed. Additional data for all categories of the characterization data will be published in subsequent versions of this report.

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1.0 CONCLUSIONS

As a result of the characterization completed to date, the following conclusions are made:

1. ATM-101 is a moderate-burnup, low-releasing (fission products in-reactor), originally solid-pellet, UO_2 fuel material that falls into the class of "typical" spent fuel that may be deposited in a repository (Barner, 1984).

2. The premise appears to be confirmed that a correlation between limited burnup sampling and axial gamma-scanning distribution data for ^{137}Cs can be used to predict the burnup and, therefore, the radionuclide inventory (source term) in sibling, low-releasing ATM-101 material.

2.0 INTRODUCTION

The Materials Characterization Center (MCC) has the responsibility to provide spent fuel Approved Testing Materials (ATMs) for use in the investigation of nuclear waste disposal forms. The first lot of spent fuel, ATM-101, for use as an ATM has been obtained after discharge from the H. B. Robinson pressurized water reactor. This material is a moderate burnup fuel, approximately 30 MWd/kgM, that had only minor fission gas release from the UO_2 during operation. This report describes the initial characterization results for ATM-101. These results are expected to be beneficial to experimenters that will utilize the material for ascertaining the release behavior of the entrained radionuclides. The characterization plan (Section 3.0) was developed based upon the general MCC plan for characterization of spent fuel ATMs described by Barner (1984). The results of the characterization are presented in Section 4.0. Because not all the ATM-101 fuel rods have been sampled for characterization, and because of budgetary/schedule considerations, the characterization results that are presented in this original document are incomplete. Section 5.0 describes the distribution of ATM-101 specimens as of the date of publication of this report. Additional characterization results and ATM distributions are anticipated in the near future, and will be described in future issues of this report.

ATM-101 consists of 27 fuel rod segments of approximately equal length from nine H. B. Robinson, Unit 2, fuel rods from Assembly BO-5. The cutting of the fuel rods into segments was required to transport them expeditiously from the Test Area North (TAN) hot cell at the Idaho Nuclear Engineering Laboratory (INEL) to the PNL hot cells at Hanford. The exposure of the segments to air was minimized by sealing the segments with plastic caps during transport and by subsequent storage of individual segments in a limited-volume, air-atmosphere, sealed tube after arrival at PNL.

3.0 CHARACTERIZATION PLAN FOR ATM-101

The logic for and an example of a generic characterization plan for MCC spent fuel ATMs was described by Barner (1984). The actual plan for characterization of ATM-101 is based on this generic plan and consists of measurements or descriptions in the following areas:

- Descriptions of the fuel rods, the assembly of rods, and the reactor (Section 4.1).
- A description of the irradiation and decay histories of the fuel assembly (Section 4.2).
- A description of unusual incidents to the fuel assembly subsequent to discharge from the reactor (Section 4.3).
- Measurement of the fission gas release from each fuel rod (Section 4.4).
- Light microscope examination of transverse and longitudinal samples to ascertain the degree of fuel cracking, fuel microstructure characteristics, and cladding oxidation (Section 4.5).
- Measurement of the fuel burnup distribution (Section 4.6).
- Measurement of the axial distribution of the gross gamma activity and the activities of individual radionuclides in the fuel rods (Section 4.7).
- Calculation of the radionuclide inventory in the fuel as a function of burnup and the decay period (Section 4.8).
- Chemical determination of the inventory of several radionuclides to spot-check the calculated radionuclide inventory (Section 4.9).
- Calculation of the radial distribution of the radionuclide inventory in the fuel as a function of burnup and the decay period.
- Measurement of radial distribution of the radionuclides within the fuel as an overcheck of the calculation of the radial distributions.

The last two characterization items have not yet been conducted. Results for these items will be published as they become available.

The detailed characterization plan and sampling matrix for the nine fuel rods that comprise ATM-101 are listed in Table 3.1. Fuel rod N-9 was used to obtain several ceramography/metallography, burnup, and chemical samples. The locations of these groups of samples were selected to cover the wide range in burnup levels present in any of the fuel rods. The selected burnup analyses and the gamma scan results from each individual rod can be combined to assign the burnup and a resultant radionuclide inventory for any ATM specimen that will be provided from the lot of fuel rods.

In addition to the characterizations planned for the ATM-101 material, special characterizations were conducted on some processed specimens distributed to experimenters. The results from these special characterizations are described in the appropriate subsection of Section 5.0 of this report that describes the distribution of ATM-101 specimens, e.g., results from the special examination of crushed ATM-101 material for the Basalt Waste Isolation Project (BWIP) are described in Section 5.1.

Five to ten percent of the ATM-101 spent fuel will be retained by the MCC as archive material for future use.

TABLE 3.1. Characterization Plan and Sampling Matrix for ATM-101[a]

Fuel Rod	Historical Records[b]	Fission Gas Release[c]	Ceramography-Metallography		Burnup	Gamma Scan[d]	Inventory Calculation	Analytical Spot-check Inventory[e]	Radial Distribution Calculation	Analytical Spot-check Radial Distribution
			Transverse	Longitudinal						
C-5	X	X	1	-	1	X	X	-	X	-
D-10	X	X	1	-	-	X	X	-	X	-
G-9	X	X	1	-	-	X	X	-	X	-
G-13	X	X	1	-	-	X	X	-	X	-
J-12	X	X	1	-	-	X	X	-	X	-
L-8	X	X	1	-	-	X	X	-	X	-
N-4	X	X	1	-	-	X	X	-	X	-
N-9	X	X	5	5	5	X	X	5	X	1
N-12	X	X	1	-	-	X	X	-	X	-

(a) X denotes description/measurement will be made.
- denotes measurement will not be made.
numerical value indicates number of samples from the individual fuel rod.
(b) Includes descriptions of fuel, irradiation history and any unusual incidents.
(c) Includes gas composition, gas pressure and volume.
(d) Includes gross, ^{137}Cs, ^{134}Cs and ^{154}Eu axial gamma scans.
(e) Includes analyses for ^{235}U, ^{249}Pu, ^{237}Np, ^{99}Tc, ^{137}Cs, and ^{14}C.

4.0 CHARACTERIZATION OF ATM-101

This section describes the characterization results obtained to date for ATM-101. Historical information is described in Sections 4.1, 4.2, and 4.3, fission gas release results in Section 4.4, ceramography/metallography results in Section 4.5, burnup results in Section 4.6, gamma scanning results in Section 4.7, calculated radionuclide inventories in Section 4.8, and results of the radionuclide chemical overchecks in Section 4.9. The bulk of the historical information was taken from the summary provided by Einziger and Fish (1982). Other pertinent information for rods from Assembly BO-5, taken from this reference, are described in Section 4.10.

Locations of individual samples from sectioned ATM-101 rods are given in Appendix B.

4.1 REACTOR, ASSEMBLY AND FUEL ROD DESCRIPTIONS

The ATM-101 fuel was irradiated in the H. B. Robinson, Unit 2, reactor, which is a three-loop, 665 MWe (2192 MWt), pressurized water reactor (PWR) located in Hartsville, S. C. and is operated by Carolina Power and Light Company. The core consists of 157 fuel assemblies of the 15 x 15 design that were designed and fabricated by Westinghouse Company. The core has three enrichment zones (Figure 4.1). The ATM-101 fuel was originally 2.55 wt% enriched in ^{235}U. Each assembly contains 204 fuel rods, 20 control rods, and one possible in-core instrumentation tube as shown in Figure 4.2. The rod separation is maintained along the length of the assembly by seven grids, five of which are wholly within the fueled length. The ATM-101 fuel was irradiated in Assembly BO-5 during the first two operating cycles of the H. B. Robinson, Unit 2, the first cycle in position F9 and the second cycle in position M11 (Figure 4.1).

Each fuel rod in the assembly consisted of a column of dished cylindrical urania fuel pellets stacked within a sealed Zircaloy-4 cladding tube. The fuel rods were pressurized with helium during fabrication. Although the initial pressurization level is proprietary, gas analysis after irradiation indicates the original pressurization level was approximately 1.8 MPa (260 psia). It was

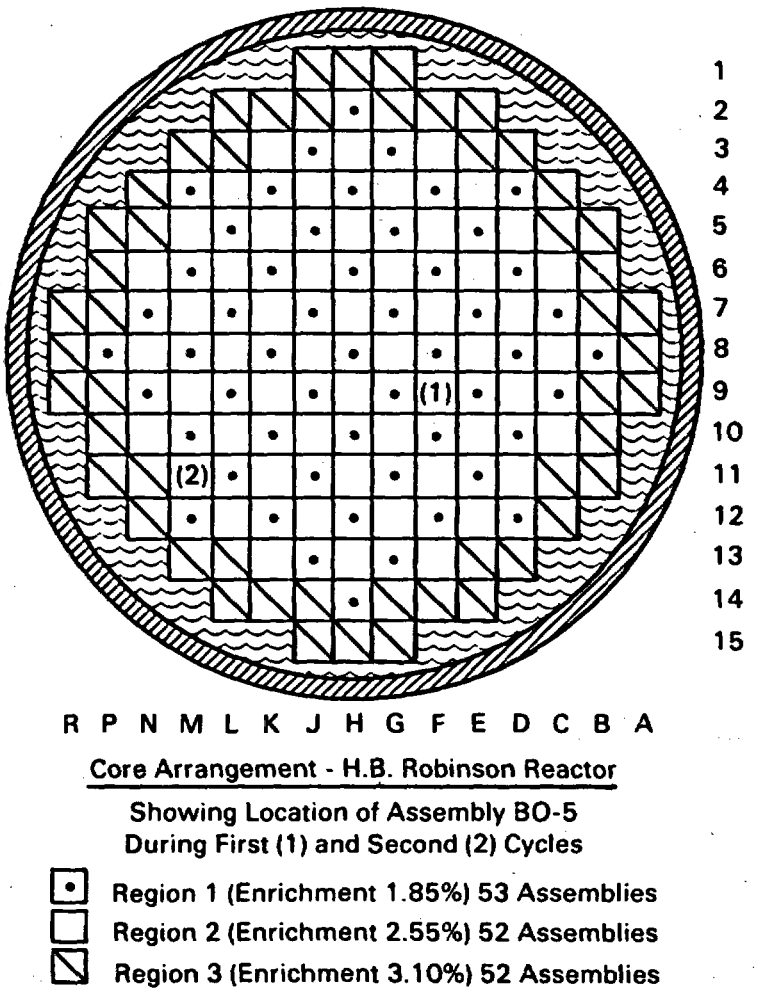


FIGURE 4.1. Core Arrangement of H. B. Robinson Unit 2 Reactor

also reported that there were indications that the rods might have been pressurized without completely purging the internal air. However, review of the published data and the gas analyses reported in Section 4.4 for ATM-101 indicates the nitrogen content of the gas is only 1% of that that would be expected for an originally air-filled rod. As-built characteristics of the fuel rods are given in Table 4.1. The location of the ATM-101 fuel rods in Assembly BO-5 are shown in Figure 4.2.

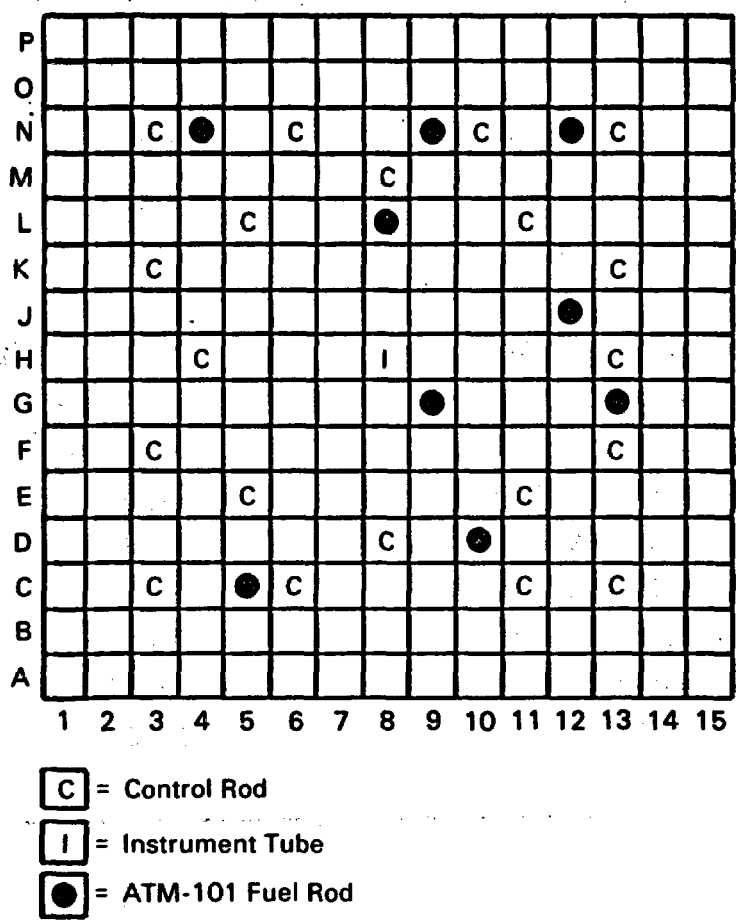


FIGURE 4.2. Layout of H. B. Robinson Assembly BO-5

4.2 ASSEMBLY BO-5 IRRADIATION HISTORY

The Assembly BO-5 irradiation commenced with the initial operation of H. B. Robinson, Unit 2, reactor in March 1971. The Assembly BO-5 irradiation was completed after two reactor cycles and the assembly discharged on May 6, 1974. The irradiation accumulated a total of 799 effective full power days (EFPD). The power history is illustrated in Figure 4.3 and tabulated in Appendix A. The peak linear heat generation rate (LHGR), of 32.7 kW/m (10.0 kW/ft), occurred in December 1971 shortly after the irradiation began. At the end of the irradiation, the LHGR had dropped to 21.2 kW/m (6.5 kW/ft). The estimated peak-pellet and assembly-average burnups were 31.36 and 28.03 MWd/kgM, respectively.

TABLE 4.1. As-Fabricated Fuel Rod Characteristics for ATM-101

Cladding O.D., mm	10.70
Cladding I. D., mm	9.46
Cladding wall thickness, mm	0.62
Diametral gap, mm	0.165
Cladding material	Zircaloy-4
Fuel rod length, m	3.86
Fuel pellet material	Sintered UO_2
Pellet type	Solid, dished
Fuel density, g/cm^2 (% T.D.)	10.08 (92)
^{235}U enrichment, wt%	2.55
Pellet diameter, mm	9.30
Pellet length, mm	15.2
Fuel stack height, m	3.65
Plenum length, mm	173.5
End cap length, mm	17.5

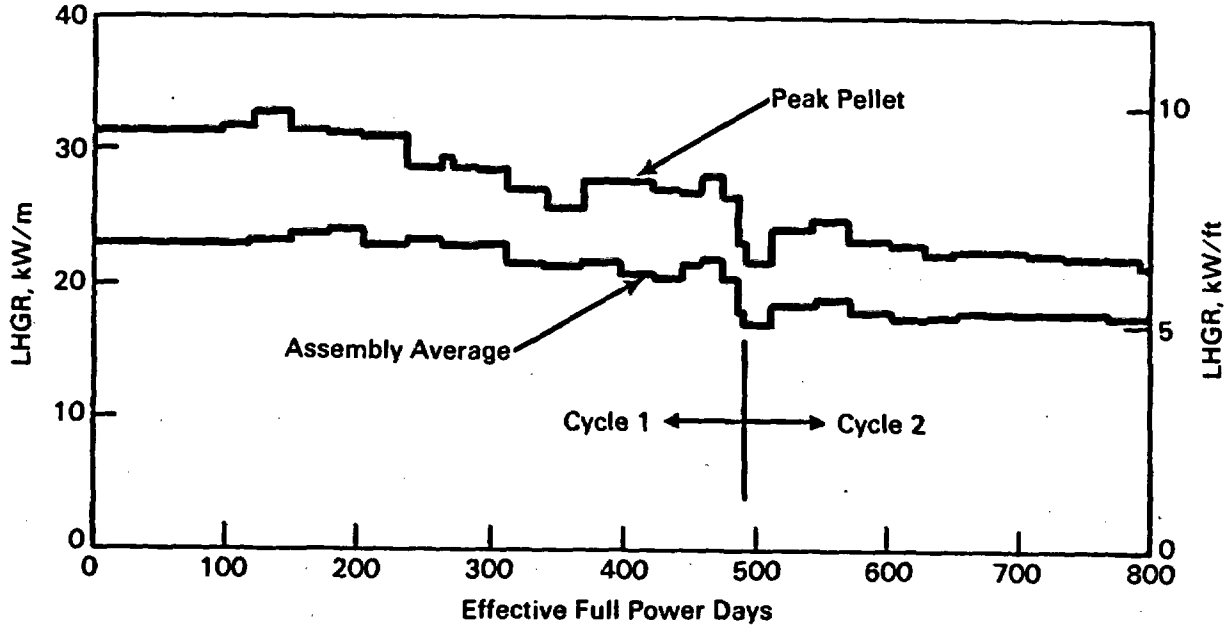


FIGURE 4.3. Power History for Assembly BO-5

4.3 DESCRIPTION OF UNUSUAL INCIDENTS

During the transport of Assembly BO-5 from the reactor to the TAN hot cell and the subsequent unloading of the transport cask, a series of events took place that caused the temperature of portions of the assembly to exceed the boiling point of water. During initial transport of the assembly in a horizontal position from the H. B. Robinson, Unit 2, site to the TAN hot cell, a portion of the assembly was uncovered for about one week. This happened because an air space was permitted in the cask in order to allow for thermal expansion of the cooling water. When the cask arrived at the hot cell, it was placed in a vertical attitude where the assembly was also partially uncovered for about six hours. After removal of the assembly from the cask, it was held vertically in the air for approximately two hours before it was placed in a storage pool. When it was placed in the pool, large amounts of steam formed. Later the assembly was held in a horizontal position for seven hours during rod removal, but no steam formed when the assembly was placed back in the pool. Calculations indicate that cladding temperatures could have been as high as 466°C during the vertical hold in air and 343°C during the horizontal shipment. However, microhardness measurements made on the cladding did not reveal any significant recovery of irradiation-induced hardening, indicating that the cladding temperature was less than 350°C during the handling in the vertical attitude and less than 300°C during the horizontal holding period. Further, subsequent temperature measurements made to estimate the fuel temperatures in the horizontal and vertical attitudes indicated that the cladding surface temperature was less than 150°C for both cases. It was, therefore, concluded that none of the assembly temperature excursions was long enough or high enough to significantly change the condition of the fuel rods in Assembly BO-5.

During repacking of the fuel segments in the PNL hot cells, segment G-9C was damaged by bending while sealed in its storage tube. This segment has been set aside and will only be used as a source of ATM material if the nondamaged portions can be removed from the storage tube in a manner that assures that the material is adequate for any intended use.

4.4 FISSION GAS RELEASE MEASUREMENTS

Fission gas release measurements were previously made on thirteen fuel rods from Assembly BO-5 (Einziger and Fish, 1982). For the ATM-101 rods the measured internal rod void volume, total volume of gas recovered, internal rod pressure, and gas analyses are listed in Table 4.2. Table 4.3 provides the individual isotopic analyses for the fission gases. Table 4.4 lists the items used in the fission gas release calculation and the fission gas release value for each rod. The average fission gas release from the thirteen sibling rods was 0.21% with a standard deviation of 0.05%. Results for the nine rods comprising ATM-101 are apparently similar (Table 4.4). The generated fission gas was calculated using a value of 31.0 cm^3 of generated fission gas per MWd at standard temperature and pressure and the rod average burnup for each rod. The procedures for gas sampling, void volume measurement, gas analysis and methods of determining uncertainties are described in Appendix C.

The rod-average burnup values were taken from Section 4.6 of this report. For the case where the gamma scanning has not been completed as of the issuance of this report, burnup for the rod in question was assumed to be the same as for rod N-9 and the preliminary fission gas release value for the rod is shown in brackets in Table 4.4.

4.5 CERAMOGRAPHIC/METALLOGRAPHIC EXAMINATIONS

Ceramography was conducted on fuel samples, primarily from fuel rod N-9, in order to determine the degree of pellet fragmentation and changes in microstructure/porosity. The cladding from the same samples was examined to characterize the outer and inner surface oxidation and the hydride orientation. Both transverse and longitudinal cross-sections were sectioned from positions adjacent to burnup/chemistry samples. (See sectioning diagrams in Appendix B).

Photomacrographs of the transverse and longitudinal sections from segments N-9C are shown in Figures 4.4, 4.5, 4.6, and 4.7, respectively. The N-9C-C/F pair of samples is typical of the high-burnup/high-power region of the fuel, while the N-9C-I/K pair of samples is typical of material from the grid spacer region of the high-burnup/high power portion of the rod, i.e., the power in the

TABLE 4.2. Gas Pressure, Gas Composition, and Rod Void Volume for Rods from ATM-101

Rod No.	Measured Void Volume, cm^3	Total Recovered Gas at STP, cm^3	Pressure at 0°C, MPa	He	Xe	Kr	Ar	H_2	CO_2	N_2	O_2	Organics
C-5	23.9 ±1.1	362 ±8.7	1.54 ±0.07	98.3 ±0.2	0.89 ±0.015	0.10 ±0.044	0.61 ±0.01	<0.01 --	<0.01 --	0.06 ±0.004	<0.01 --	<0.01 --
D-10	22.5 ±1.1	369 ±8.9	1.66 ±0.08	98.2 ±0.2	1.03 ±0.08	0.12 ±0.004	0.61 ±0.01	0.02 ±0.008	<0.01 --	0.05 ±0.004	<0.01 --	0.02 --
G-9	22.2 ±1.0	373 ±8.9	1.70 ±0.08	98.9 ±0.2	0.72 ±0.012	0.08 ±0.003	0.30 ±0.005	<0.01 --	<0.01 --	0.04 ±0.004	<0.01 --	<0.01 --
G-13	20.0 ±0.9	357 ±8.6	1.81 ±0.08	97.9 ±0.2	0.98 ±0.017	0.11 ±0.004	0.91 ±0.016	0.02 ±0.008	<0.01 --	0.05 ±0.004	<0.01 --	<0.02 --
J-12	22.8 ±1.1	368 ±8.8	1.63 ±0.08	98.7 ±0.2	0.88 ±0.015	0.10 ±0.004	0.25 ±0.005	<0.01 --	<0.01 --	0.05 ±0.004	<0.01 --	<0.01 --
L-8	22.1 ±1.0	364 ±8.7	1.67 ±0.08	96.7 ±0.02	1.42 ±0.024	0.16 ±0.006	0.76 ±0.013	0.03 ±0.008	<0.01 --	0.74 ±0.13	0.12 ±0.004	0.02 --
N-4	20.1 ±0.9	368 ±8.8	1.85 ±0.09	98.7 ±0.2	0.74 ±0.013	0.08 ±0.003	0.33 ±0.006	0.02 ±0.008	<0.01 --	0.08 ±0.004	<0.01 --	0.02 --
N-9	19.7[a] --	371 ±8.9	1.91[a] --	98.3 ±0.2	0.89 ±0.015	0.10 ±0.004	0.63 ±0.01	<0.01 --	<0.01 --	0.08 ±0.005	0.01 ±-.006	<0.01 --
N-12	12.5[b] --	365 ±8.8	2.96[b] --	98.5 ±0.2	0.85 ±0.015	0.09 ±0.003	0.40 ±0.01	<0.01 -	<0.01 --	0.15 ±0.004	0.03 ±0.005	<0.01 --

(a) Result may be slightly low due to incipient valve failure that was discovered during sampling the next fuel rod; however, result is within two standard deviations of results for first seven rods listed.
(b) Result in error due to faulty valve.

TABLE 4.3. Isotopic Gas Analyses for ATM-101 Rods

Rod No.	Xenon, %						Krypton, %				Xe-Kr Ratio
	I28	I30	I31	I32	I34	I36	83	84	85	86	
C-5	<0.1	0.1	8.3	20.6	28.6	42.4	12.0	31.7	3.8	52.4	8.9
	--	±0.05	±0.3	±0.4	±0.5	±0.7	±0.5	±1.2	±0.7	±1.9	
D-10	<0.1	0.1	8.3	20.5	28.4	42.7	12.1	31.9	3.7	52.5	8.6
	--	±0.005	±0.13	±0.4	±0.5	±0.7	±0.6	±1.2	±0.6	±1.9	
G-9	<0.1	0.1	8.4	20.5	28.2	42.8	12.1	31.9	3.5	52.4	9.0
	--	±0.06	±0.03	±0.4	±0.5	±0.7	±0.8	±1.2	±0.5	±1.9	
G-13	<0.1	0.1	8.2	20.4	28.4	42.8	11.9	31.9	3.8	52.4	8.9
	--	±0.04	±0.3	±0.4	±0.5	±0.7	±0.7	±1.2	±0.5	±1.9	
J-12	<0.1	0.1	8.1	20.6	28.5	42.6	11.6	32.1	3.6	52.7	8.8
	--	±0.05	±0.3	±0.4	±0.5	±.07	±0.4	±1.2	±0.5	±1.9	
L-8	<0.1	0.1	7.7	20.9	28.5	42.8	11.5	32.5	3.6	52.4	8.9
	--	±0.03	±0.3	±0.4	±0.5	±0.7	±0.4	±1.2	±0.5	±1.9	
N-4	<0.1	0.2	8.3	20.7	28.3	42.5	12.2	31.8	3.7	52.3	9.3
	--	±0.08	±0.3	±0.4	±0.5	±0.7	±0.9	±1.2	±0.9	±1.9	
N-9	<0.1	0.1	8.0	20.8	28.2	42.8	12.0	32.2	4.1	51.8	8.9
	--	±0.05	±0.3	±0.4	±0.5	±0.7	±0.7	±1.2	±0.7	±1.9	
N-12	<0.1	0.1	8.5	20.5	28.2	42.6	12.2	31.5	3.9	52.3	9.4
	--	±0.05	±0.03	±0.04	±0.5	±0.7	±0.8	±1.1	±0.8	±1.9	

latter pair was about 12% lower than the former pair. The fuel from both regions is fragmented both transversely (longitudinal sections) and radially (transverse sections). In order to estimate the degree of fragmentation for use in dissolution/leaching experiments on similar fuel specimens the following logic was applied.

- First, the sum of the lengths of the major radially oriented, longitudinal cracks was estimated from the transverse photomacrograph in units of equivalent radii. The assumption was made that all these cracks were parallel to the centerline of the fuel rod. An estimate of the area per unit length of fuel rod of longitudinal crack was made by multiplying the sum of the crack lengths by the fuel pellet radius (4.65 mm), by two for the two new facing surfaces, and by a

TABLE 4.4. Fission Gas Release Results for ATM-101 Rods

Rod No.	Total Recovered Gas at STP, cm^3	Xe + Kr, %	Volume of Xe + Kr at STP, cm^3	Rod-Average Burnup, MWd/kgM[a]	Estimated Fission Gas[a,b] Produced, cm^3	Fission Gas[a] Released, %
C-5	362	0.99	3.58	28.2	1906	0.19
D-10	369	1.15	4.24	[28.4]	[1919]	[0.22]
G-9	373	0.80	2.98	<28.4]	[1919]	[0.16]
G-13	357	1.09	3.89	[28.4]	[1919]	[0.20]
J-12	368	0.99	3.64	[28.4]	[1919]	[0.19]
L-8	364	1.58	5.75	30.0	2027	0.28
N-4	368	0.82	3.02	[28.4]	[1919]	[0.16]
N-9	371	0.99	3.67	28.4	1919	0.19
N-12	365	0.94	3.43	29.4	1987	0.17
Sibling Rods	--	--	--	--	--	0.21

(a) Values shown in brackets are preliminary pending ^{137}Cs gamma scan results. For nonscanned rods the burnup is assumed to be the same as N-9.
(b) Calculated from fuel dimensions and density listed in Table 2, and assuming a fuel volume reduction of 1% for dishes, metal to oxide ratio of 0.88, and 31.0 cm^3 fission gas per MWd.

unit length of one millimeter. This method tends to overestimate the fragment surface area by assuming the cracks run the total length of a pellet, where in fact most do not. However, it tends to underestimate the area by ignoring small cracks and the fact that cracks that are not parallel to the centerline will have a larger area than estimated.

- Second, the areas of the transverse cracks were estimated by counting the primarily radial (crack is near normal to cladding) transverse cracks in the longitudinal photomacrograph. For cracks that tended to intercept the cladding surface at an angle between ~45° and 80° a value of one-half a transverse crack was assigned because of the possibility that its equivalent had been counted in the transverse photomacrograph. Cracks intercepting the cladding at

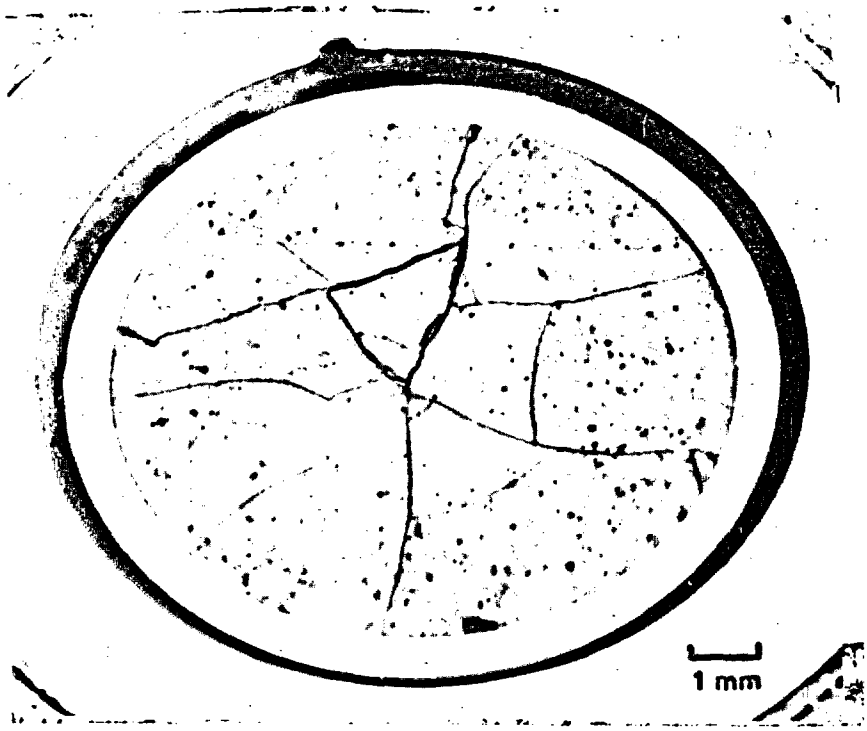


FIGURE 4.4. Transverse Photomacrograph of Sample N-9C-C High Power Region

angles of less than 45° were ignored. The area per unit length of the transverse cracks was estimated by equating the sum of the cracks to equivalent diameters, calculating the number of equivalent cross-sections in the sample, multiplying by two for the two new surfaces, and dividing by the length of the samples.

- Third, the area/per unit length of the new surfaces generated during commercial operation can be estimated by summing the estimates of the area of the longitudinal and transverse crack areas as described above.
- Fourth, the area per unit length of the original pellet was determined by summing the cylindrical and end surfaces and dividing by 15.2 mm (the original length of the pellets).
- Finally, the total fragment surface area per unit length can be obtained by summing the totals for the new surfaces and the original surfaces.

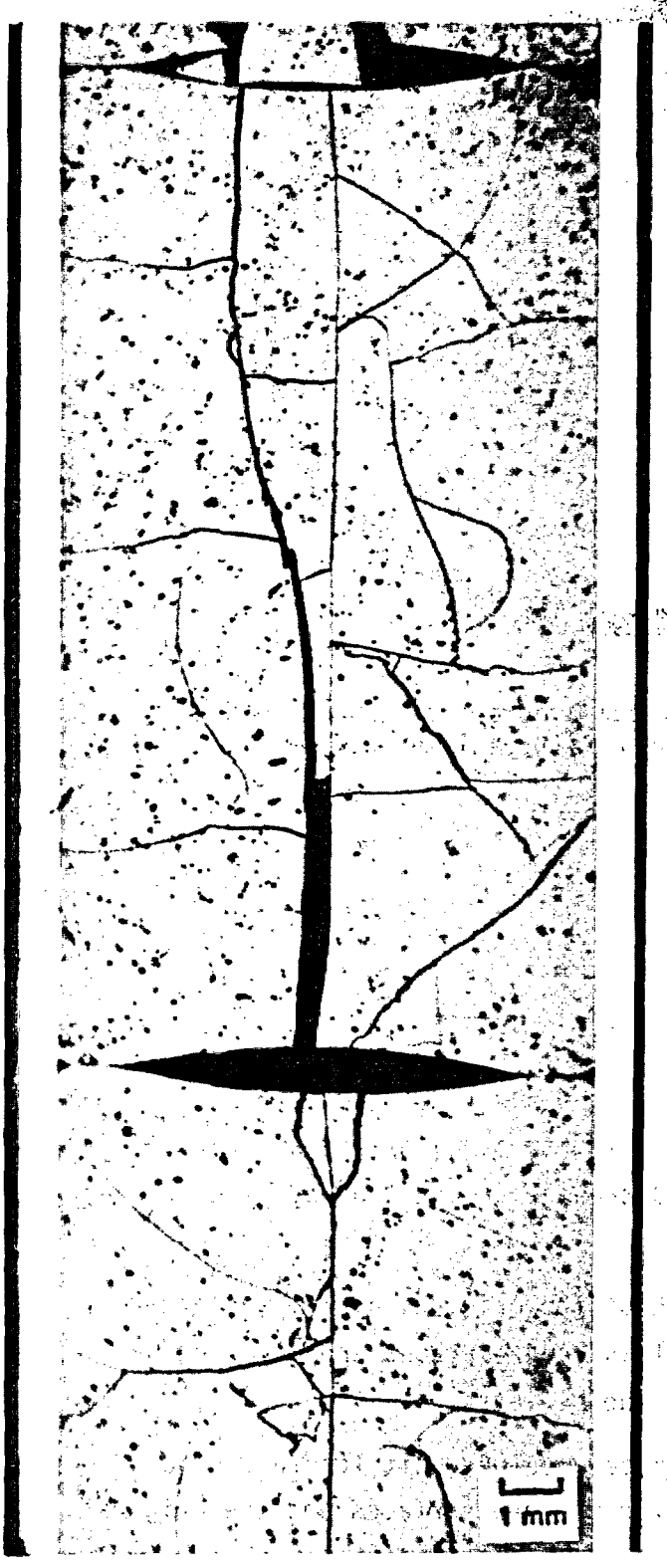


FIGURE 4.5. Longitudinal Photomacrograph of Sample N-9C-F High Power Region

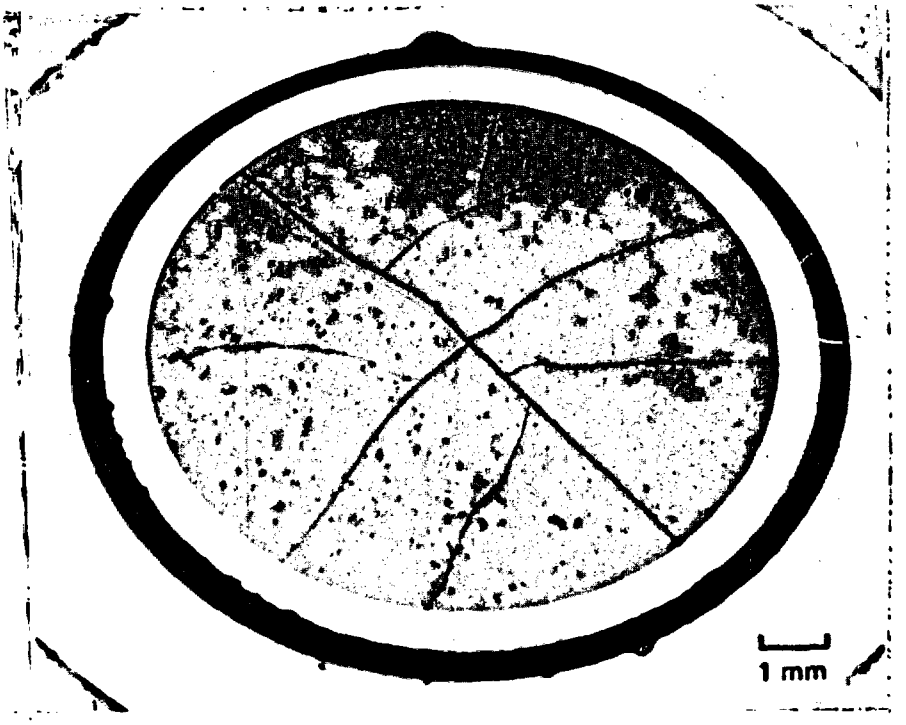


FIGURE 4.6. Transverse Photomacrograph of Sample N-9C-I Grid Spacer Area in High Power Region

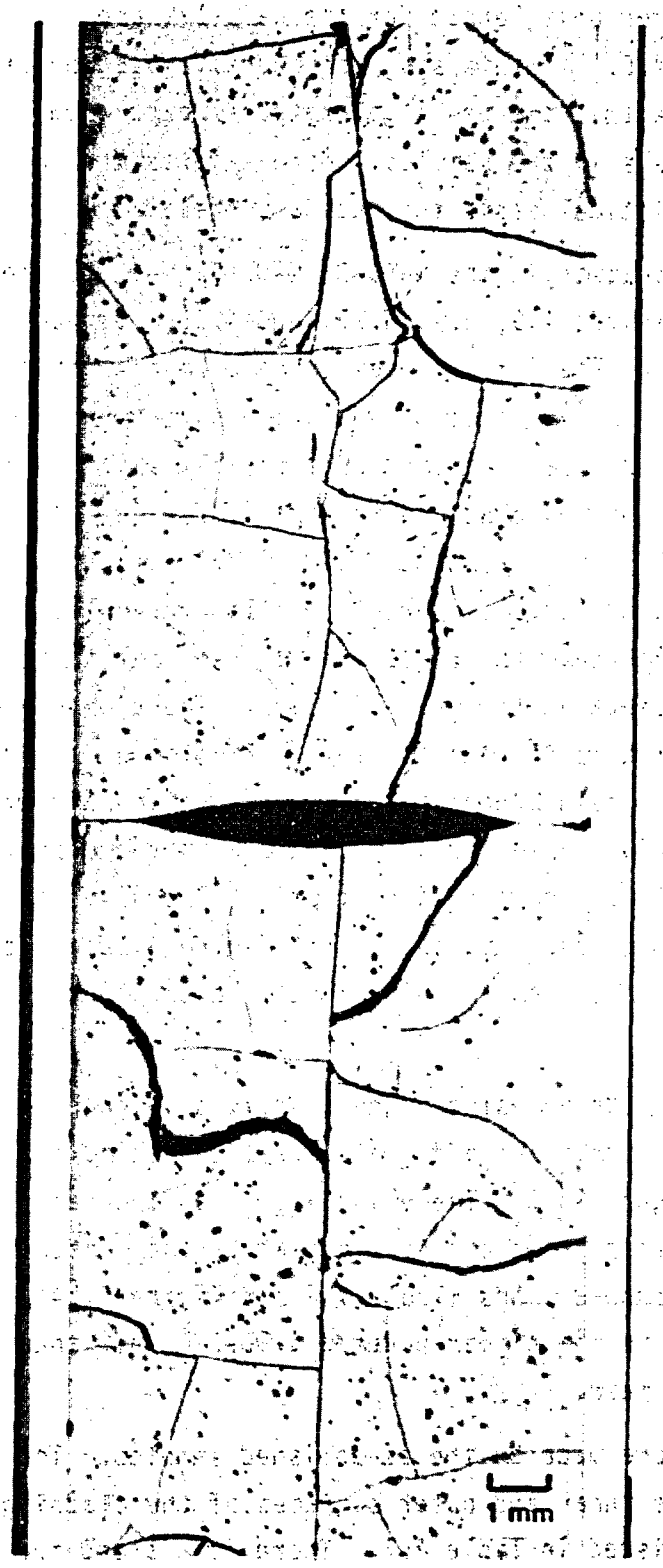


FIGURE 4.7. Longitudinal Photomacrograph of Sample N-9C-K Grid Spacer Area of High Power Region

The estimates of the surface areas per unit length for the N-9C-I/K and N-9C-C/F pairs are listed in Table 4.5. At this stage of characterization of ATM-101, it is considered fortuitous that the newly generated surface areas correlate with the burnup/power levels in the samples. More samples are required in order to provide a statistical basis for such a correlation.

Examples of the porosity distribution in the N-9C-C, N-9C-F, N-9C-I, and N-9C-K samples are illustrated in Figures 4.8, 4.9, 4.10, and 4.11, respectively, as a function of fuel radius. The larger pores evident in most of the photomacrographs are typical of the porosity caused by using a pore-former during fabrication of the fuel. The significant amount of relatively small porosity near the edges of the pellets that was observed in most of the pellets is apparently a combination of original porosity (relatively rounded porosity) and grain pullout during sample preparation (angular porosity). Intergranular fission-gas-generated porosity is evident near the centerline of the fuel in the N-9C-C/F pair of samples, but was absent in the N-9C-I/K pair. These observations indicate that the power was just sufficient to cause diffusion of xenon and krypton out of the grains to the grain boundaries in the N-9C-C/F pair and was not high enough to cause gas diffusion in the N-9C-I/K pair that operated at a power level approximately 12% lower than the former pair. There was also more evidence of noble metal fission product agglomeration (Figure 4.12) in the higher powered region, samples N-9C-C/F, than in the slightly lower power region, samples N-9C-I/K.

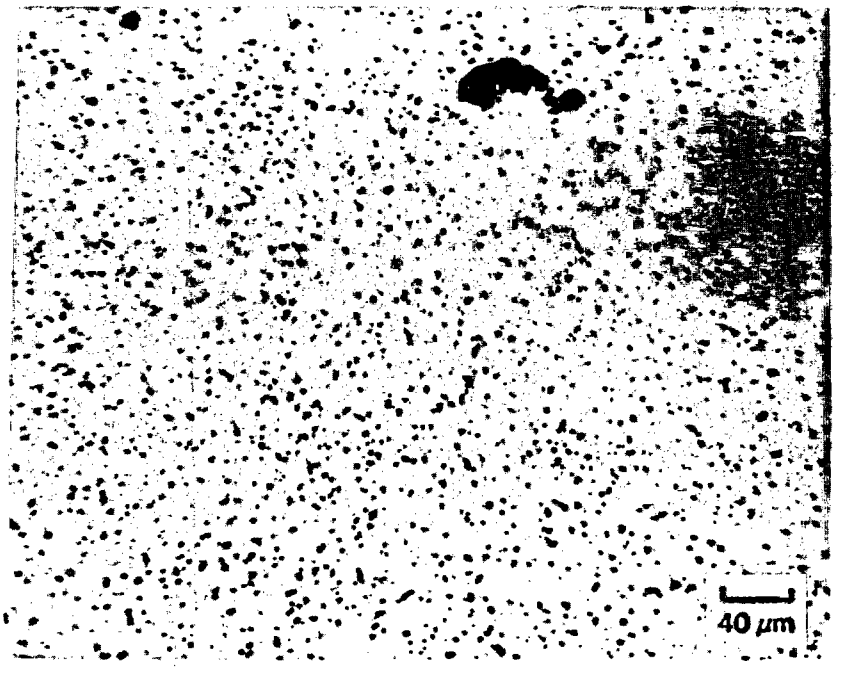
The ceramographic sections were etched using argon ions in a cathode vacuum etcher to determine the grain structure and grain size. An example of the etched structure is shown in Figure 4.13. There was a general increase in the size of the grains from the outer edge of the fuel pellet to the centerline for both the N-9C-C/F and N-9C-I/K sample pairs (Table 4.6 and Figure 4.14). The grain size increase was greater in the higher-powered N-9C-C/F pair than in the slightly lower-powered N-9C-I/K pair.

Oxide thickness measurements were made on the as-polished samples. The results of these measurements on the inner and outer surfaces of the cladding for samples N-9C-F and N-9C-K are listed in Table 4.7. There is a trend for an increase in the thickness of the outer, uniformly thick, oxide layer with

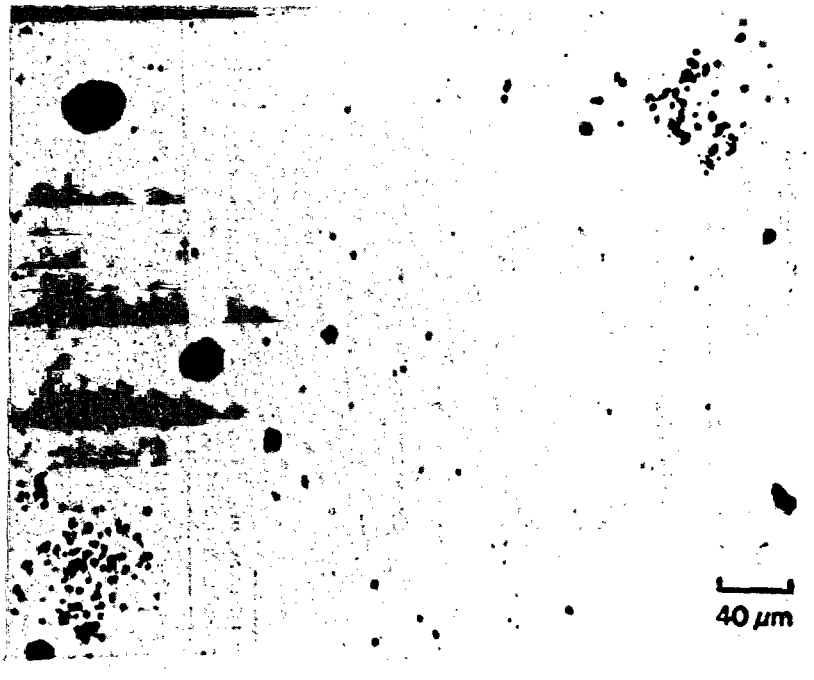
TABLE 4.5. Summary of Estimate of Fragment Areas per Unit Length of Fuel Rod

Section No.	Major Longitudinal Cracks,[a] Equivalent Radii	Major Transverse Cross-Sections,[b] Number	Length of Longitudinal Section, mm	Area, mm^2/mm				
				Longitudinal Cracks[c]	Transverse Cracks[d]	Total Cracks	Original Surface[e]	Total Fragments
C-5C-B C-5C-F	Examinations in progress							
N-9C-C	a	-	-	84	-	114	38	152
N-9C-F	-	6.25	28	-	30			
N-9C-I	8	-	-	74	-	109	38	147
N-9C-K	-	7.50	29	-	35			
N-9B-C N-9B-E N-9B-O N-9B-M N-9B-T N-9B-R	Examinations in progress							

(a) Determined by counting major crack equivalent radii.
(b) Determined by counting major radial transverse cracks plus cracks of <45° to tube wall being equivalent to one-half a major radial transverse crack.
(c) Area = (number equivalent radii) (4.65 mm radius) (2 sides) (1 mm length).
(d) Area = (number equivalent cross-sections) (π) ($4.65^2 mm^2$ radius) (2 sides) $\frac{\text{(length of specimen)}}{\text{(length of specimen)}^2}$
(e) Area = $\frac{\text{(area cylinrical surface) + (area ends)}}{\text{15.2 mm pellet length}} = \frac{38\ mm^2}{mm}$

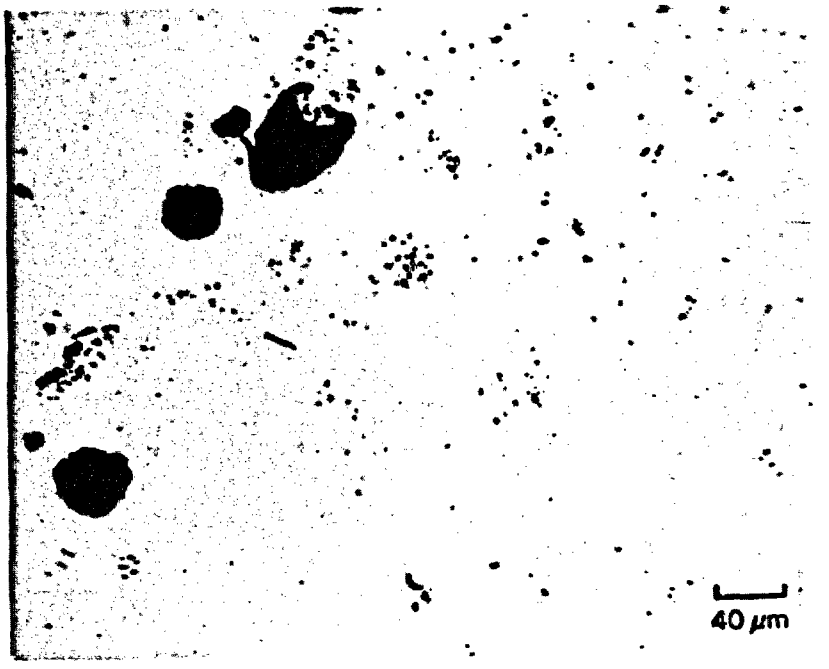


a) Centerline

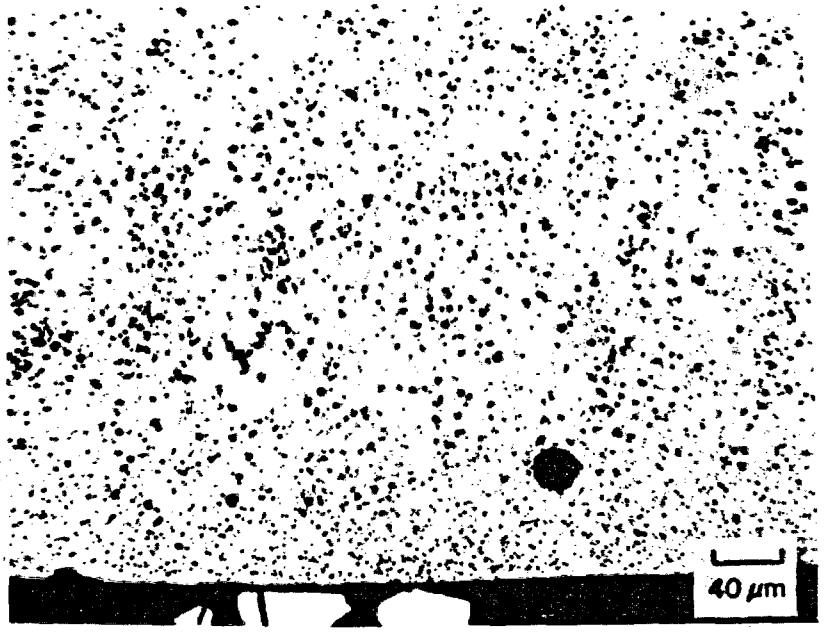


b) 1/3 Radius

FIGURE 4.8. As-Polished Transverse Sample N-9C-C (Neg. Nos. N-4700 through N-4704)

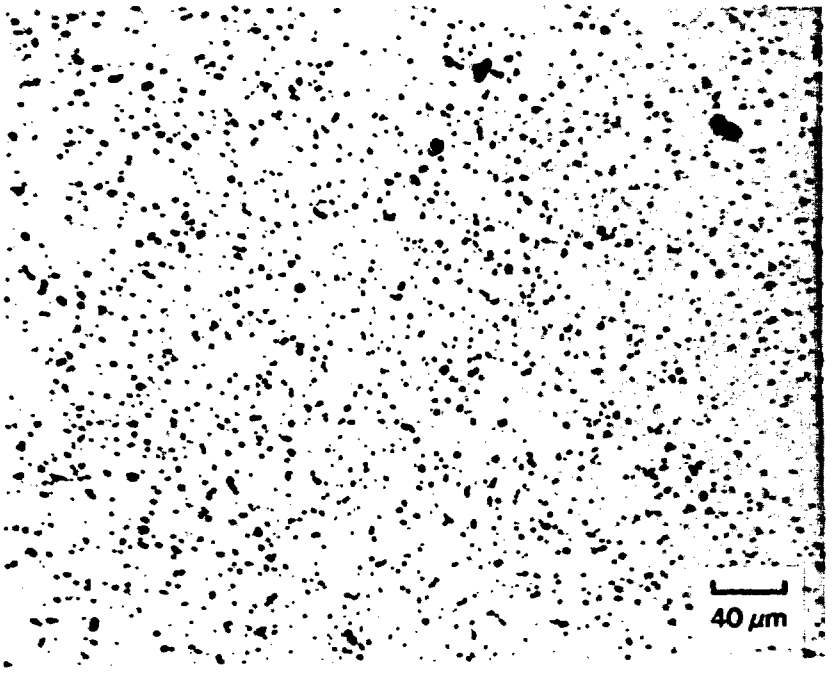


c) 2/3 Radius

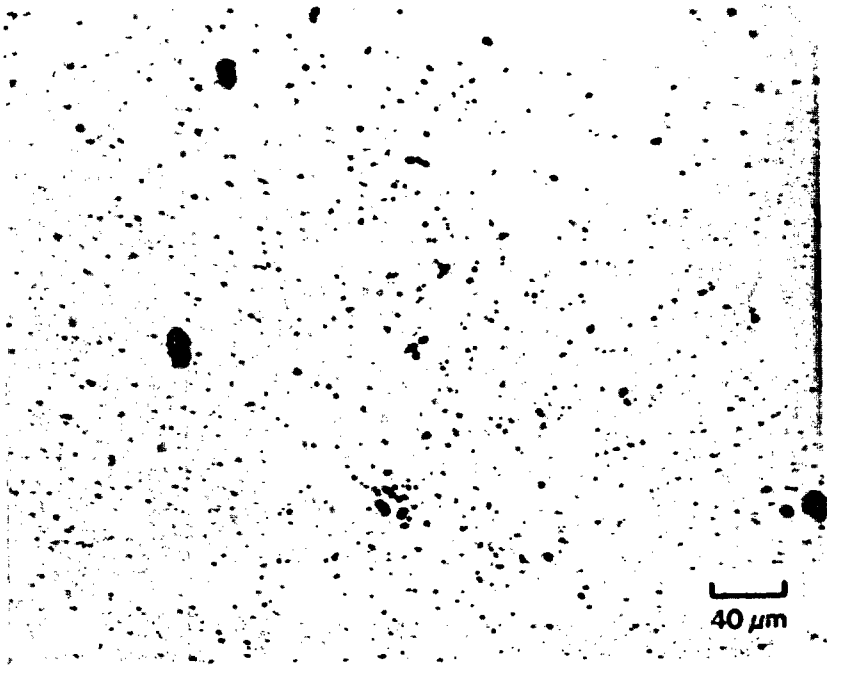


d) Edge

FIGURE 4.8. (Contd)

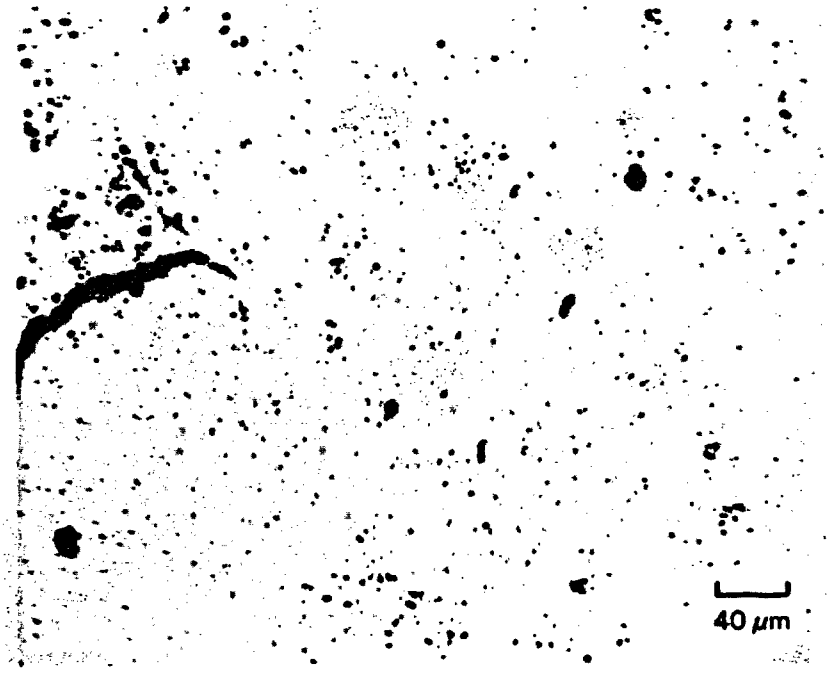


a) Centerline



b) 1/3 Radius

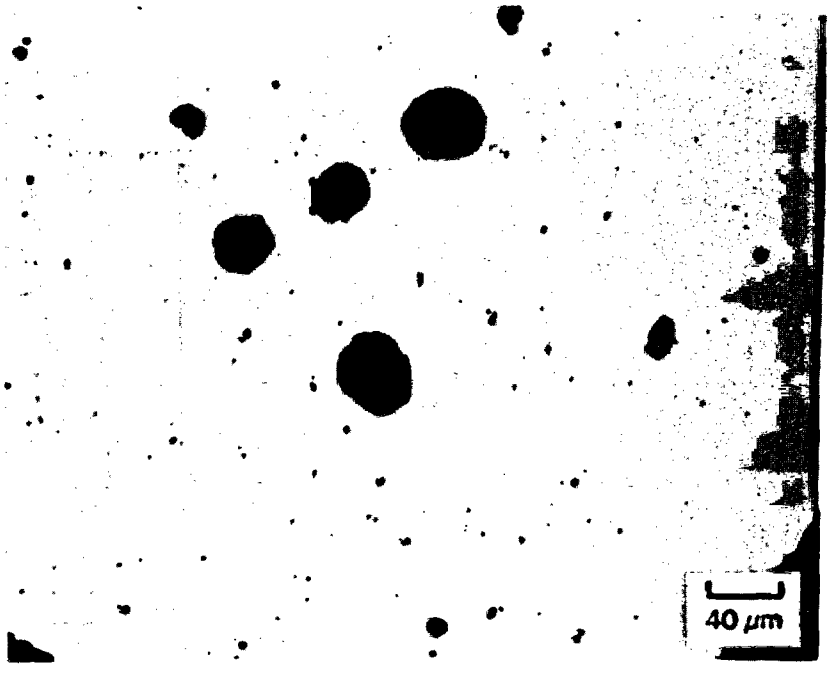
FIGURE 4.9. As-Polished Longitudinal Sample N-9C-F (Neg. Nos. N-4786 through N-4789)



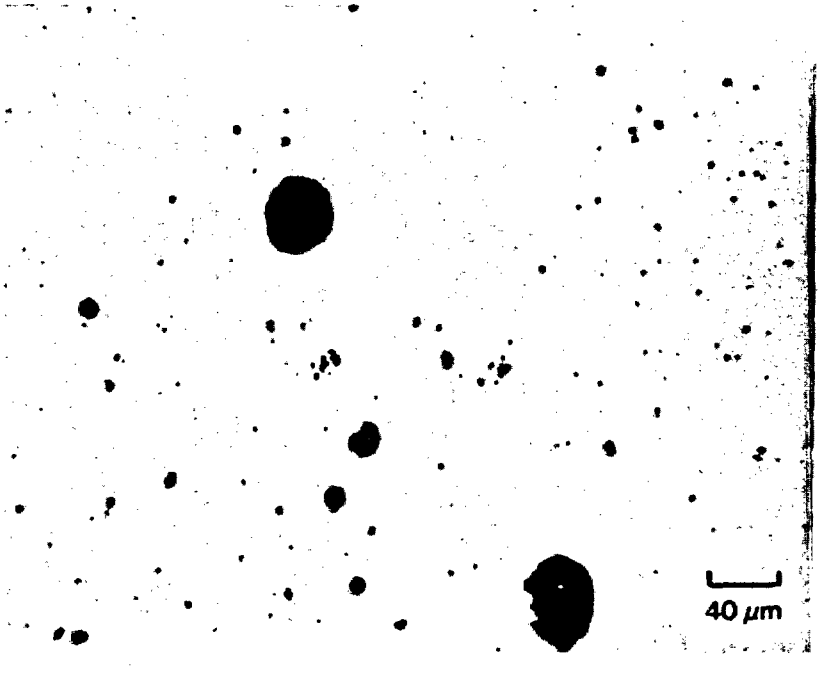
c) 2/3 Radius

d) Edge

FIGURE 4.9. (Contd)

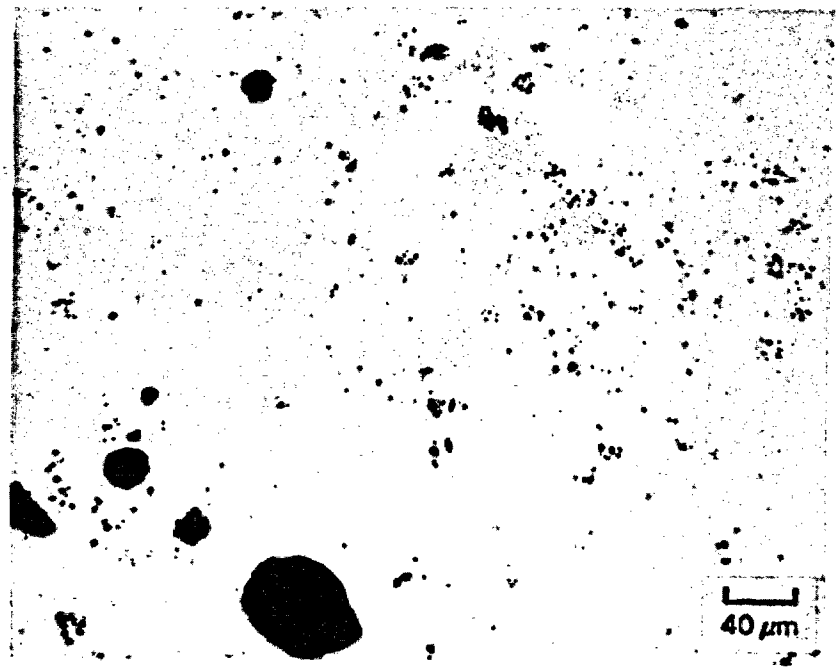


a) Centerline

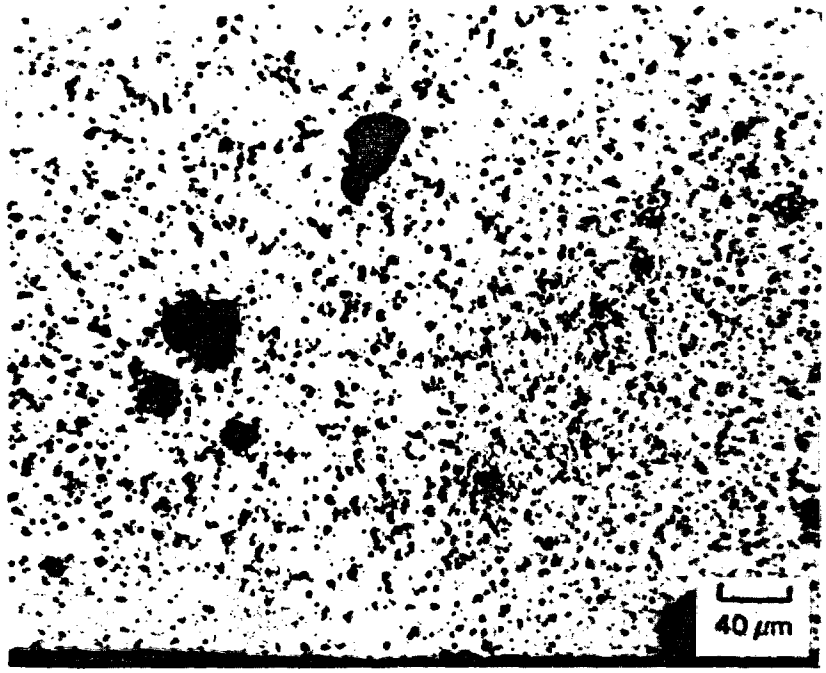


b) 1/3 Radius

FIGURE 4.10. As-Polished Transverse Sample N-9C-I (Neg. Nos. N-4706 through N-4709)

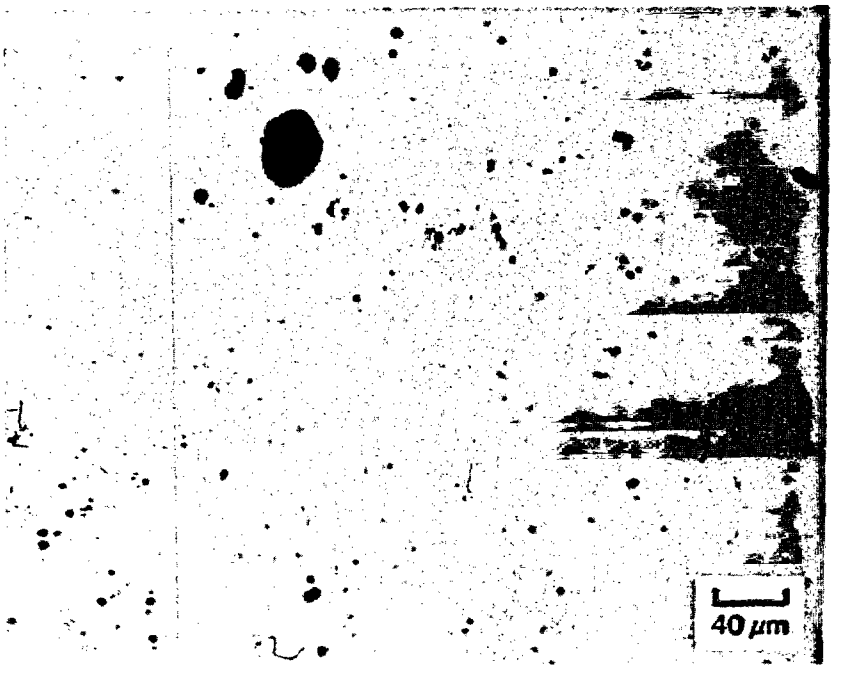


c) 2/3 Radius

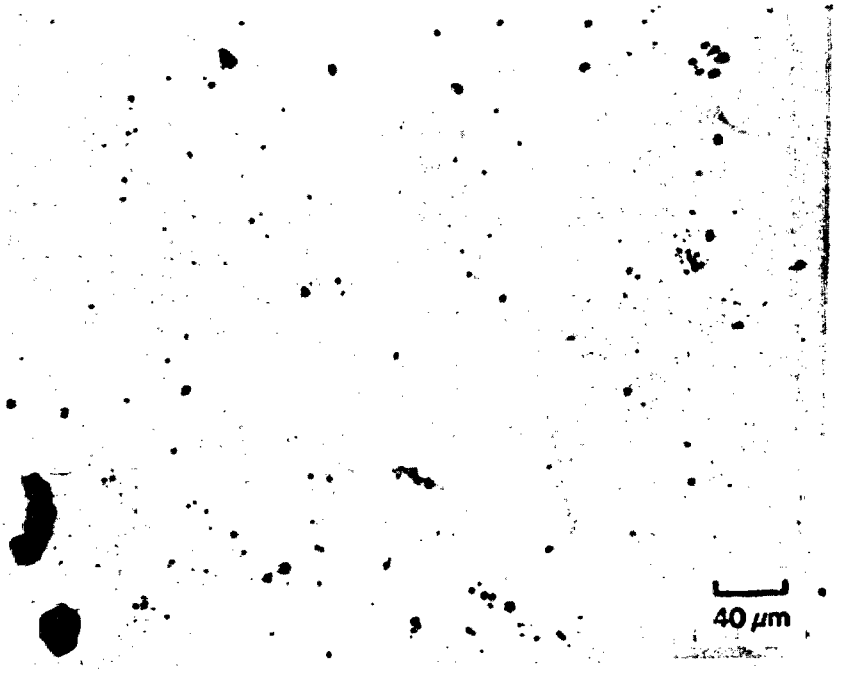


d) Edge

FIGURE 4.10. (Contd)

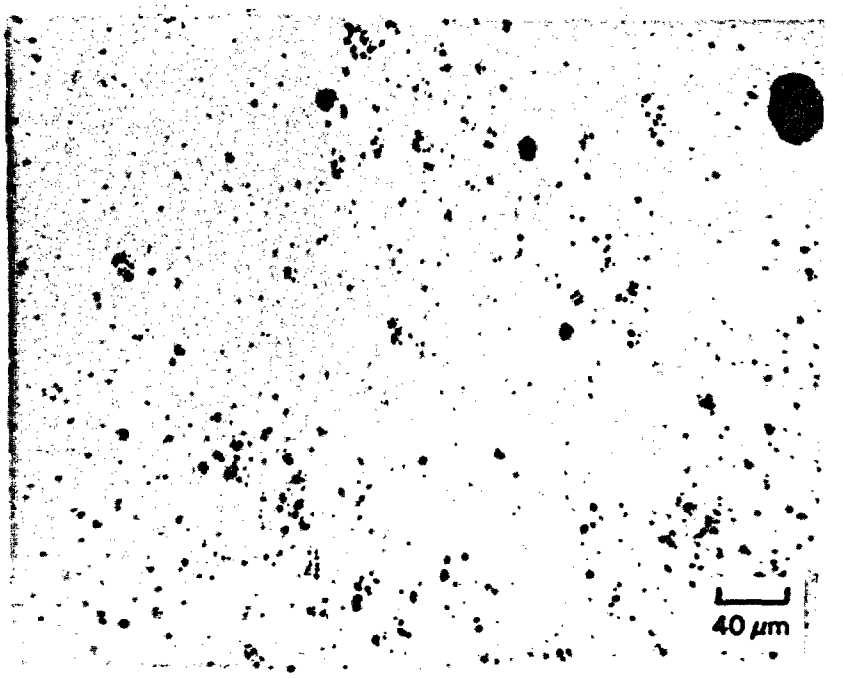


a) Centerline

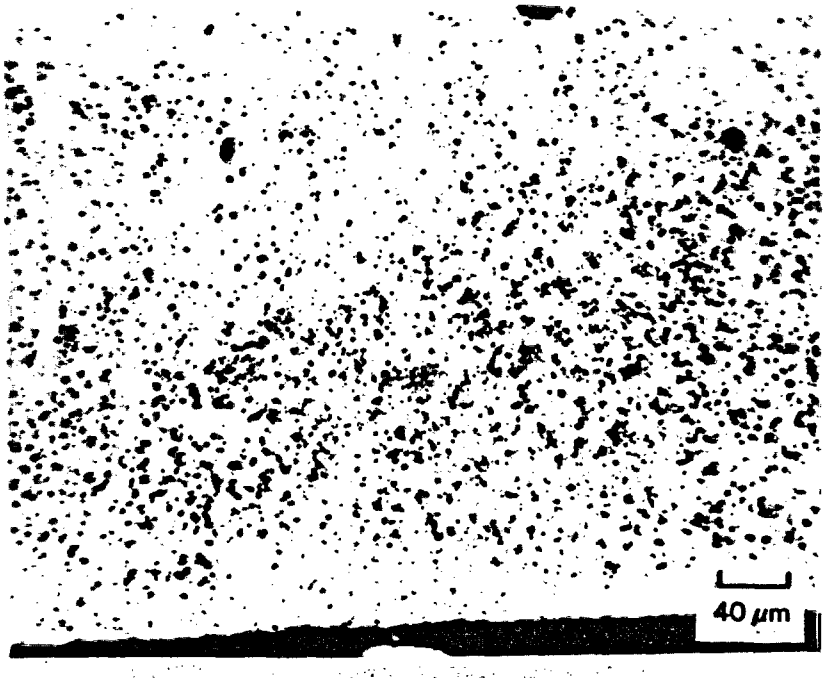


b) 1/3 Radius

FIGURE 4.11. As-Polished Longitudinal Sample N-9C-K (Neg. Nos. N-4679 through N-4682)

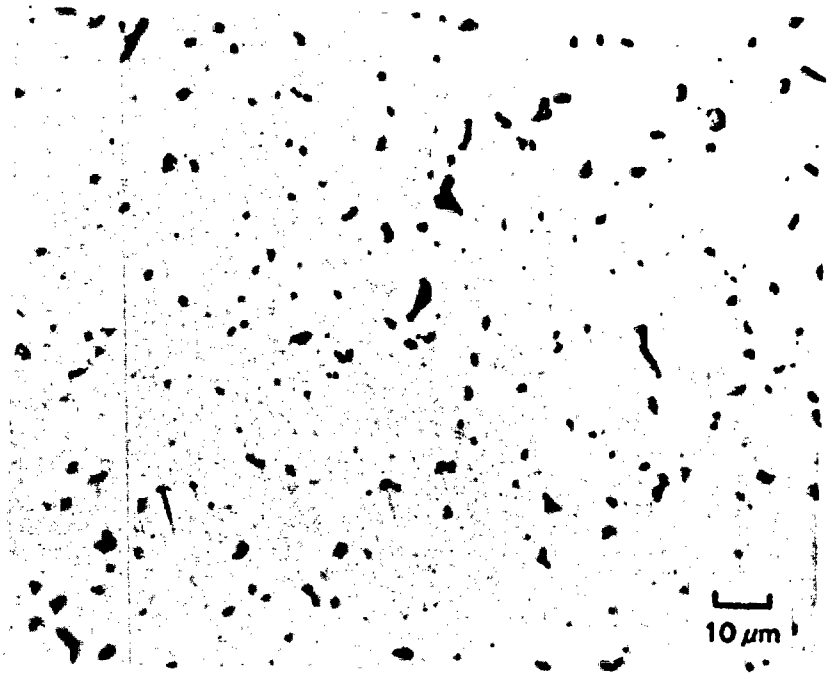


c) 2/3 Radius

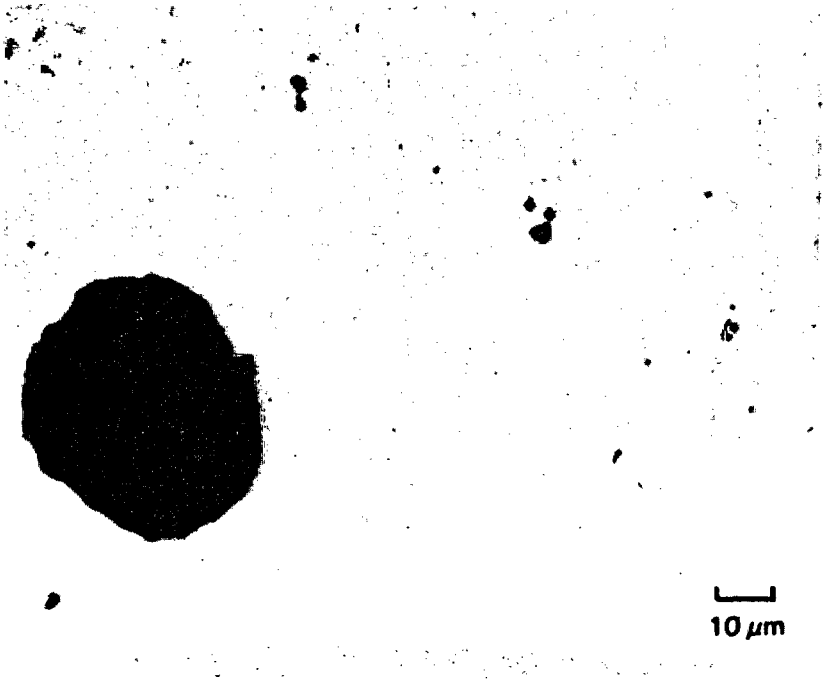


d) Edge

FIGURE 4.11 . (Contd)



a) Sample N-9C-C (Neg. No. N-7404)



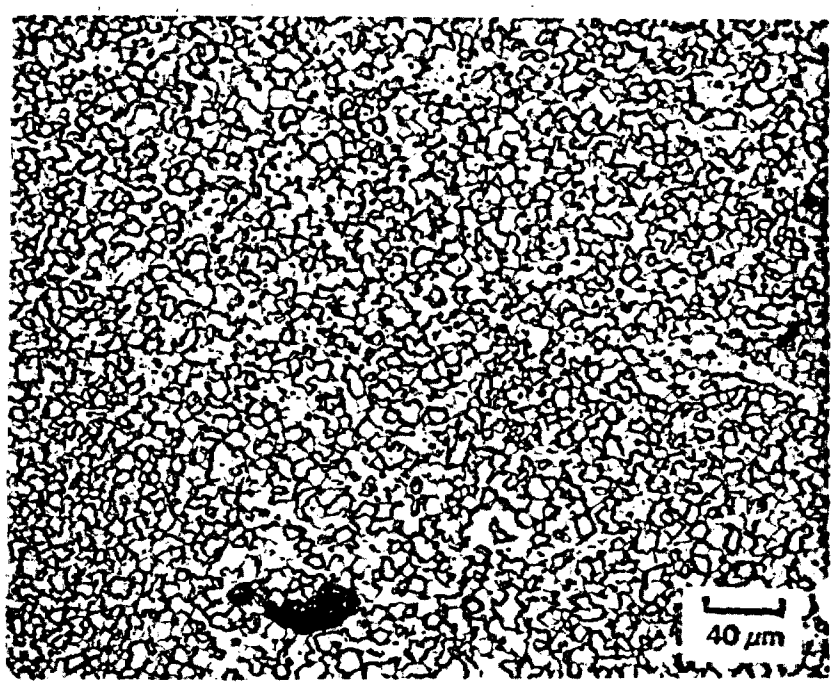
b) Sample N-9C-I (Neg. No. N-4710)

FIGURE 4.12. Noble Metal Fission Product Agglomeration (light-colored spots) in Samples from (a) Central High-Power Region of Rod N-9, and (b) Grid Spacer Region at 12% Lower Power

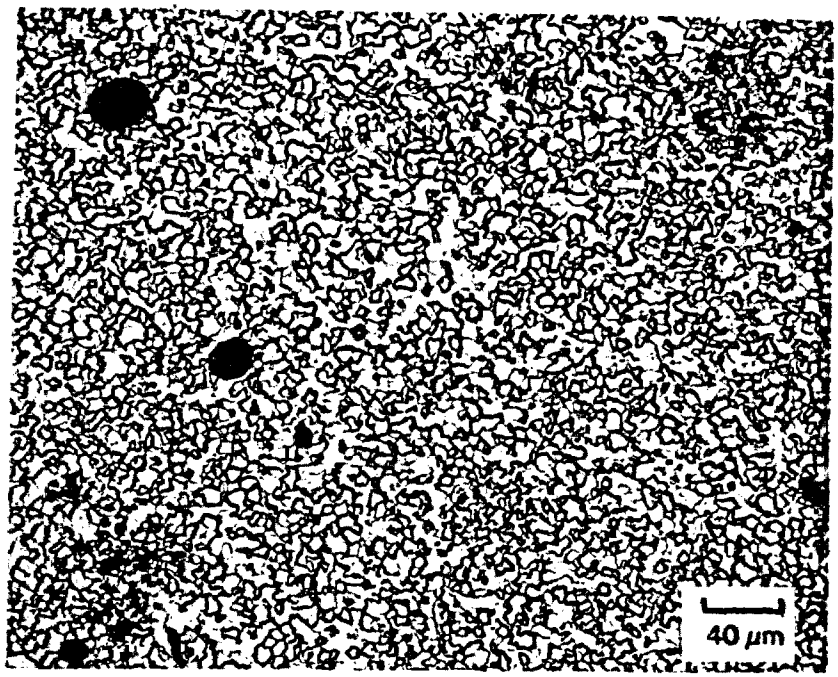
TABLE 4.6. Results of Fuel Grain Size Measurements[a]

Section No.	Grain Size at Fractional Radius, μm							
	Centerline		1/3 Radius		2/3 Radius		Edge	
	Intercept	True	Intercept	True	Intercept	True	Intercept	True
N-9C-C	5.8	9.1	5.1	8.0	3.9	6.2	3.9	6.1
N-9C-F	6.5	10.2	6.1	9.6	5.1	8.0	--	--
N-9C-I	5.0	7.8	4.9	7.7	3.9	6.1	3.8	5.9
N-9C-K	5.8	9.0	5.0	7.8	3.9	6.1	3.8	5.9
N-9B-C	Examinations in progress							
N-9B-E								
N-9B-O								
N-9B-M								
N-9B-T								
n-9B-R								
C-5C-B								
C-5C-F								

(a) "Intercept" grainsize determined by line intercept method from ASTM E 112. "True" grain size equals the "intercept" grain size multiplied by 1.57.

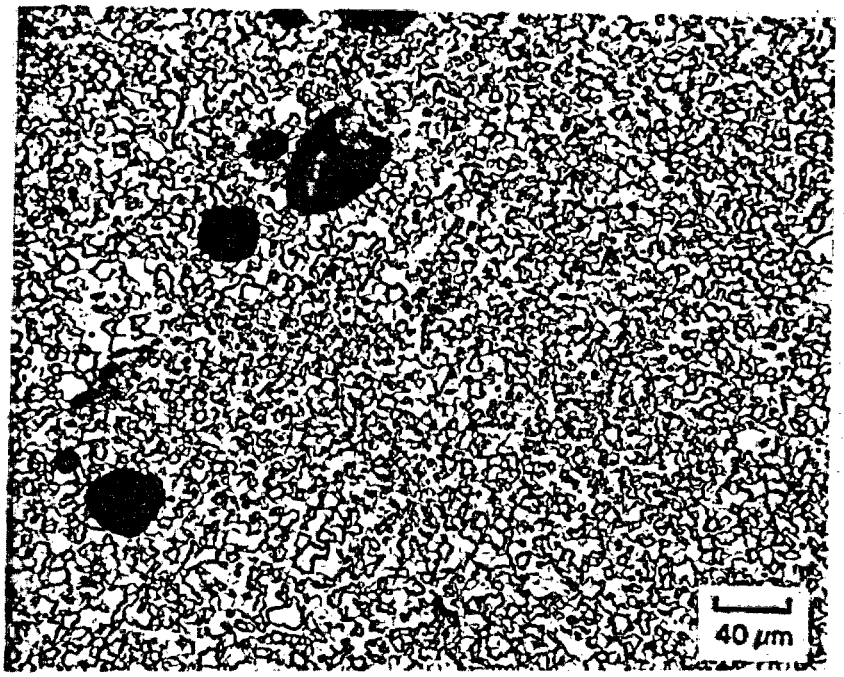


a) Centerline

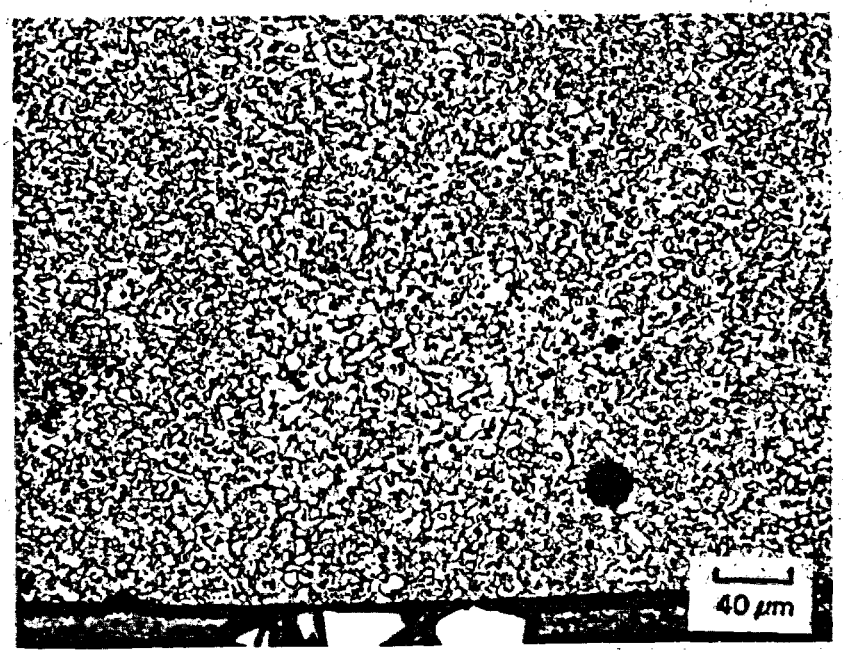


b) 1/3 Radius

FIGURE 4.13. Ion-Etched Transverse Sample N-9C-C (Neg. Nos. N-4757 through N-4760)



c) 2/3 Radius



d) Edge

FIGURE 4.13. (Contd)

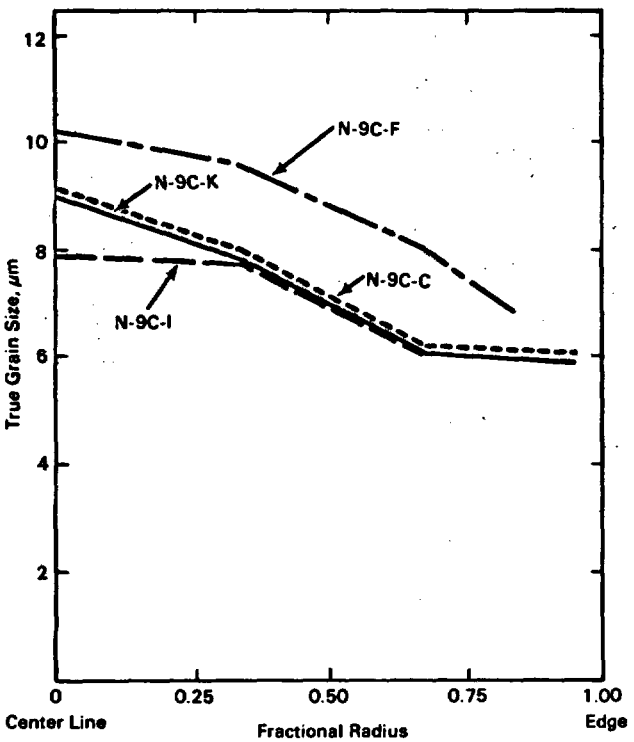


FIGURE 4.14. True Grain Size of Fuel as a Function of Radius for Four Samples from N-9C

increasing elevation in the assembly, as would be expected for PWR fuel. The outer oxide was layered and tended to be cracked in a direction parallel to the surface of the cladding (Figure 4.15). The inner oxide layer varied significantly in thickness (Figure 4.16); in some places it was not observed. In some cases the inner oxide appeared to be spalling away from the zircaloy cladding.

The cladding was etched with "B-etch" (45% glycerine, 45% nitric acid, and 10% hydrofluoric acid) in order to check the hydride orientation. Examples of the hydride orientation is shown in Figure 4.17. The hydrides are primarily oriented as platelet-type stringers in the longitudinal-tangential direction.

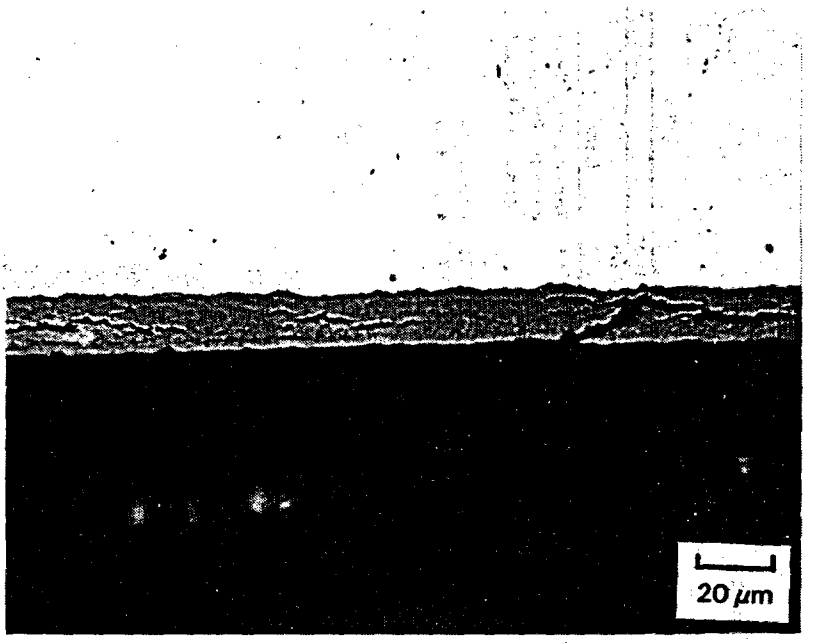
4.6 FUEL BURNUP MEASUREMENTS

Burnup analyses were completed on five samples from rod N-9 at positions representative of five burnup levels. An additional random burnup sample was

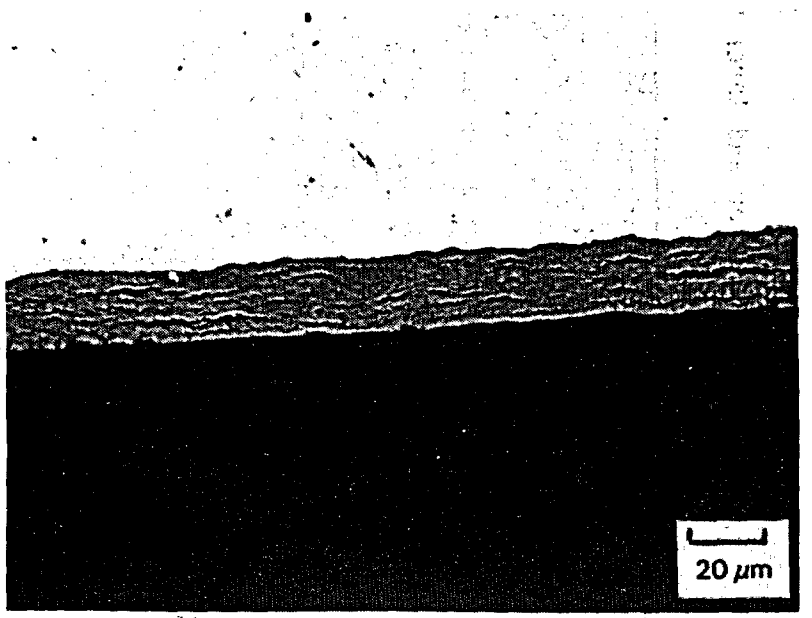
TABLE 4.7. Outer and Inner Oxide Thickness in ATM-101 Rods

Section No.	Approximate Axial Location, cm (in) from Bottom of Fuel Stack	Oxide Thickness, mm(in) x 10^{-3}					
		Outer Layer			Inner Layer		
		Typical	Approximate Range	Comments	Typical	Approximate Range	Comments
N-9C-K	198 (78)	15.2 (0.60)	±1.0 (0.04)	Uniform thickness, layered, often cracked	9.7 (0.38)	±9.7 (0.38)	Varies significantly in thickness, solid oxide
N-9C-F	225 (88.5)	19.8 (0.78)	±2.0 (0.08)	Uniform thickness, layered	4.4 (0.17)[a]	+2.5 (0.10) -4.4 (0.17)	Localized, spalling
N-9B-E	105 (41.5)	Examinations in progress					
N-9B-M	25 (9.8)						
N-9B-R	12 (4.8)						
C-5C-F	217 (85)						

a.) Typical where present.

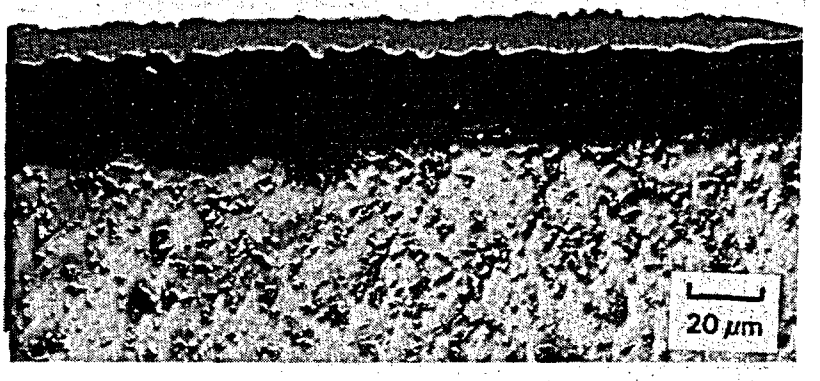


a) Sample N-9C-K Neg. No. N-5006)

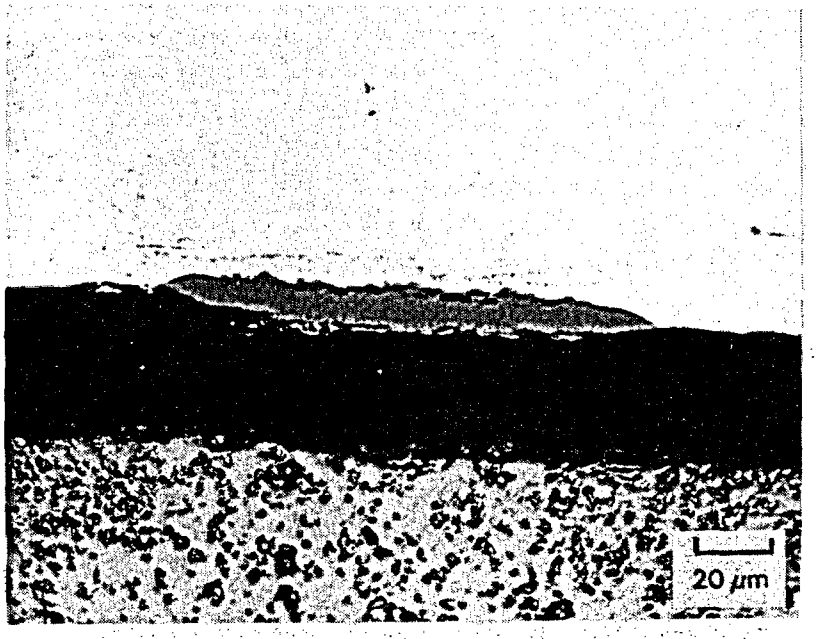


b) Sample N-9C-F (Neg. No. N-4995)

FIGURE 4.15. Examples of Outer Surface Oxide on ATM-101 Rods

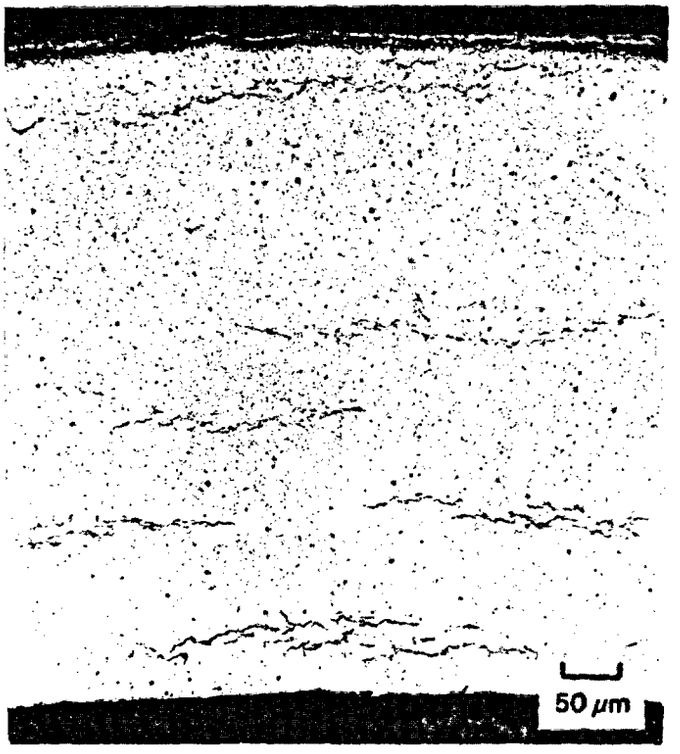


a) Sample N-9C-K (Neg. No. N-5012)



b) Sample N-9C-F (Neg. No. N-5001)

FIGURE 4.16. Examples of Inner Surface Oxide from Rod N-9C



a) Transverse Sample N-9C-C (150X) (Neg. No. N-5015)

b) Longitudinal Sample N-9C-F (Neg. No. N-5003)

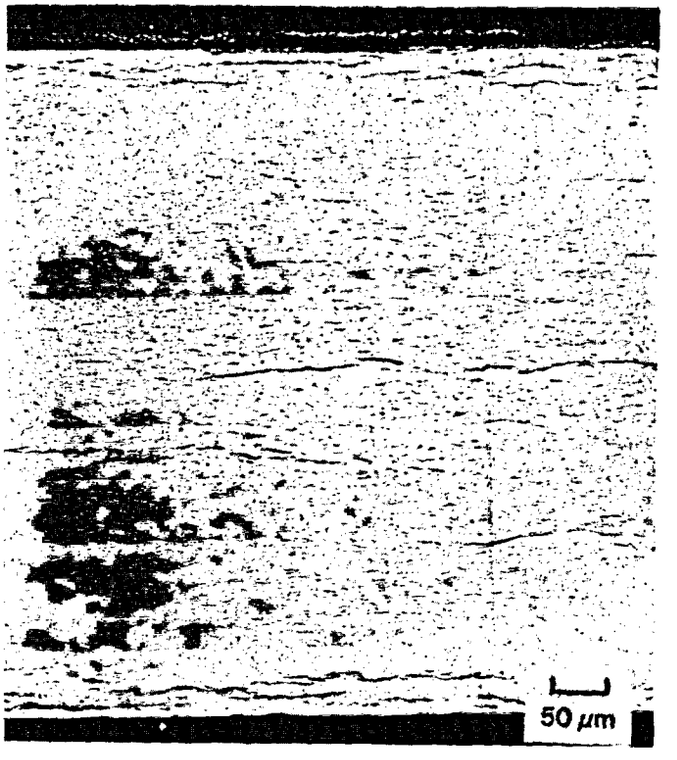


FIGURE 4.17. Hydride Orientation in Rod N-9C Cladding

taken from rod C-5. The burnup samples were taken in order to correlate with ^{137}Cs gamma scan results to predict the burnup and radionuclide content of any particular specimen of ATM-101 that might be provided to a repository experimenter. The burnup analyses were performed by Hanford Engineering Development Laboratory (HEDL) according to ASTM Standard E 321. The results are listed in Table 4.8. The results of the burnup analyses are compared to the ^{137}Cs counts taken during 300 s (Section 4.7), at the location of the burnup sample, in Figure 4.18. Burnup values based upon ^{137}Cs are also listed in Table 4.8. The good correlations between ^{137}Cs and burnup, and the burnup values based upon ^{148}Nd and ^{137}Cs, indicate that the ^{137}Cs has not migrated axially to any significant degree, and therefore, burnup values determined by intercomparison of ^{137}Cs gamma activities between rods is valid for ATM-101.

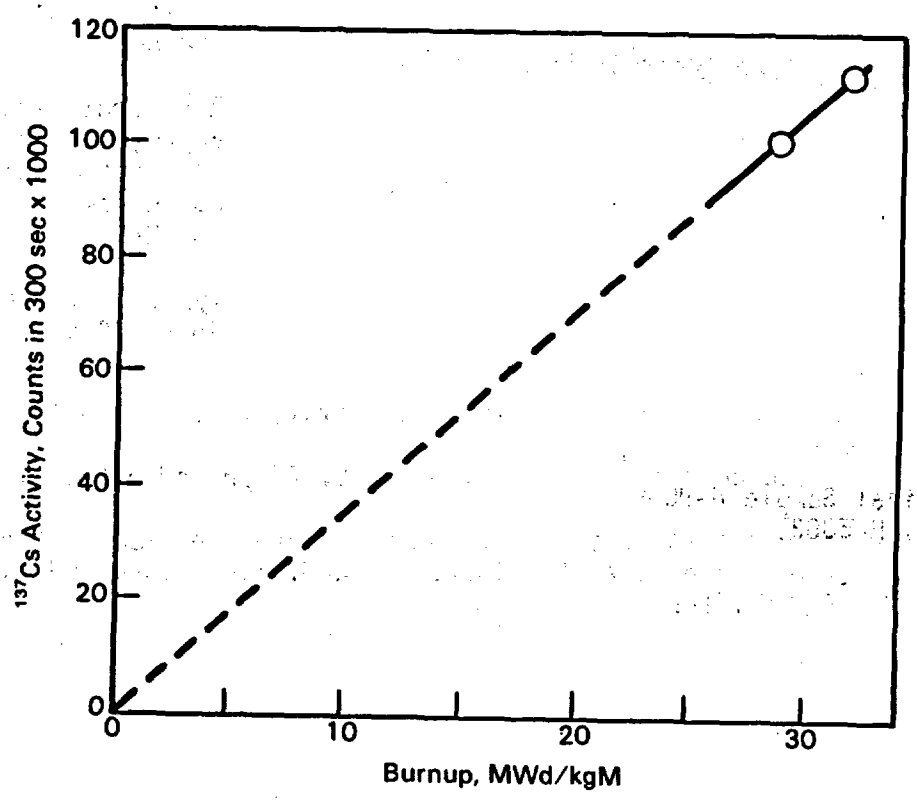


FIGURE 4.18. Correlation Between Burnup Analyses and ^{137}Cs Gamma Counting

TABLE 4.8. Burnup Results for ATM-101 Samples[a]

Specimen No.	Burnup (^{148}Nd basis) At. %	Burnup (^{148}Nd basis) MWd/kgM	Burnup (^{137}Cs basis) MWd/kgM[b]	Sample Location
N-9C-D	3.32[c]	31.66[c]	31.8	Typical peak burnup in center segment of rod N-9.
N-9C-J	2.98[c]	28.47[c]	27.9	Burnup in grid spacer location of rod N-9.
N-9B-D				Typical peak burnup in bottom segment of rod N-9.
N-9B-N				Representative of approximately 75% of peak ^{137}Cs activity in bottom segment of rod N-9.
		Analyses in progress		
N-9B-S				Representative of approximately 50% of peak ^{137}Cs activity in bottom segment of rod N-9.
C-5C-D				Typical of peak burnup in rod C-5.

(a) See sectioning diagrams in Appendix B for sample locations with respect to gamma activity.
(b) Calculation based upon ^{137}Cs half-life of 30.174 yr and effective fission yield of 6.138%.
(c) Results listed for specimens N-9C-D and N-9CJ are the average two analyses. Ranges were 0.07 at % (0.70 MWd/kgM) for N-9C-D and 0.02 at % (0.15 MWd/kgM) for N-9C-J.

This burnup-^{137}Cs activity correlation is

$$B.U._i = B.U._{N-9D} \frac{\bar{A}_i}{\bar{A}_{N-9D}} \quad (1)$$

where $B.U._i$ = the burnup for the portion of the rod in question, MWd/kgM

$B.U._{N-9D}$ = the average of the two analyses for the burnup sample N-9C-D = 31.7 MWd/kgM

$\bar{A}_i$ = the average ^{137}Cs activity for the portion of the rod in question, counts per 300 s

$\bar{A}_{N-9D}$ = the average ^{137}Cs activity for the burnup sample N-9C-D = 112,496 counts per 300 s

This burnup value can be used in conjunction with the radionuclide inventory calculations in Section 4.8 to determine the radioisotope inventory for a particular portion of specimen that might be used by an experimenter.

In order to determine the average burnup in a particular fuel rod that is required for the fission gas release calculation (Section 4.4), a modification of Equation 1 was used. Normalizing factors for determining the rod-average burnup in rod N-9 and the relationship between rods were used, i.e.,

$$\overline{B.U.}_i = B.U._{N-9D} \frac{\bar{A}_{N-9}}{\bar{A}_{N-9D}} \frac{\bar{A}^*_{i-C}}{\bar{A}^*_{N-9C}} \quad (2)$$

where $\overline{B.U.}_i$ = rod-average burnup for the rod in question, MWd/kgM

$B.U._{N-9D}$ = the average of the two analyses for the burnup sample N-9C-D = 31.7 MWd/kgM

$\bar{A}_{N-9}$ = the average ^{137}Cs activity for the entire rod N-9 = 100,926 counts per 300 s

$\bar{A}_{N-9D}$ = the average ^{137}Cs activity for for burnup sample N-9C-D = 112,496 counts in 300 s

$\bar{A}^*_{i-C}$ = the average ^{137}Cs activity along the length of the center segment of the rod in question, counts per 300 s.

$\bar{A}^*_{N-9C}$ = the average ^{137}Cs activity along the length of the center segment of rod N-9 = 110,259 counts in 300 s

or,

$$\overline{B.U.}_i = 2.58 \times 10^{-4} \left(\bar{A}^*_{i-C}\right) \quad (3)$$

The results of this calculation for the nine rods in ATM-101 are tabulated in Table 4.9. For those rods for which the center segment has not as yet been gamma scanned, A^*_{i-C} has been assumed to be the same as for segment N-9C and the rod-average burnup value is shown as preliminary in brackets.

It is noted that the $\bar{A}_{N-9}$ to $\bar{A}_{N-9D}$ ratio (0.897) is very close to the peak to assembly-average burnup ratio (0.894) previously reported (Einziger and Fish, 1982). It is also noteworthy that the burnup and ^{137}Cs counts for sample N-9C-D, in the typical peak burnup region, and sample N-9C-J, in grid spacer region, agree within 0.2%, i.e, 31.16 MWd/kgM and 112,496 counts vs. 28.47 MWd/kgM and 101,348 counts, respectively.

TABLE 4.9. Rod-Average Burnup in ATM-101 Fuel Rods

Rod No.	Central Segment Average ^{137}Cs Activity, $\bar{A}^*_{i-C}$, Counts per 300 s[a]	Rod-Average Burnup MWd/kgM[a]
C-5	109,416	28.2
D-10	*	[28.4]
G-9	*	[28.4]
G-13	*	[28.4]
J-12	*	[28.4]
L-8	116,341	30.0
N-4	*	[28.4]
N-9	110,256	28.4
N-12	113,833	29.4

(a) * = Value assumed to be equal to that for N-9 pending gamma scan result. Preliminary burnup value in [].

4.7 GAMMA SCANNING RESULTS

Each fuel rod segment was gamma scanned axially in the HEDL hot cells using a germanium-drifted gamma-ray detector. In most cases, the same counting geometry, counting equipment, analyzing equipment, and data storage equipment were used for each measurement. Because of changes in an electronic package and a resulting change in calibration, it was necessary to determine a normalization factor for some of the gross gamma scans by counting segment N9T with both electronic packages.

Initial spectral counting of the high activity regions of the fuel showed only one large peak corresponding to the 662.5 Kev ^{137}Cs gamma ray. Several other very small peaks were observed. Of these the 605.5 and 796.8 Kev peaks for ^{134}Cs and the 724.1 and 1275.0 Kev peaks for ^{154}Eu were adjudged to have sufficient activity to record. An additional peak at 98.6 Kev, possibly ^{241}Am, was also recorded. Of the axial gamma distributions that were recorded, the gross (total activity), the ^{137}Cs (606.5 Kev), the ^{134}Cs (605.5 Kev) and the ^{154}Eu (1275.0 Kev) data had adequate counting statistics to be published. The individual plots for each fuel rod segment that has been scanned to date are shown in Appendix D. Composites of the individual scans for the bottom, center, and top segments of rod N-9 for the gross and ^{137}Cs scans are shown for illustration in Figures 4.19 and 4.20. Of note is, that even using a relatively wide slit width of 2.5 mm (0.100 in.) and steps of 2.5 mm (0.100 in.), the pellet-pellet interfaces and associated dishing are easily distinguished as sharp dips in the gamma activity on an approximate pellet-length pitch of 15 mm, even in the central higher-power regions of the fuel rods. The axial locations of the grid spacers in the BO-5 assembly are also easily distinguished as a general activity decrease of approximately 10% over several centimeters in length.

Several segments exhibit nonsymmetric, relatively random decreases in the axial gamma activity distribution, indicating the presence of localized regions where there is a decrease in the effective density of the fuel. For those localized regions where the activity changed drastically in the first few centimeters of fuel from the end of the segment that was sectioned prior to shipping to PNL, the activity loss can be attributed to fuel fallout during

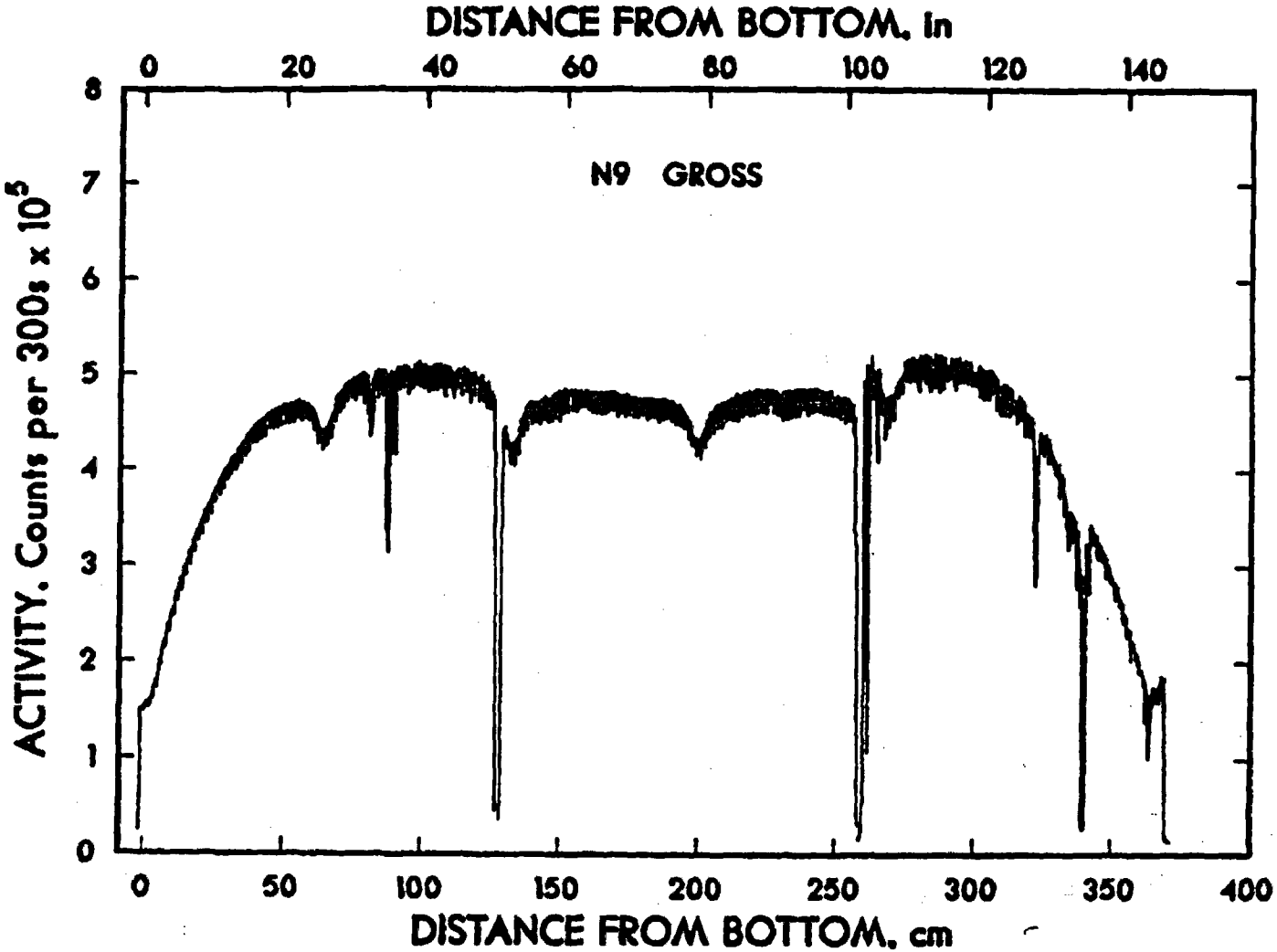


FIGURE 4.19. Composite of Gross Gamma Scans for Rod N-9

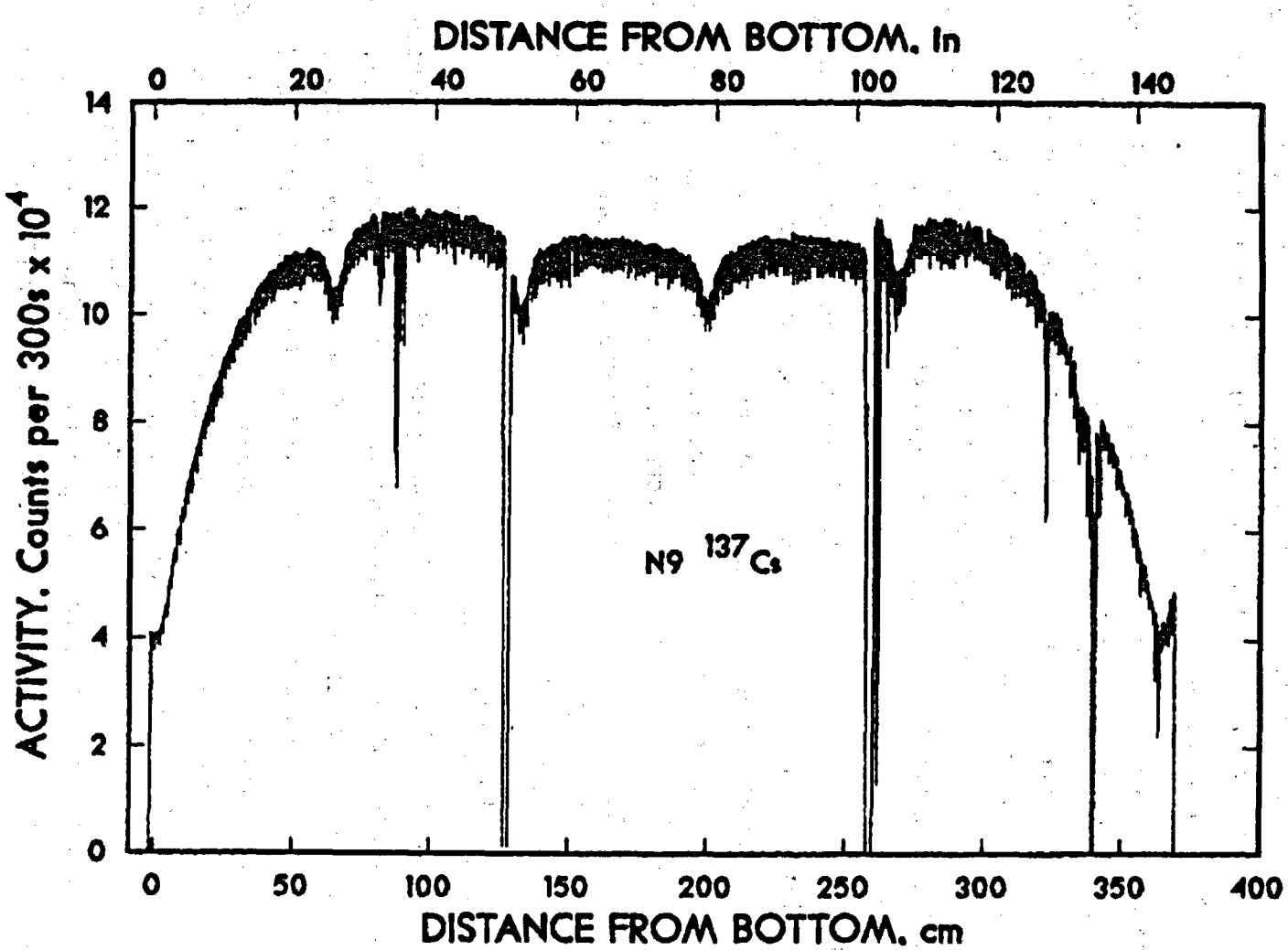


FIGURE 4.20. Composite of ^{137}Cs Gamma Scans for Rod N-9

handling and/or shipping. Where activity decreases occur away from a sectioned end of a segment, the region of low activity is assumed to be due to a small amount of in-reactor densification and minor rearrangement or settling of the fuel stack during commercial operation. These regions of low activity due to in-reactor densification are tabulated in Table 4.10.

A portion of the center segment of rod C-5 was gamma scanned with a narrow slit, i.e., 0.25 mm (0.010 in.), in an effort to determine if any significant ^{137}Cs migration had occurred during operation. This slit width probably approximates the sum of the dish depth in adjacent pellets, although the as-built geometry of the dishes has not been published. Axial steps of 0.25 mm (0.010 in.) and a counting time of 1000 s for each step were used. The results of the scan over approximately four pellets is shown in Figure 4.21. Whereas the interpellet activity dropped approximately 4% with the wider 2.5 mm slit, the dips in activity with the narrow 0.25 mm slit were about 30%. The latter approximates the decrease in activity that would be expected from the missing fuel associated with typical dishes. Therefore, it is concluded that no significant axial or radial migration of ^{137}Cs occurred during the commercial operation and that the ^{137}Cs activity is appropriate for use in normalizing burnups between rods (see Section 4.6).

4.8 RADIONUCLIDE INVENTORY CALCULATION

The radionuclide inventory in the ATM-101 spent fuel was calculated using the ORIGEN-2 code (Croff, 1980) for functions of burnup level (power level) and decay time. These inventory calculations were performed to permit estimation of the source term for any particular portion of ATM-101 that might be used in an experiment. Calculations were made for burnup levels from 10 to 35 MWd/kgM in 5 MWd/kgM increments with decay times of 10, 12, 14, and 16 years, i.e., the period over which ATM-101 is expected to be used in radionuclide release experiments. The ORIGEN-2 results provide inventories of both the actinides and fission products in units of both grams per gram original uranium and curies per gram of original uranium. Appendix E provides tables of the inventories at the six burnup levels and the four decay times for individual

TABLE 4.10. Regions of Apparent In-Reactor Densification and Fuel Setting[a]

Rod Segment No.	Regions of Apparent Densification, and Settling, Distance from Bottom of Fuel in Segment, cm (in.)
C-5-B	
-C	11.7 to 29.2 (5.4 to 11.5)
-T	
D-10-B	
-C	
-T	
G-9-B	
-C	
-T	
G-13-B	
-C	
-T	
J-12-B	
-C	
-T	
L-8-B	
-C	0 to 11.4 (0to 4.5)
-T	
N-4-B	
-C	
-T	
N-9-B	80.8 to 85.6 (31.8 to 33.7), 89.7 to 93.5 (35.3 to 36.8)
-C	None
-T	0 to 7.1 (0 to 2.8), 61.5 to 65.0 (24.2 to 25.6), 78.2 to 83.8 (30.8 to 33.0), 102.9 to 105.7 (40.5 to 41.6)
N-12-B	None
-C	
-T	

(a) Blank spaces indicate examinations not currently scheduled.

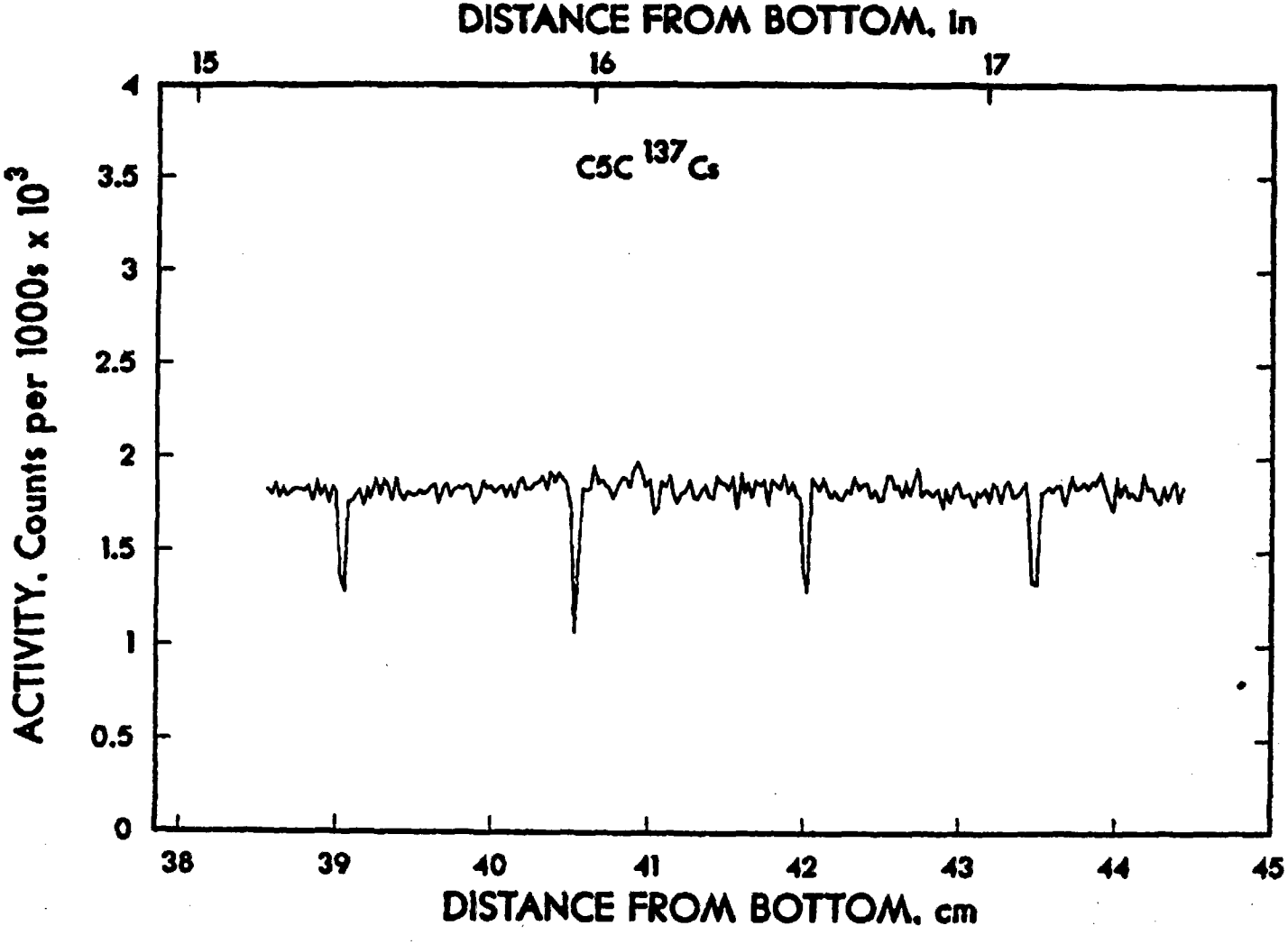


FIGURE 4.21. ^{137}Cs Gamma Scan of Rod C5C with Narrow Slit and Small Steps

isotopes and the elements, as well as listings of the sources of neutrons. A concentration cutoff of 10^{-15} units was used to reduce the listings to a manageable level.

An estimate of the amount of an isotope or element of interest in a particular specimen sample can be determined from a knowledge of the fuel burnup (Section 4.6), weight of the specimen sample, and linear interpolations between 1) the burnup levels that bracket the actual burnup, and 2) the decay periods that bracket the decay time of interest. For example, if the one is interested in the curies of ^{233}U in a 10 g sample of UO_2 at a burnup of 28.0 MWd/kgM in November 1987, the inventory is found as follows:

- The tables that bracket the burnup levels for actinides in units of Ci/gU are determined, i.e., Tables E.4.c (25 MWd/kgM) and E.5.c (30 MWd/kgM).
- The inventories per gram uranium of ^{233}U after a decay period of 13 1/2 years are determined by linear interpolation between the 12 and 14 year data columns for both burnup levels, i.e., 1.540×10^{-11} Ci/gU at 25 MWd/kgM and 1.874×10^{-11} Ci/gU at 30 MWd/kgM.
- The inventory per gram uranium of ^{233}U at the specific burnup of 28.0 MWd/kgM is determined by linear interpolation between the burnup values, i.e., 1.740×10^{-11} Ci/gU.
- Finally, the total ^{233}U inventory for the specimen is determined, i.e., $(1.740 \times 10^{-11}$ Ci/gU) (10 g) (0.881) = 1.533×10^{-10} Ci.

Note that the inventories are listed in units per gram of uranium. Therefore, if the weight of the specimen sample is in units per gram of oxide, the listed values need to be multiplied by 0.881.

4.9 RADIONUCLIDE CHEMICAL OVERCHECK

A few isotopes from the ORIGIN-calculated inventories listed in Section 4.8 were compared with chemically determined inventories. The isotopes that were planned for chemical determination for this overcheck were ^{235}U, ^{239}Pu, ^{237}Np, ^{99}Tc, and ^{137}Cs. The ^{235}U and ^{239}Pu were determined as part of the burnup analyses using ASTM Standard procedure E 321. Analyses for ^{237}Np

are currently still in progress. The ^{99}Tc was determined using a combination ion-exchange and solvent-extraction separation procedure and beta counting on calibrated thin-window gas flow proportional counters. The ^{137}Cs analyses were made using ASTM Standard Procedure E 692. Analyses for these isotopes have been completed for two of the five samples from five burnup levels in rod N-9.

The analytical results are compared to the ORIGEN-calculated inventories in Table 4.11. Values of other radioisotopes routinely determined as part of the burnup analyses are also tabulated in Appendix F. The analytical results are within ±10% of the calculated results, indicating that the ORIGEN-calculated results can be used for estimates of the radionuclide inventory in ATM-101 specimens for radionuclide release studies.

In addition, because the original nitrogen content (the source of ^{14}C) of the fuel was unknown, the ^{14}C content of a fuel sample and a nondecrudded cladding sample were determined, and are listed in Table 4.11. The ^{14}C was determined by a total combustion technique in an induction furnace at 1300°C. The released gases were passed over a catalyst for conversion of any CO to CO_2, and then trapped in a basic solution for counting in solution by liquid scintillation.

4.10 PERTINENT RESULTS FROM SIBLING RODS

Several nondestructive examinations and destructive examinations have been performed on sibling rods from Assembly BO-5. The results of these examinations are discussed below and were primarily taken from the summary of Einziger and Fish, 1982.

4.10.1 Nondestructive Examination Results

Visual examinations were performed for defects and crud deposits on eighteen fuel rods from Assembly BO-5 in the Battelle Columbus Laboratory (BCL) hot cells. Below approximately the 320 cm (130 in.) level only light axial scratches were observed during the assembly dismantling process. The crud in this region was very light and almost unnoticeable. Above the 320 cm level there was a relatively heavy crud deposit on all the rods.

TABLE 4.11. Comparison of Chemical Overcheck Results to ORIGEN-Calculated Radionuclide Inventory

Sample No.	Burnup, MWd/kgM	Radionuclide Inventory																
		^{235}U, wt% (oxide)			^{239}Pu, wt% (oxide)			^{237}Np			^{137}Cs, Ci/g (oxide)			^{99}Tc, Ci/g (oxide)			^{14}C, Ci/g (sample)
		Analytical[a]	ORIGEN[b]	Analytical ORIGEN	Analytical[a]	ORIGEN[b]	Analytical ORIGEN	Analytical	ORIGEN	Analytical ORIGEN	Analytical	ORIGEN[b]	Analytical ORIGEN	Analytical	ORIGEN[b]	Analytical ORIGEN	Analytical
N-9C-D	31.66	4.86×10^{-3}	4.92×10^{-3}	0.989	4.20×10^{-3}	4.47×10^{-3}	0.940				7.13×10^{-2}	6.99×10^{-2}	1.020	1.02×10^{-5}	1.09×10^{-5}	0.934	-
N-9C-J	28.47	6.18×10^{-3}	5.86×10^{-3}	1.050	4.55×10^{-3}	4.41×10^{-3}	1.030				6.27×10^{-2}	6.27×10^{-2}	1.000	8.95×10^{-5}	9.96×10^{-5}	0.899	-
N-9B-D																		
N-9B-M																		
N-9B-S																		
N-9C-B	31.66	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.30×10^{-10}
N-9C-B	Cladding	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.00×10^{-10}

(a) From analytical burnup analysis, Table F.1.
(b) From ORIGEN runs, Appendix E. Values are from a linear interpolation between nearest burnup levels, multiplied by 0.881 to correct to basis of original oxide weight, and a ten year decay period.

Diameter measurements were also performed in the BCL hot cells on eighteen rods from Assembly BO-5. A spiral profilometer was used to make the measurements. The amount of creepdown over the central two-thirds of the length of the rods was apparently about 0.7 percent, i.e., 0.076 mm (0.003 in.), based upon the preirradiation diameter. No evidence of ridging at pellet-pellet interfaces was observed. The position of maximum ovality in the cladding of the rods was routinely in the upper 10% of the fueled length.

Gamma scanning results were also carried out on several rods at BCL, ANL, and LANL. The results were similar to those obtained for the ATM-101 rods (Section 4.7) except that fuel stack heights were determined for the nonsectioned sibling rods. The stack heights in eighteen rods measured at BCL was very uniform in length, 365.5 ±1.0 cm (143.5 ±0.4 in.). On the average the stacks contained 6 ±3 large pellet-pellet gaps. Pellet-pellet interfaces were easily discerned when the counting geometry and statistics permitted resolution.

Eddy-current examinations were conducted by BCL on eighteen rods from Assembly BO-5. Cladding defect indications were found on only four rods. Indications in two of these rods correlated with large pellet-pellet gaps. The eddy-current indications in the other two rods did not correlate with any known feature, and may be actual defects. The signal from one rod, P-4, indicated a very long-length defect, e.g., about 7.6 cm, and apparently the source of the signal was a longitudinal defect on the inner surface of the cladding. This type of signal is not typical of more common defects, e.g., pits, holes, hydride cracks, and pellet-cladding interaction type cracks, and may represent an as-fabricated tubing defect that was not detected.

4.10.2 Destructive Examination Results

Gas analyses were performed on the fill gas from 28 sibling rods from Assembly BO-5. The results from the rods are compared to the data from ATM-101 rods in Table 4.12. The results from the two data sets compare very favorably.

Metallographic examination of the cladding from two sibling rods was performed by EG&G-Idaho. Hydride precipitation was primarily circumferentially oriented. The thickness of exterior and interior oxide formation was measured

TABLE 4.12. Comparison of Fission Gas Data from Nine ATM-101 Rods to Data from 28 Sibling Rods from Assembly BO-5 (including standard deviations)

	Void Volume, cm^3	Gas Volume, cm^3 @ STP	Gas Pressure, MPa	Fission Gas Release, %
Sibling rods	24.7 ±1.5	370 ±10	1.52 ±0.10	0.21 ±0.05
ATM-101 rods[a]	21.9 ±1.3	366 ±5	1.69 ±0.10	0.20[b]

(a) Computed from acceptable data from Table 4.2.
(b) Sufficient burnup data not available to compute actual average and standard deviation

along the length of the fuel rods. The data are depicted in Figure 4.22, along with the external oxide thickness determined for two samples from rod N-9. The exterior oxide thickness increases with height along the rod, as expected due to increasing coolant temperature up the rod. The results for rod N-9 tend to be slightly lower than results for similar rods. No evidence of nodular oxidation/corrosion was observed.

Cladding microhardness measurements were made at BCL during the effort to estimate the assembly temperatures during the handling incident (Section 4.3). The Knoop hardness with a one kilogram load was measured at five axial locations on six rods with indentions both parallel to and perpendicular to the radius of the cladding. No significant differences in hardness were observed either between rods, at the different levels, or in the two directions. The average microhardness was 250.

Tensile specimens from the cladding of several rods were also tested at BCL over the temperature range from 27 to 371°C. Strength and elongation values are listed in Table 4.13.

Ceramographic examination of the fuel was reported by EG&G-Idaho and ANL. Transverse ceramography indicated formation of from four to thirteen fragments with the cracks oriented primarily radially. There was some indication of grain growth in the fuel, from 4 to 7 μm diameter at the centerline of specimens taken near the midplane of the rod. This result compares favorably with

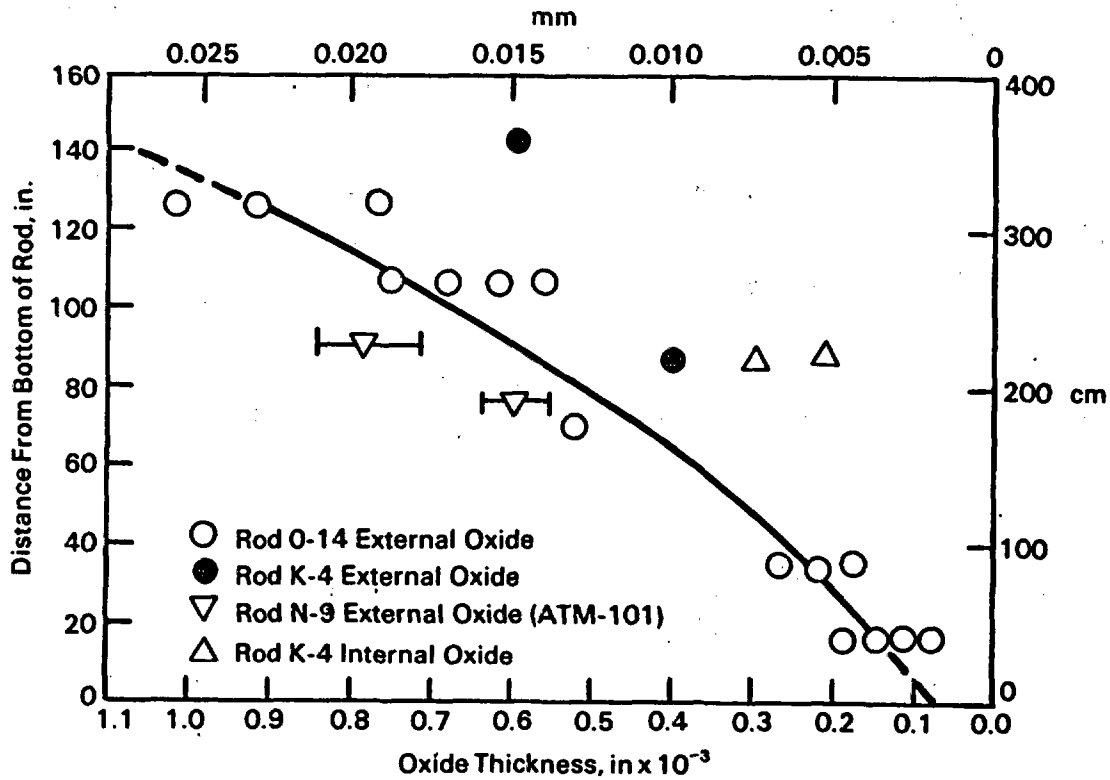


FIGURE 4.22. Oxide Thickness Variations Along Zircaloy Fuel Rod from H. B. Robinson Unit 2

TABLE 4.13. Strength and Elongation Values for Cladding from Assembly BO-5 Sibling Rods[a]

Temperature, °C ±3°	Strength, MPa (ksi)[b]		Elongation	
	Ultimate	0.2% Offset	Uniform	Total
27	974 (141)	815 (118)	3.37	6.01
93	907 (132)	750 (109)	3.73	6.57
204	799 (116)	659 (96)	4.01	6.74
316	685 (100)	578 (84)	2.59	6.29
371	659 (96)	528 (77)	3.63	12.6[c]

(a) Average of three measurements at strain rate of 0.005/min to yield and 0.025/min to fracture.
(b) Based on tube area of 0.19 cm^2 (0.029 $in.^2$).
(c) Based on only two measurements.

the "intercept" grain sizes determined for rod N-9 (Table 4.6). The presence of large pores indicated that the fuel had been fabricated using a pore-former.

Both PNL and LANL conducted radial microprobe measurements on fuel from Assembly BO-5. The distributions of plutonium and ruthenium peaked near the outer edge of the pellet, while technetium, barium, cesium, zirconium, iodine, tellerium, and cerium distributions were essentially constant across the radius. Details for these measurements are discussed in Einziger and Fish, 1982.

5.0 DISTRIBUTION OF ATM-101 SPENT FUEL

Several segments of ATM-101 have been sectioned and distributed to experimenters. This section describes pertinent information relating to these distributed materials. Sectioning diagrams for the segments are provided in Appendix B.

5.1 CRUSHED MATERIAL FOR BWIP - SEGMENT N-9C

The Basalt Waste Isolation Project (BWIP) requested 250 g of ATM-101. The material was requested to be crushed to the -60 to +250 mesh size range, with material in the -60 to +115 mesh range being preferred. ATM-101 fuel rod segment N-9C was used to produce this material, along with several MCC characterization samples. The sectioning diagram for segment N-9C is shown in Figure B.3.

Material for the crushed BWIP fuel was taken from Sections A, G, and N. The material from Sections A and G was first ground and sieved and then the location of the N-O cut was determined to provide sufficient material for the lot. Each cut for MCC samples was made using an Isomet low-speed saw equipped with a Buehler low concentration diamond wafering blade. The cuts were made dry, i.e., no lubricant was used. No loss of fuel fragments from the ends of any of the samples or BWIP material was observed during this sectioning procedure. Sections A and G were cut into approximately 5 cm-long (2 in.) lengths using a tubing cutter. The fuel in each rod piece was removed from the cladding by striking the cladding with an impactor. The collected fuel was weighed and placed in a Torsien Model MG-2 power-grinder. The power-grinder was equipped with corundum mortar and pestle. The fuel was ground for approximately five seconds and then sieved through a 60 mesh screen. The +60 mesh material was returned to the grinder. This sequence was repeated approximately 40 times until all the material from Sections A and G passed through the 60 mesh screen. After further screening, the quantity of material in the various particle size ranges was determined (Table 5.1).

TABLE 5.1. Description of Initial Run on BWIP Material

Particle Size	Weight, g	Weight, %
(Initial fuel)	287.7	100.0
-60 +115	155.7	54.1
-115 +250	61.6	21.4
-250	63.8	22.2
Not recovered	6.6	2.3

Section N was processed in the same manner as Sections A and G. It required approximately 25 grindings/screenings to reduce the material to less than the 60 mesh size. Loss of material during processing Section N was not recorded. The crushed fuel from Sections A, G, and N was combined and mixed by repeating the screening operation. The quantities of material in the various particle size ranges for the entire lot are listed in Table 5.2.

The three sizes fractions were separated into samples/specimens as listed in Table 5.3.

The crushed BWIP material was also subjected to analyses by inductively-coupled plasma (ICP) spectrometry and x-ray diffraction in order to ascertain if there were any significant differences in composition between the three particle size ranges.

For the ICP analyses, the materials were fused in KOH in a nickel crucible at red heat and then dissolved in distilled water. A drop of acid was added to the solution to prevent precipitation. Because the presence of uranium interfered with the individual elemental analyses, a set of matrix-matched standard uranium solutions was prepared, analyses completed at the appropriate elemental

TABLE 5.2. Description of BWIP Material

Particle Size	Weight, g	Weight, %	Weight in -60 to +250 Range, %
-60 +115 mesh	221.8	55.2	0.72
-115 +250 mesh	88.2	21.9	0.28
-250 mesh	91.9	22.9	-
Total	401.9	100.0	100.0

TABLE 5.3. BWIP Crushed Fuel Distribution

Sample/Specimen Identification[a]	Weight, g	Distribution/Location
ATM-101, R1	166.3	BWIP product shipped to HEDL - 325 Bldg.
ATM-101, R2	32.3	
ATM-101, R3	35.1	
N-9C, R1,222S	30.4	BWIP product stored in D-cell - 324 Bldg.
N-9C, R2, 222S	30.3	for later transfer to Rockwell-222S Bldg.
N-9C, R3, 222S	30.9	
N-9C, R1, MCC	14.9	MCC archive material, stored in D-cell -
N-9C, R2, MCC	15.2	324 Bldg.
N-9C, R3, MCC	15.6	
N-9C, R1	1.9	Shipped to HEDL - 327 Bldg. for optical
N-9C, R2	2.2	microscopy
N-9C, R3	2.0	
N-9C, R1	3.2	Shipped to HEDL/PNL-325 Bldg. for chemical
N-9C, R2	3.0	analysis
N-9C, R3	2.9	
N9C, R1	5.1	Spare material stored in D-cell - 324 Bldg.
N9C, R2	5.2	
N9C, R3	5.4	

(a) R1 = -60 to +115 mesh material.
R2 = -115 to +250 mesh material.
R3 = -250 mesh material.

signals, and a uranium data fit was produced, using a linear regression analysis, in order to provide a curve for subtraction of the uranium background from the individual elemental results. The regression coefficient was sufficient for all the standard elements analyzed by ICP except Ba, Ca, Mg, Na, and Zn. The results of the ICP analyses are listed in Table 5.4 and the results for the fission product elements are shown graphically in Figure 5.1. One's initial reaction to the data is that there might be a tendency for lower concentration of the fission products in the smaller sized particles, e.g., the concentration of Ce, Rh, Te, Ru, La and Nd appear to decrease with particle size. However, these are the elements for which the largest corrections are required for uranium interference (greater than one-half the total signal) and,

TABLE 5.4. ICP Results on Crushed BWIP Material[a]

Element[b]	Concentration, µg/g of fuel[c]								
	-60 + 115 mesh			-115 + 250 mesh			-250 mesh		
Al	-	-	(-)	-	-	(-)	1320	690	(1005)
B	220	700	(460)	-	190	(95)	-	-	(-)
Ca	806	-	(403)	350	-	(175)	-	-	(-)
Fe	200	170	(185)	280	32	(156)	170	170	(170)
La	980	900	(940)	980	890	(935)	950	880	(915)
Mn	260	230	(245)	350	320	(335)	210	220	(215)
Mo	2500	2400	(2450)	2500	2450	(2475)	2480	2380	(2430)
Nd	2780	2200	(2490)	2900	1660	(2280)	1920	1950	(1935)
Rh	730	-	(365)	790	-	(395)	-	-	(-)
Ru	1680	1430	(1555)	1580	1260	(1420)	1320	1320	(1320)
Si	-	-	(-)	-	-	(-)	2650	2120	(2385)
Sr	530	510	(520)	520	520	(520)	530	510	(520)
Te	260	80	(170)	-	-	(-)	-	-	(-)
Zr	2330	2130	(2230)	2280	2230	(2255)	2420	2250	(2335)

(a) Fuel fused in KOH in a nickel crucible.
(b) Cr, Dy, Li, and Ti not detected. Regression fit for interference of U not adequate to determine Ba, Ca, Mg, Na and Zn.
(c) Values shown are derived from two solutions prepared at 2000X dilution, and 1000X dilution; average in parentheses.

therefore, are subject to the largest variability in result. For those elements with the lowest required correction for uranium interference, i.e., Mo, Sr, and Zr, there are no significant differences between the three particle sizes. There is not sufficient information to absolutely conclude that there was no significant segregation of the radionuclides during preparation of the material; however, given the relatively moderate operating temperature of the fuel and minor amount of fission product migration observed in the fuel material, it is likely that most radionuclides are in solid solution in the UO_2 and it is probable that there was no significant segregation during preparation.

The source of the Al and Si in the smallest sized particle fraction was probably the grinding material used in the automated mortar and pestal. The

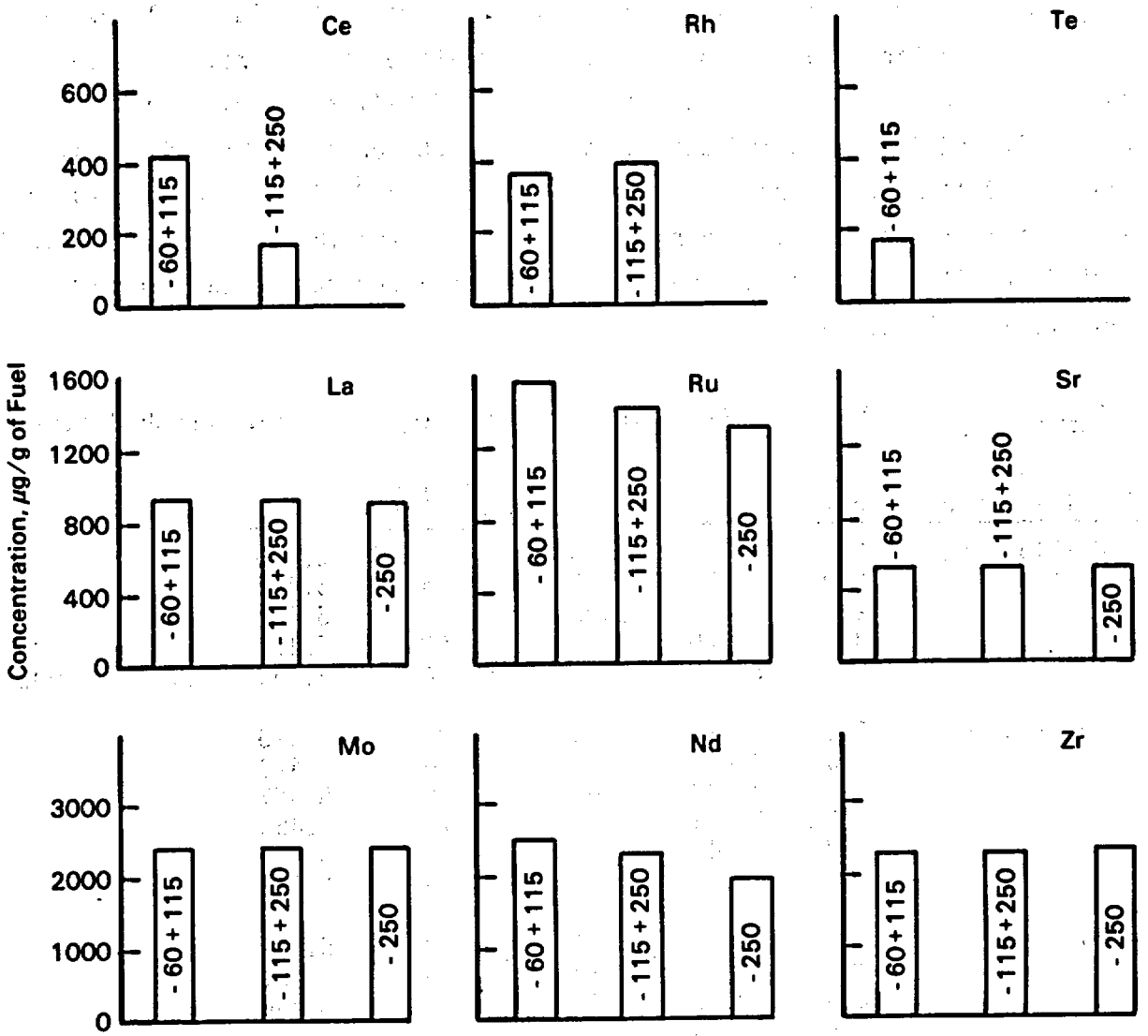


FIGURE 5.1. Comparison of Fission Product Concentration in BWIP Material with Three Particle Sizes

source of the iron was probably the cutoff saw blade, because the iron concentration is nearly constant in all the particle sizes. No source of the boron is offered.

The x-ray diffraction analyses were performed using the as-crushed materials. These particles were mounted in a 5/8 in. diameter, 3/64 in. deep specimen holder. A 0.00025 in. thick Mylar film was used to retain the powder and prevent contamination. The 26°-2θ Mylar peak was used as an internal standard. Diffraction scans were made in 0.02° steps with one second counting times. The

only phase observed in the three particle sizes was α-urania (Table 5.5). The two larger particle sizes showed identical lattice parameters, while in the smallest sized material the parameters were slightly smaller. The latter is generally considered to indicate a higher oxygen content, which is consistent with a small amount of room-temperature surface oxidation of the high-surface-area smallest particles. A possible explanation for the variation in relative peak intensities is that the particles are too large to prevent nonrandom orientation of the particles.

TABLE 5.5. Results from X-ray Diffraction Analyses of BWIP Crushed Material

Sample Identification	hkl	2θ	d, A	I, %(a)	a_o, A	
-60 +115 mesh	111	28.22	3.160	90	5.470	
	200	32.73	2.734	64	5.468	
	220	46.95	1.934	100	5.469	
	311	55.70	1.649	90	5.468	
	222	58.45	1.578	4	5.465	5.468 ± .002 A
-115 +250 mesh	111	28.19	3.163	100	5.478	
	200	32.70	2.736	36	5.472	
	220	46.97	1.933	82	5.467	
	311	55.74	1.648	79	5.465	
	222	58.44	1.578	14	5.466	
	400	68.62	1.367	6	5.466	5.469 ± .005 A
-250 mesh	111	28.30	3.151	73	5.457	
	200	32.83	2.726	70	5.451	
	220	47.07	1.929	88	5.456	
	311	55.85	1.645	100	5.455	
	222	58.57	1.575	37	5.455	
	400	68.73	1.365	29	5.458	5.455 ± /002 A

(a) Relative intensities for UO_2 are: 111, 100; 200, 48; 220, 49; 311, 47; 222, 13; and 400, 9. (JPDS card 5-0555).

5.2 MATERIAL FOR NNWSI - SEGMENT C-5C

The Nevada Nuclear Waste Site Investigation (Tuff Program) requested a segment of ATM-101 for studies at HEDL of the effects of potential cladding breaches on the release of radionuclides. ATM-101 fuel rod segment C-5C was provided to HEDL for these tests. A MCC transverse ceramography/metallography sample and MCC burnup sample were to be sectioned from the segment for characterization purposes. HEDL also planned to section a longitudinal ceramography/metallography specimen from the segment and will provide the examination results for inclusion in Section 4.5 of later versions of this report. The preliminary sectioning diagram for segment C-5C is shown in Figure B.1.

5.3 MATERIAL FOR CSFMPO - SEGMENT N-9B

The Commercial Spent Fuel Management Program Office (CSFMPO) requested one of several segments of ATM-101 that they expect to need in the next two years. Because they desired a variation in the degree of pellet fragmentation and resultant fuel surface area for fuel oxidation studies, an end segment, N-9B, was provided for these tests. Several MCC burnup, chemistry, and ceramography/metallography samples were also planned to be sectioned from the rod segment to complete the characterization of fuel rod N-9. These samples will be sectioned using the same procedures described in Section 5.1 for the BWIP material. The preliminary sectioning diagram for segment N-9B is shown in Figure B.2.

ACKNOWLEDGMENTS

The characterization of ATM-101 is the result of the efforts of several organizations and many people. The author would like to express his thanks to the following people for their efforts in characterizing this material:

- EG&G - Idaho
  - James A. Cook; gas sampling, rod segmenting, and shipping
- Exxon Nuclear - Idaho
  - Richard A. Rankin; gas analysis
- Hanford Engineering Development Laboratory
  - Norris H. Johnson and Mabry E. McMahan; gamma scanning
  - William Y. Matsumoto and John J. McCown; chemical analysis, and ^{148}Nd and ^{137}Cs burnup calculations
  - Raymond D. Bell, Delbert J. DesChane, and Jon M. Lott; ceramography-metallography
- Pacific Northwest Laboratory
  - Randy E. Thornhill and Cheryl A. Knox; sectioning, sampling, and storage
  - Urban P. Jenquin; ORIGEN calculations
  - George B. Mellinger; shipping and BWIP material characterization
  - Nancy J. Wildung; data reduction
  - J. Leland Daniel and John E. Mendel; program direction and management

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APPENDIX A

POWER HISTORY FOR ASSEMBLY BO-5

APPENDIX A

POWER HISTORY FOR ASSEMBLY BO-5

A month-by-month summary of the power history for Assembly BO-5 in the H. B. Robinson Unit 2 reactor is listed in Table A.1.

TABLE A.1. Power History for Assembly BO-5

Cycle I			
	LHGR, kW/m		
Date	Average	Peak	EFPD
October 1971	22.9	31.3	95.7
November 1971	22.9	31.7	120.0
December 1971	23.3	32.7	149.9
January 1972	23.8	31.3	177.2
February 1972	23.9	31.1	205.3
March 1972	22.9	28.6	235.5
April 1972	22.9	29.2	265.2
May 1972	22.5	28.6	270.7
June 1972	22.5	28.6	289.5
July 1972	22.7	28.3	312.6
August 1972	21.6	27.1	341.2
September 1972	21.3	25.6	369.0
October 1972	21.5	27.5	398.6
November 1972	20.8	27.3	423.6
December 1972	20.4	27.0	443.9
January 1973	21.4	26.9	460.4
February 1973	21.8	27.9	475.7
March 1973	20.1	26.4	487.2

Cycle II			
	LHGR, kW/m		
Date	Average	Peak	EFPD
May 1973	17.8	22.9	6.5
June 1973	16.9	21.5	25.4
July 1973	18.3	24.6	58.8
August 1973	18.4	24.4	87.6
September 1973	17.9	23.1	116.6
October 1973	17.3	22.7	145.2
November 1973	17.5	21.9	166.2
December 1973	17.6	22.2	192.6
January 1974	17.7	22.2	221.2
February 1974	17.6	22.1	247.8
March 1974	17.6	21.9	278.1
April 1974	17.5	21.9	307.2
May 1974	17.5	21.2	311.8
Total			799 EFPD

Average burnup - 28.0 MWd/kgM
Peak burnup - 31.4 MWd/kgM
Removed May 6, 1974

APPENDIX B

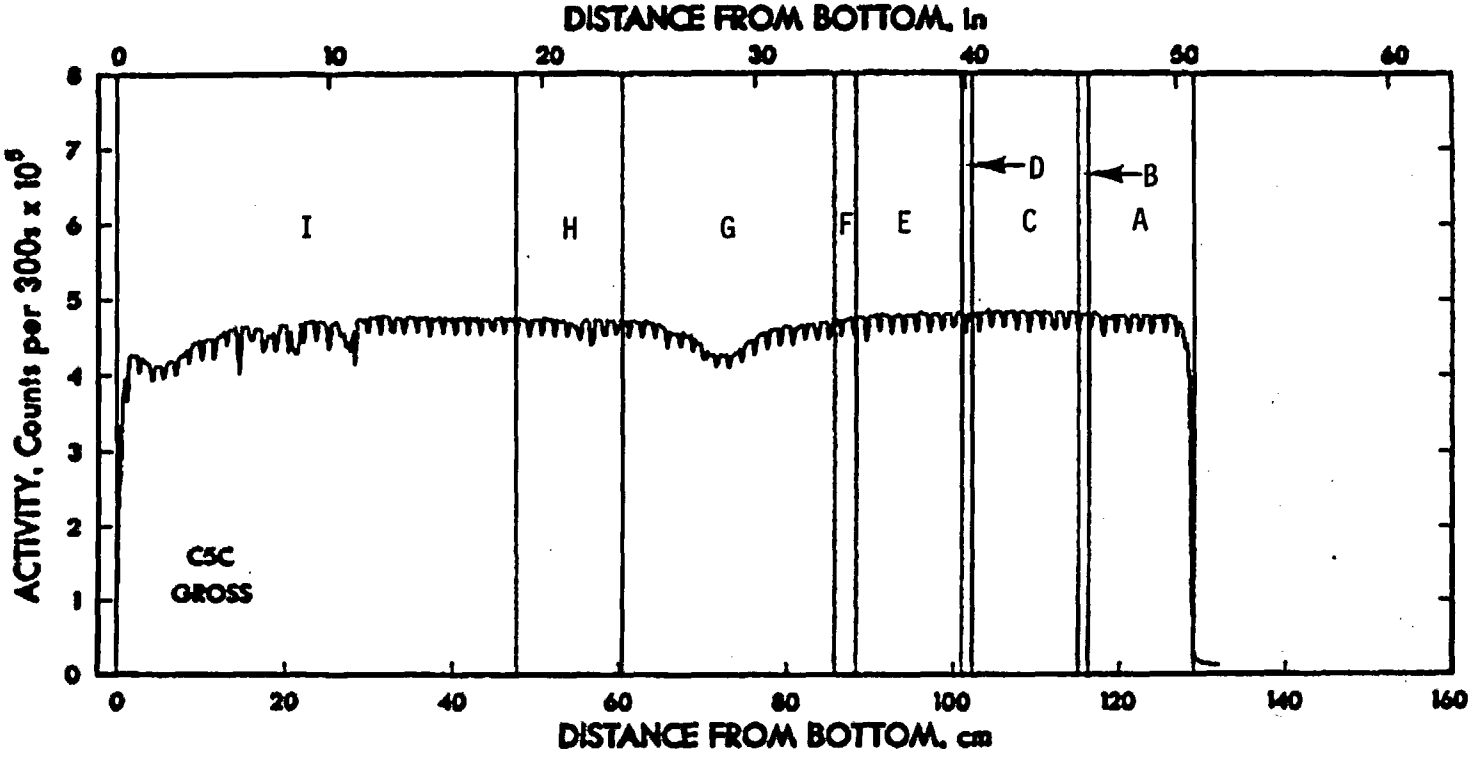
SECTIONING DIAGRAMS

APPENDIX B

SECTIONING DIAGRAMS

Segments C-5C, N-9C, and N-9B of ATM-101 have been or are in the process of being sectioned and distributed to experimenters. The material has been distributed as listed below:

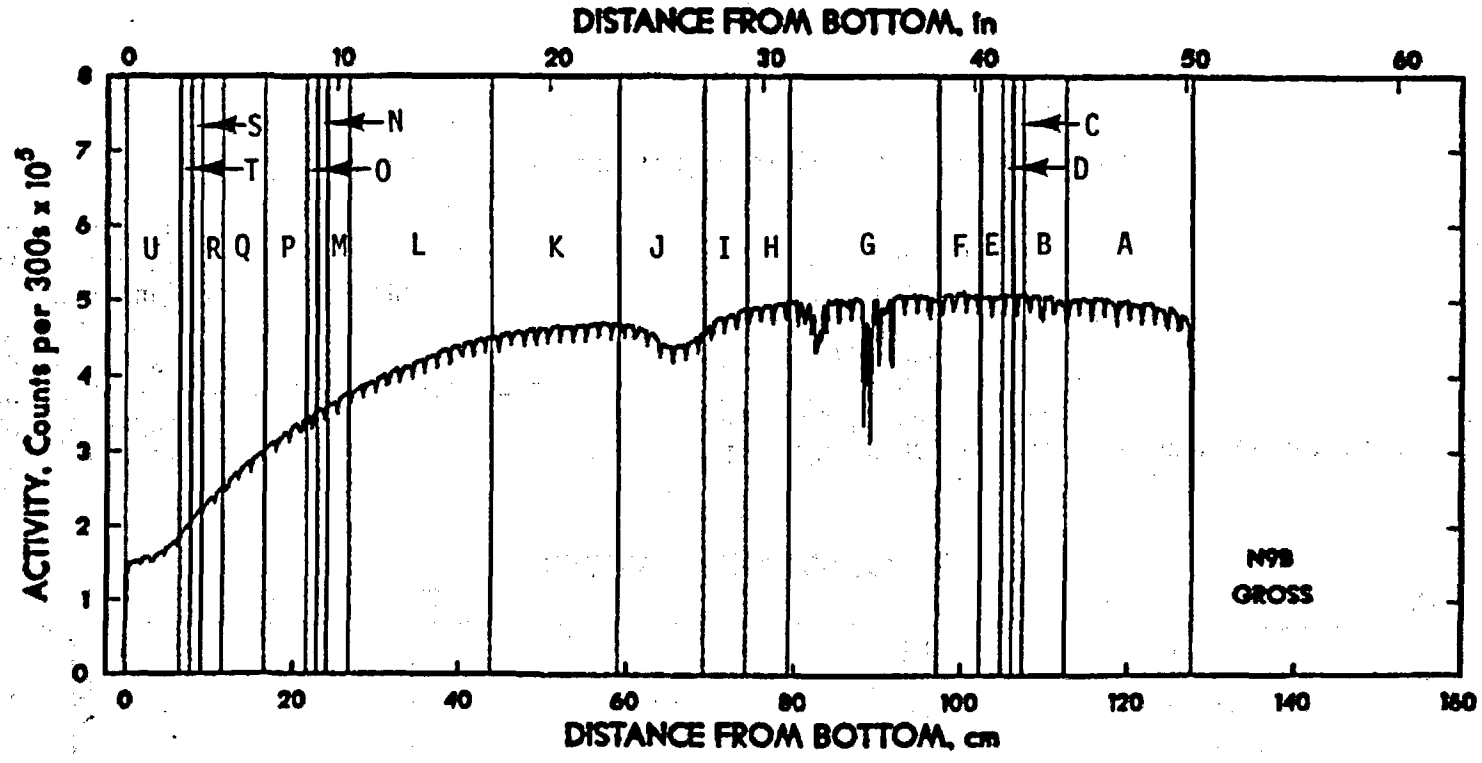
Segment No.	Destination	Figure No.
C-5C	NNWSI	B.1
N-9B	CSFMPO	B.2
N-9C	BWIP	B.3



Legend

A. NNWSI Nondefected Specimen
B. MCC Transverse Ceramography (upper surface)
C. NNWSI Laser-Drilled Specimen
D. MCC Burnup Sample
E. NNWSI Slit Specimen
F. NNWSI Longitudinal Ceramography
G. Spare Material
H. NNWSI Bare Fuel Specimen
I. Spare Material and MCC Archive

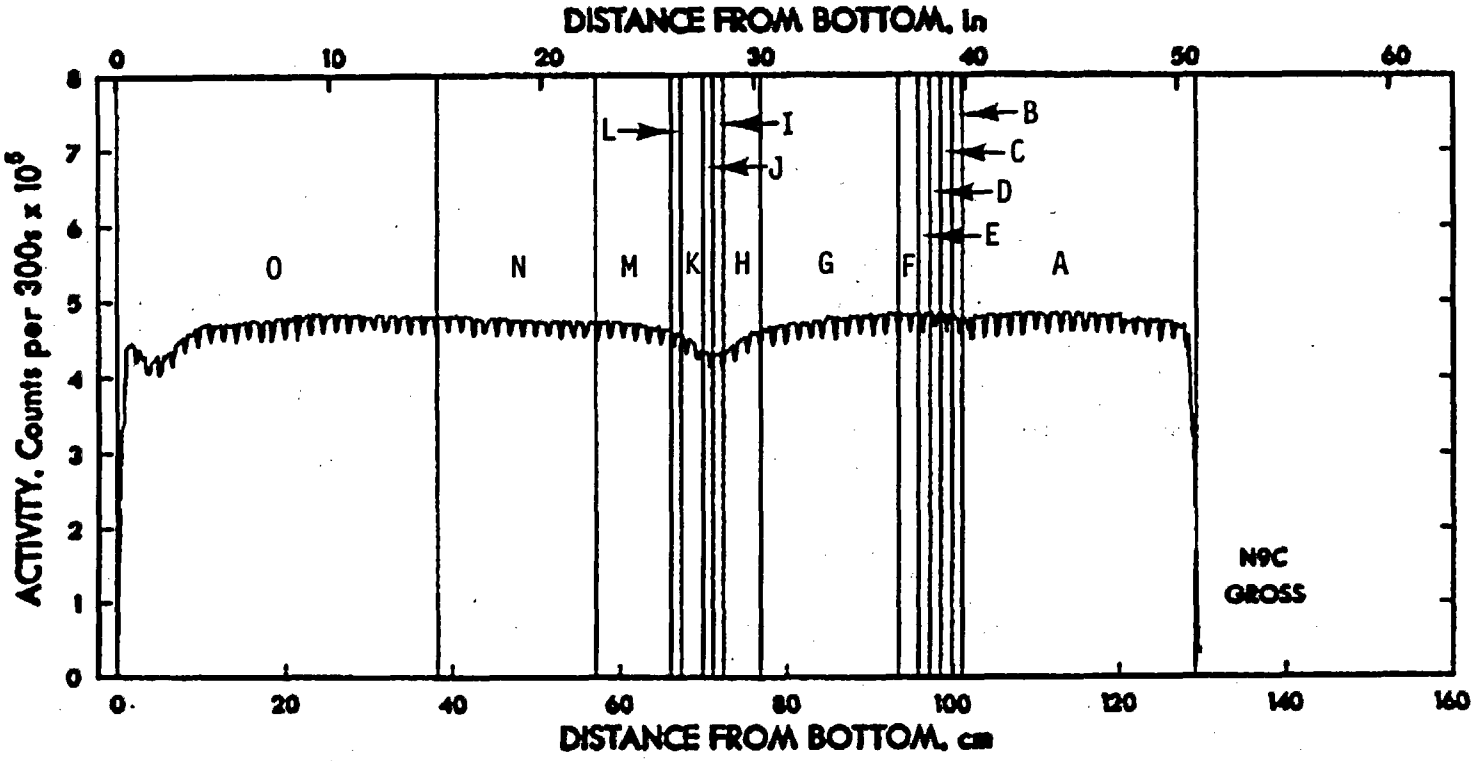
FIGURE B.1. Preliminary Sectioning Diagram for Segment C-5C



Legend

A. CSFMPO Cladding Defect Specimen
B. CSFMPO Declad-Specimen
C. MCC Transverse Ceramography (upper surface)
D. MCC Burnup Sample
E. MCC Longitudinal Ceramography
F. CSFMPO Declad Specimen
G. Spare Material
H. CSFMPO Cladding Ring Specimen
I. CSFMPO Cladding Ring Specimen
J. Spare Material
K. CSFMPO Cladding Defect Specimen
L. MCC Archive
M. MCC Longitudinal Ceramography
N. MCC Burnup Sample
O. MCC Transverse Ceramography (upper surface)
P. CSFMPO Declad Specimen
Q. CSFMPO Declad Specimen
R. MCC Longitudinal Ceramography
S. MCC Burnup Sample
T. MCC Transverse Ceramography (upper surface)
U. Spare Material

FIGURE B.2. Preliminary Sectioning Diagram for Segment N-9B



Legend

A. BWIP Material
B. MCC ^{14}C Sample
C. MCC Transverse Ceramography (upper surface)
D. MCC Burnup Sample
E. MCC SEM Sample
F. MCC Longitudinal Ceramography
G. BWIP Material
H. Spare Material
I. MCC Transverse Ceramography (lower surface)
J. MCC Burnup Sample
K. MCC Longitudinal Ceramography
L. Spare Material
M. MCC Archive
N. BWIP Material
O. Spare Material

FIGURE B.3. Final Sectioning Diagram for Segment N-9C

APPENDIX C

DETAILS OF GAS ANALYSES

APPENDIX C

DETAILS OF GAS ANALYSES

This appendix is organized in the following manner: Part 1 deals with the volume, internal pressure, and gas composition data for each fuel rod that was analyzed; Part 2 discussed the methods and assumptions used in the calculation of the random error for each of the individual data elements; Part 3 summarizes the procedures used, including the apparatus, the actual gas collection and measurement, and the void volume and internal pressure determination; and Part 4 deals with instrument calibration records. Gas sampling was conducted by EG&G-Idaho and chemical analyses were conducted by Exxon Nuclear, Idaho.

PART 1: SEPARATE DATA FOR EACH ROD

Gas volume and internal pressure data for each fuel rod are given in Section 4.4 of the body of this report along with a value representing the random error for each of the individual data elements. Details of the method used in calculating each of the random errors are given in the Part 2 of this Appendix. Note that for two of the rods N-12 and N-9, the void volume measurement appears to be in error. This was due to a faulty valve. The volume percent composition for each of the gas samples taken from the separate fuel rods is also listed in Section 4.4 of the body of the report, along with an associated random error. For these data, a lower limit of detection of 0.01 vol% was established, based upon instrument operating experience. For components which measured below this limit, no uncertainty was calculated. Organic components, estimated to be primarily lighter molecules, were only approximated. Isotopic compositions for both xenon and krypton are also given in Section 4.4 of the body of the report. Following is a synopsis of unusual events that occurred with gas collection from each rod, given in the order that they were drilled.

Element	Unusual Events
L-8	Rod was drilled without difficulty. Soon after gas collection was made, mercury inadvertently entered the pumping system (a

design flaw in the gas collection apparatus). This necessitated the removal and cleaning of parts of the pumping system. After this point, the 10 mm remote head of the Baratron pressure measurement device no longer functioned properly. At this time, a particulate filter was added to the cell line to prevent contamination of the gas collection equipment.

N-12 Several problems occurred with the drill fixture provided by EG&G Idaho Hot Cells South. It was necessary to remove the fixture and work on it. It was necessary to backfill the fuel rod three times to get two void volume measurements to agree. This was probably due to a leaking valve that was not discovered until later.

N-9 No apparent difficulties; possibility of the data being affected slightly by an incipient value failure.

C-5 Discovered that the fixture valve was leaking. The backfill procedure was changed to backfill to the cell line valve, so as to eliminate the fixture valve from consideration. Drilling of the fuel rod went well.

G-9 Time was lost in this drilling, due to room temperature rising above 100°F. Otherwise drilling was uneventful.

J-12 The temperature problem continued, with no other apparent difficulties.

D-10 On the first drill attempt, the drill broke. A new sample line had to be installed because the fitting broke at the fixture. At this time, the faulty fixture valve was removed from the system. The fixture was removed to repair the drill and returned to the cell. A leak was discovered in the fixture, and the fixture was again removed and repaired. After two days, the fuel rod was drilled.

G-13 No apparent problems.

N-4 No apparent problems.

PART 2: CALCULATION OF UNCERTAINTY

Several different methods were used by Exxon Nuclear, Idaho, to estimate uncertainty for the various types of data. An estimate of the random error encountered with the first type of data, i.e., volume and pressure data, was based upon the assumption that the largest source of error in the measurement is represented by variations in repeated calibrations of the gas collection apparatus. The random error for this type of measurement was estimated by calculating the relative standard deviation of several calibration measurements. For the simpler pressure, volume, temperature relationships, such as measurement of the gas volume within the fuel element, a factor of two times the relative standards deviation is sufficient. For the more complex measurements, such as determination of the void volume, errors obtained in the different measurement sequences were summed. Using this method, the estimated random error associated with these measurements were:

Gas volumes	±2.4%
Void volumes	±4.7%
Internal pressure	±4.7%

Note that this is only an estimate of the random error. Any systematic errors due to the method of sample collection are not included. Other data types are the volume percent of gases and isotopic composition data. There were three different methods used to estimate the random errors associated with these data elements. The first method (a) was based on the premise that the gas mass spectrometer recording medium cannot be read accurately to better than 0.5 chart divisions. This type of method would be used when the peak height was small enough that this is the dominant error associated with the calculation. The second method (b) is used in calculation of krypton isotopic composition where the peaks were large enough to be read reasonably well, but were smaller than the standard calibration peak heights. It was assumed that this error was included within the variation in the overall krypton to xenon ration. The third method (c) used to estimate the random error was based on routine calibration records for the period when the samples were analyzed. This method

was used for the components that were routinely checked during calibration and for those whose percent composition was the range of the calibration values.

The estimated random error produced by method (a) varies with individual peak height. Method (a) was used to estimate the error associated with the following data: hydrogen (where applicable); nitrogen (except element L8); oxygen, xenon 130; krypton 83; and krypton 85.

The estimated random error (twice the relative standard deviation) produced by method (b) was ±3.65%. Method (b) was used to estimate the error in the following data: krypton volume percent, xenon 131, krypton 84, and krypton 86.

The estimated random error (twice the relative standard deviation) produced by method (c) varied according to component and percent composition. This is summarized below:

N_2	0.22%	Range 40-100%
Ar	1.70%	Range 0.5-10%

Method (c) was used to estimate the error in the following data: helium; nitrogen in L8; argon; xenon volume percent; xenon 132, 134 and 136.

The organic volume percent data is an approximation, and no random error is estimated for the data elements.

PART 3: SUMMARY OF OPERATING PROCEDURES

Both the detailed operating procedure and the equipment used in the collection of gases from fuel were the responsibility of EG&G Idaho. The following summary is provided as a brief description of the gas analysis and collection procedure.

APPARATUS

The apparatus used to collect and measure the volume of gases contained in the fuel rods consisted of two basic systems. The first system, located within the EG&G hot cell, consisted of an air operated drill and vacuum-tight rod fixture. The rest of the collection and measuring system was located outside

the hot cell and was connected to the fixture with metal tubing. The collection and measurement apparatus included a Baratron pressure measurement system with two remote heads (ranges 0-10 mm and 0-1000 mm). Various expansion volumes were used, depending upon the volume of the gas collected. The volume of the system was calibrated by introducing known amounts of gas into the system and using the pressure, volume and temperature relationship to calculate the system volumes. The volume of the tubing connecting the fixture to the system and the volume of the fixture itself, were calculated using a similar procedure.

GAS COLLECTION/MEASUREMENT

With the fuel rod clamped in the vacuum tight fixture, the system was evacuated to the lowest pressure obtainable as indicated by the Baratron system, usually less than 0.1 torr. The system was then isolated from the pumping line to check for leaks as would be observed by a rise in pressure. No rise should be observed before puncturing a fuel rod.

When the system was shown to be leak tight, the rod was drilled and the gas was collected. When the system pressure stabilized, the final pressure was recorded and the quantity of gas was derived from the pressure, temperature, and system volume. The gas was then transferred to a gas bulb to await gas mass spectrometry analysis (using the Teoppler pump). The gas analysis was performed using a CEC-103 gas mass spectrometer. The use and calibration of this instrument are detailed in the CEC-103 Operations and Methods Manual.

VOID VOLUME

The void volume of the fuel rod was obtained by backfilling the rod with a known amount of gas, and measuring the volume of the system and the rod, then subtracting the volume of the system, as determined earlier. The system used for this work varied for different fuel rods due to a bad fixture valve, and the need to change the cell line.

SECTION 4: CALIBRATION

The equipment used in this work was calibrated according to the standard procedures described above. Calibration records that are applicable to this work are found in CEC-103 Gas mass Spectrometer Log Book No. 7 and Remote Gas Collection and Void Volume Log Book No. 2.

APPENDIX D

GAMMA SCAN RESULTS

FIGURES

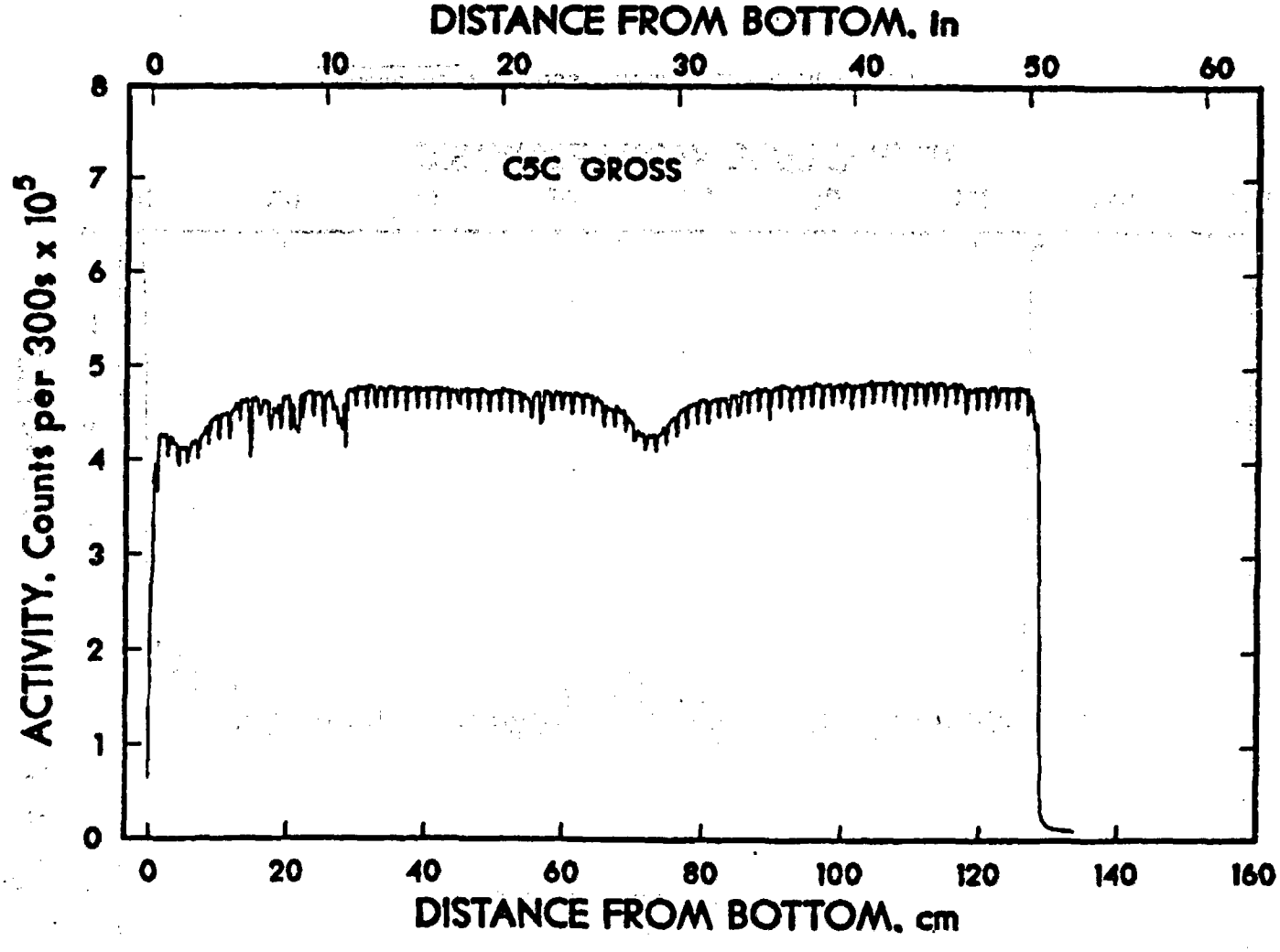


FIGURE D.1. Gross Gamma Scan-Segment C5C

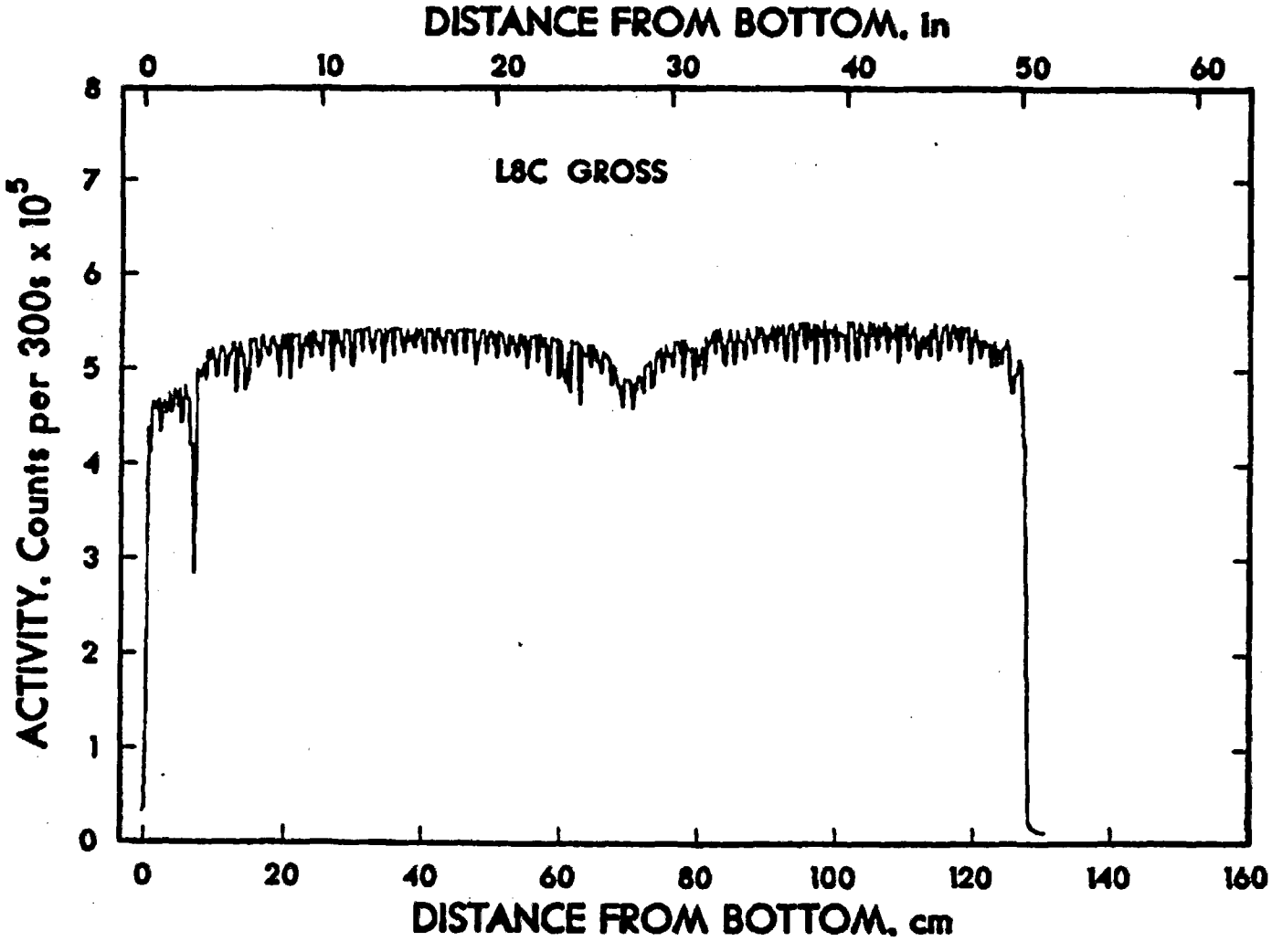


FIGURE D.2. Gross Gamma Scan-Segment L8C

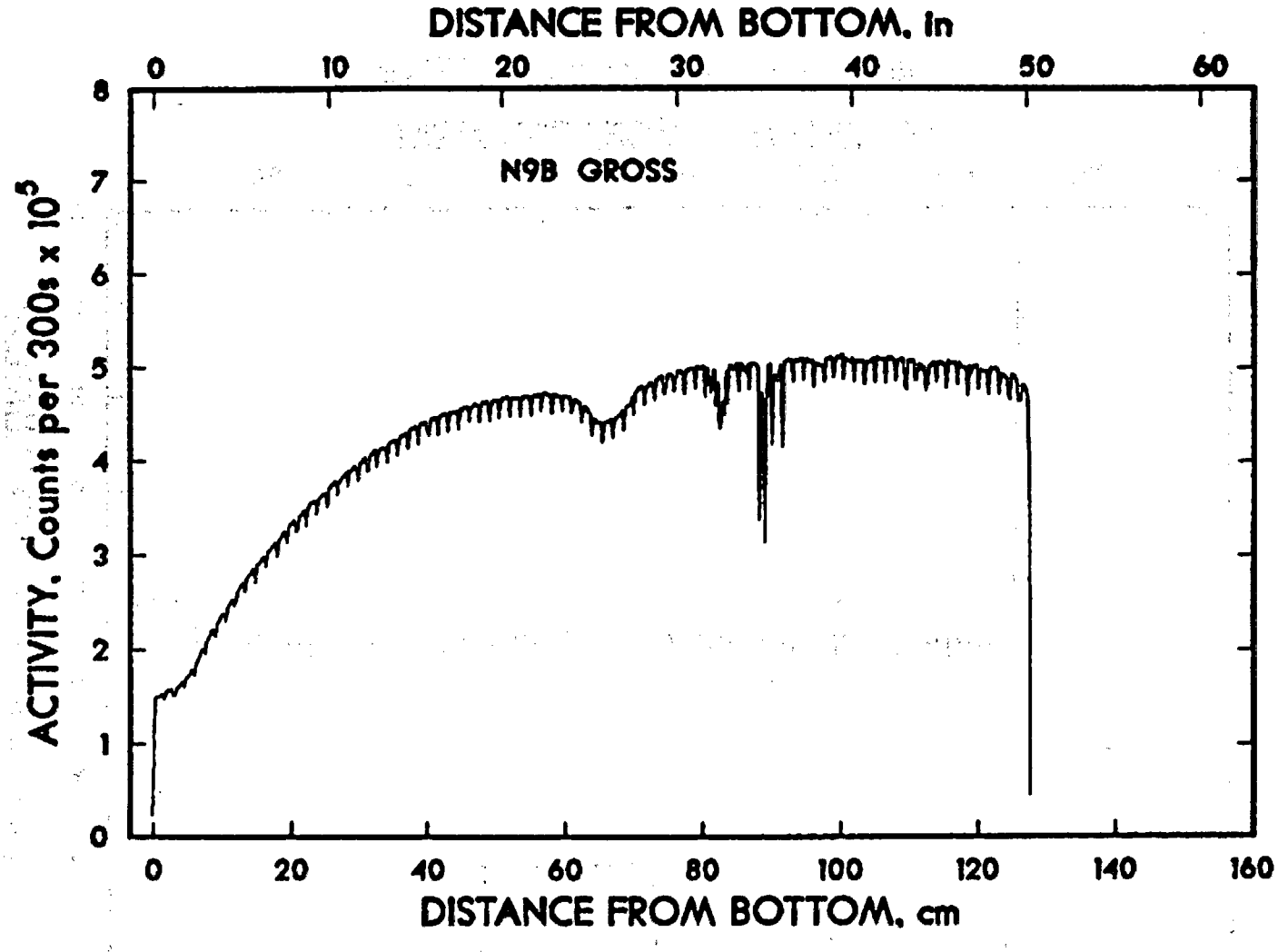


FIGURE D.3. Gross Gamma Scan-Segment N9B

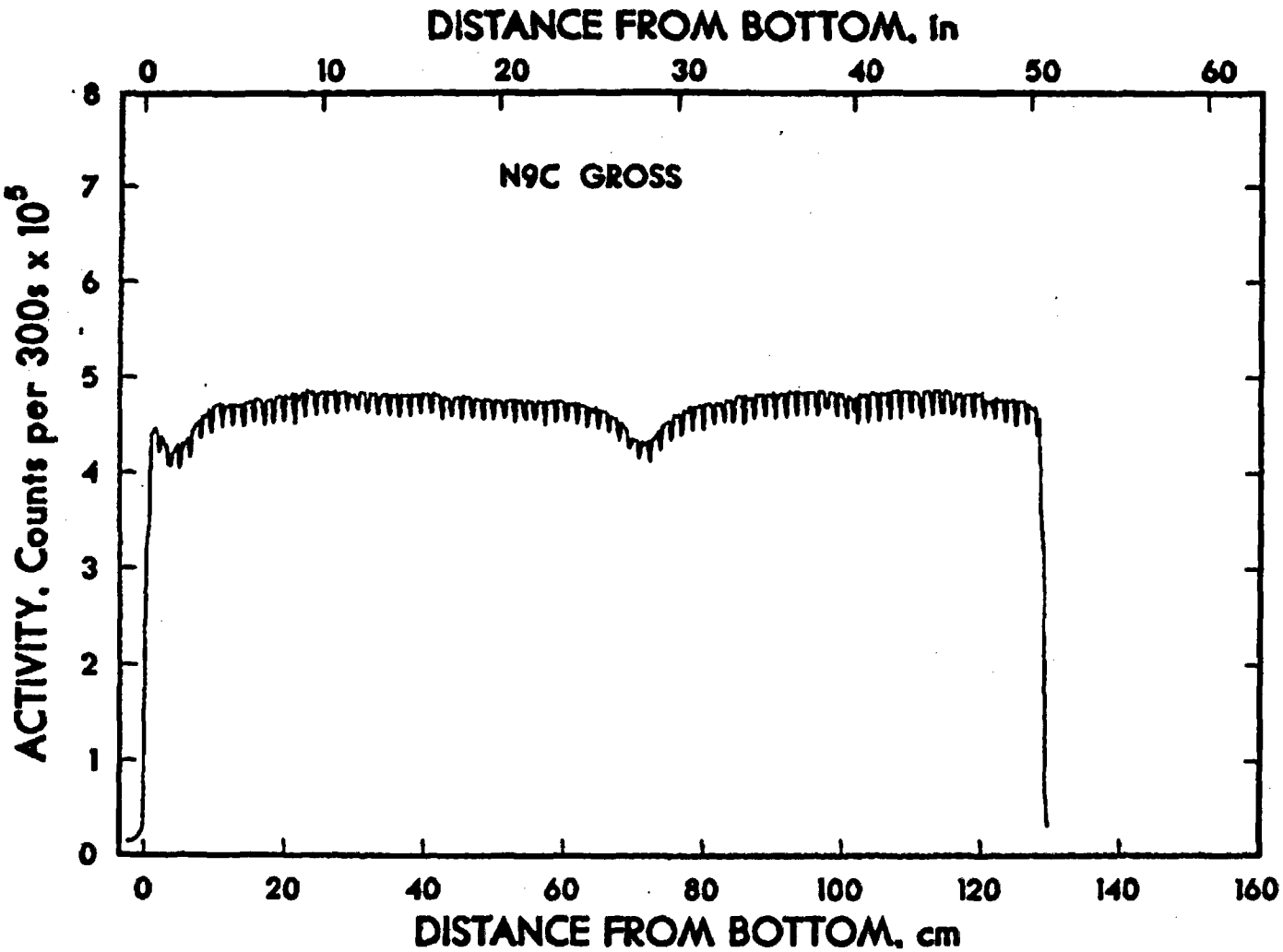


FIGURE D.4. Gross Gamma Scan-Segment N9C

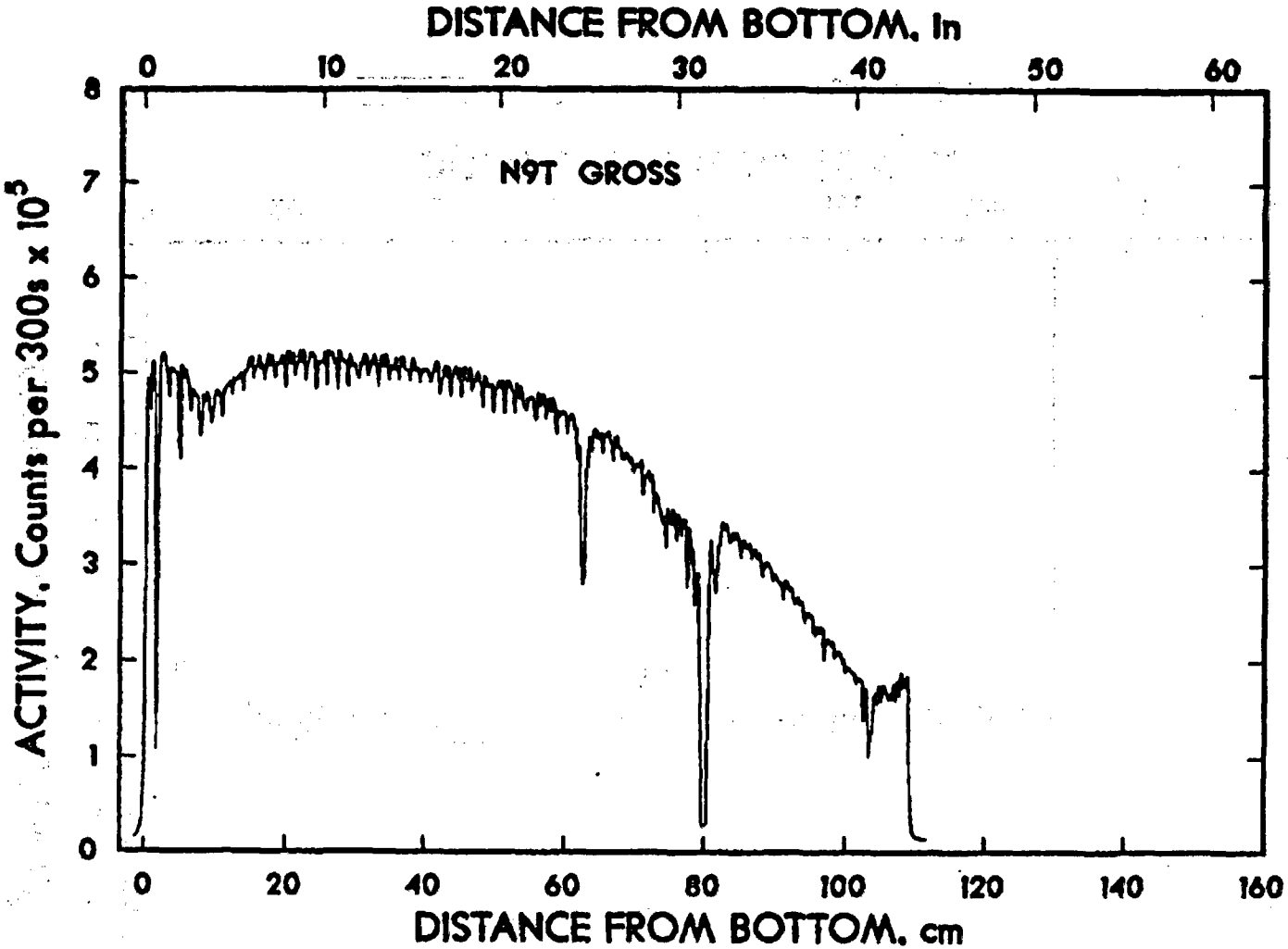


FIGURE D.5. Gross Gamma Scan-Segment N9T

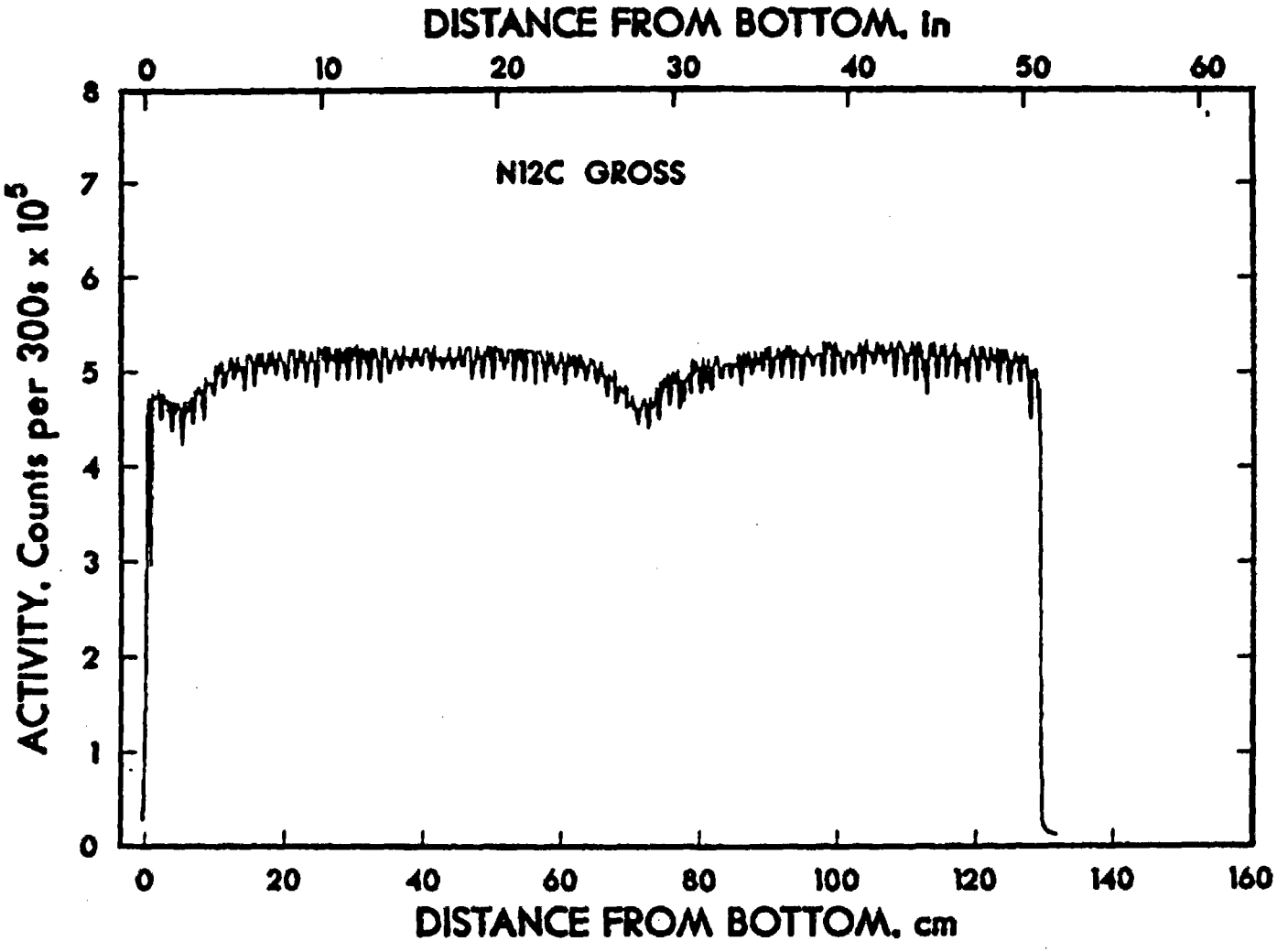


FIGURE D.6. Gross Gamma Scan-Segment N12C

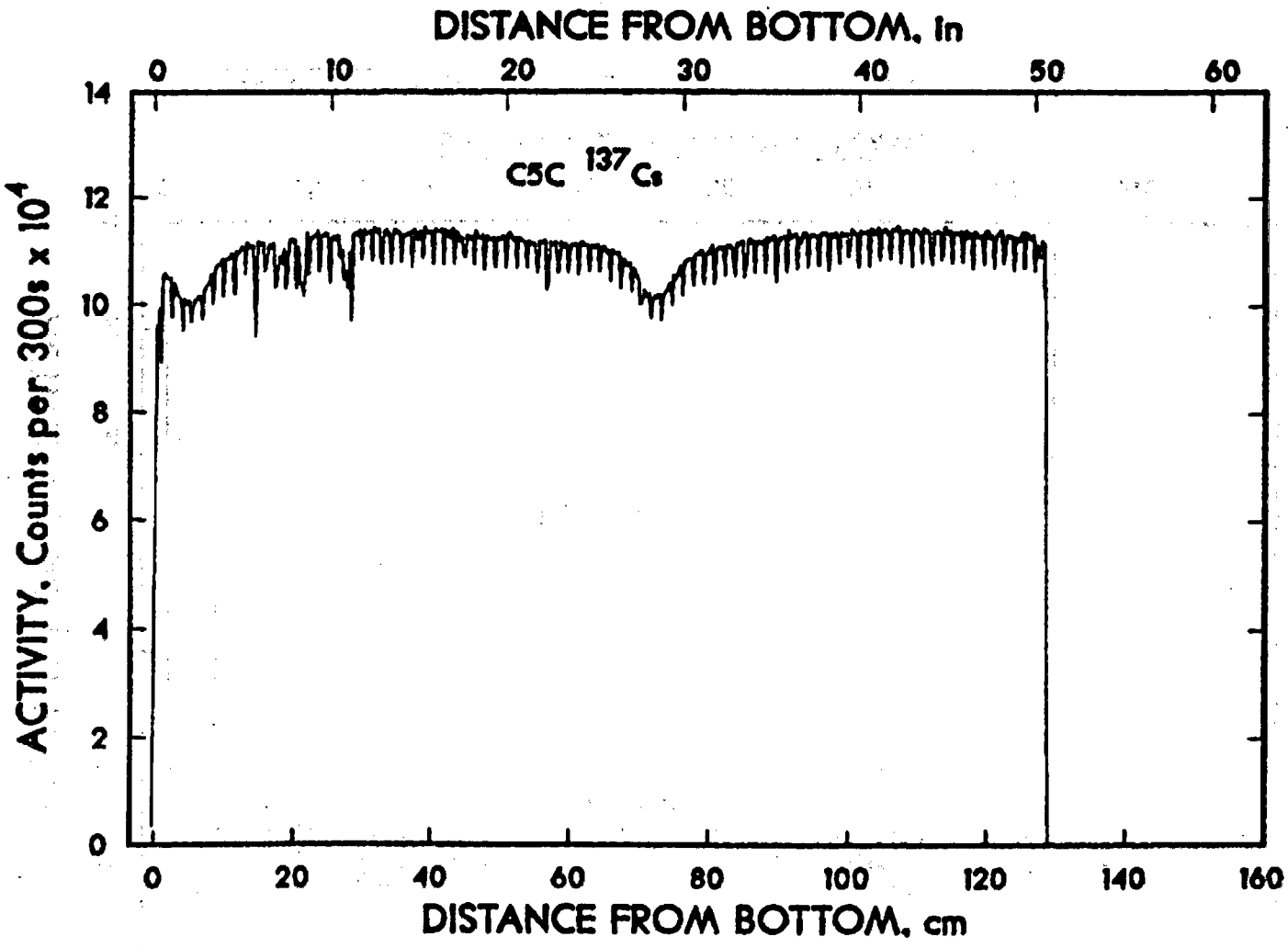


FIGURE D.7. Spectral Gamma Scan for ^{137}Cs - Segment C5C

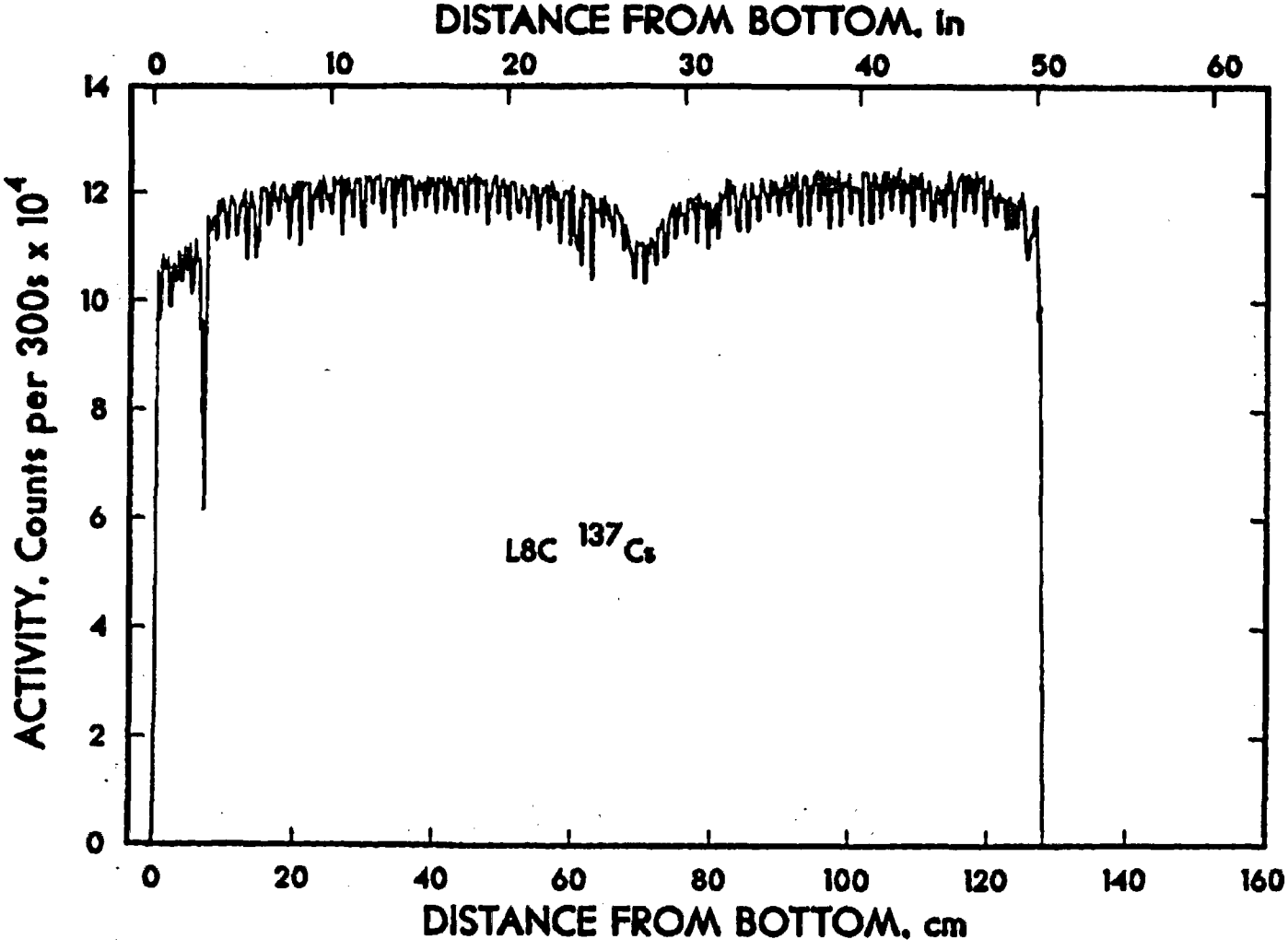


FIGURE D.8. Spectral Gamma Scan for ^{137}Cs - Segment L8C

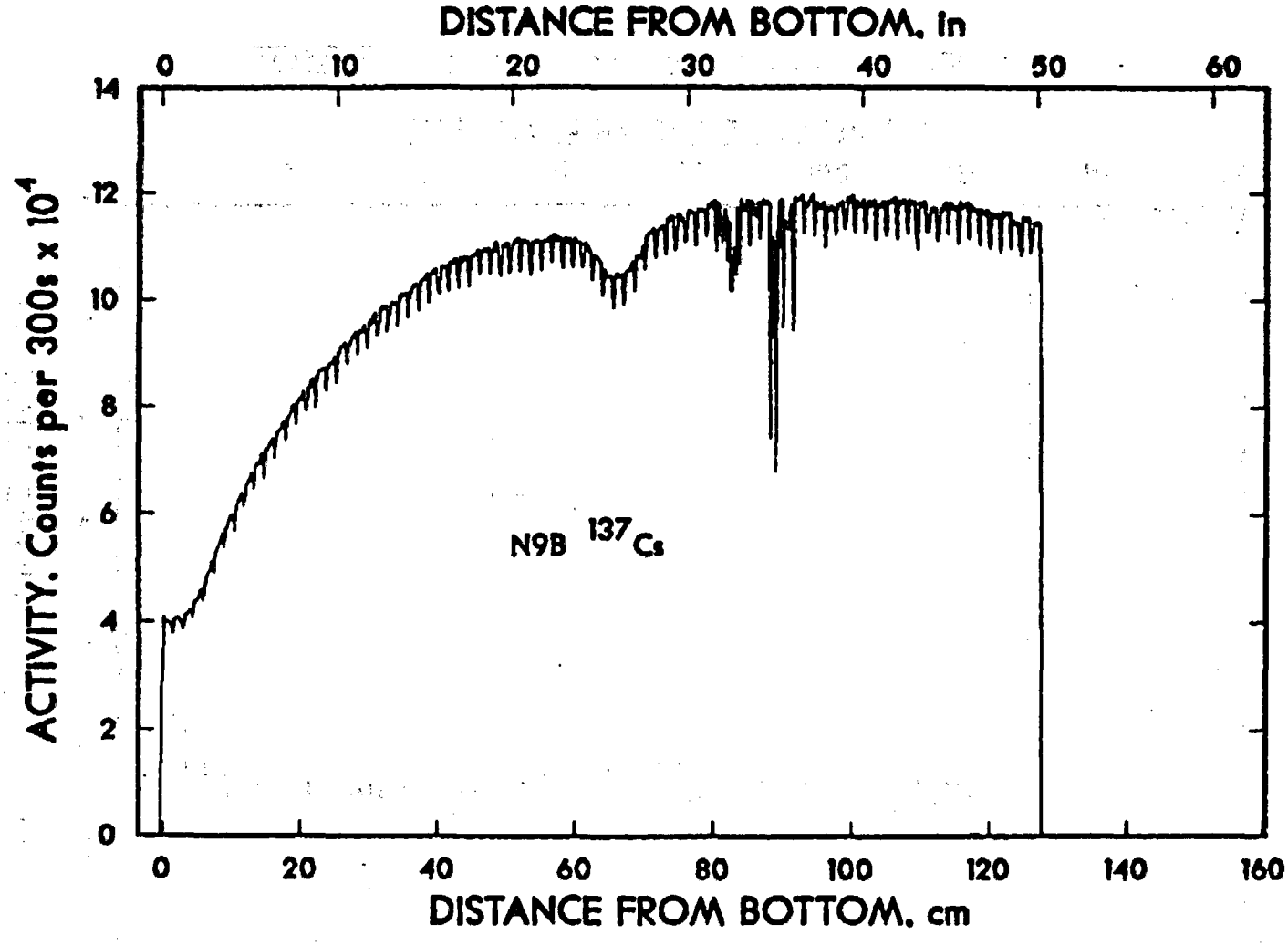


FIGURE D.9. Spectral Gamma Scan for ^{137}Cs - Segment N9B

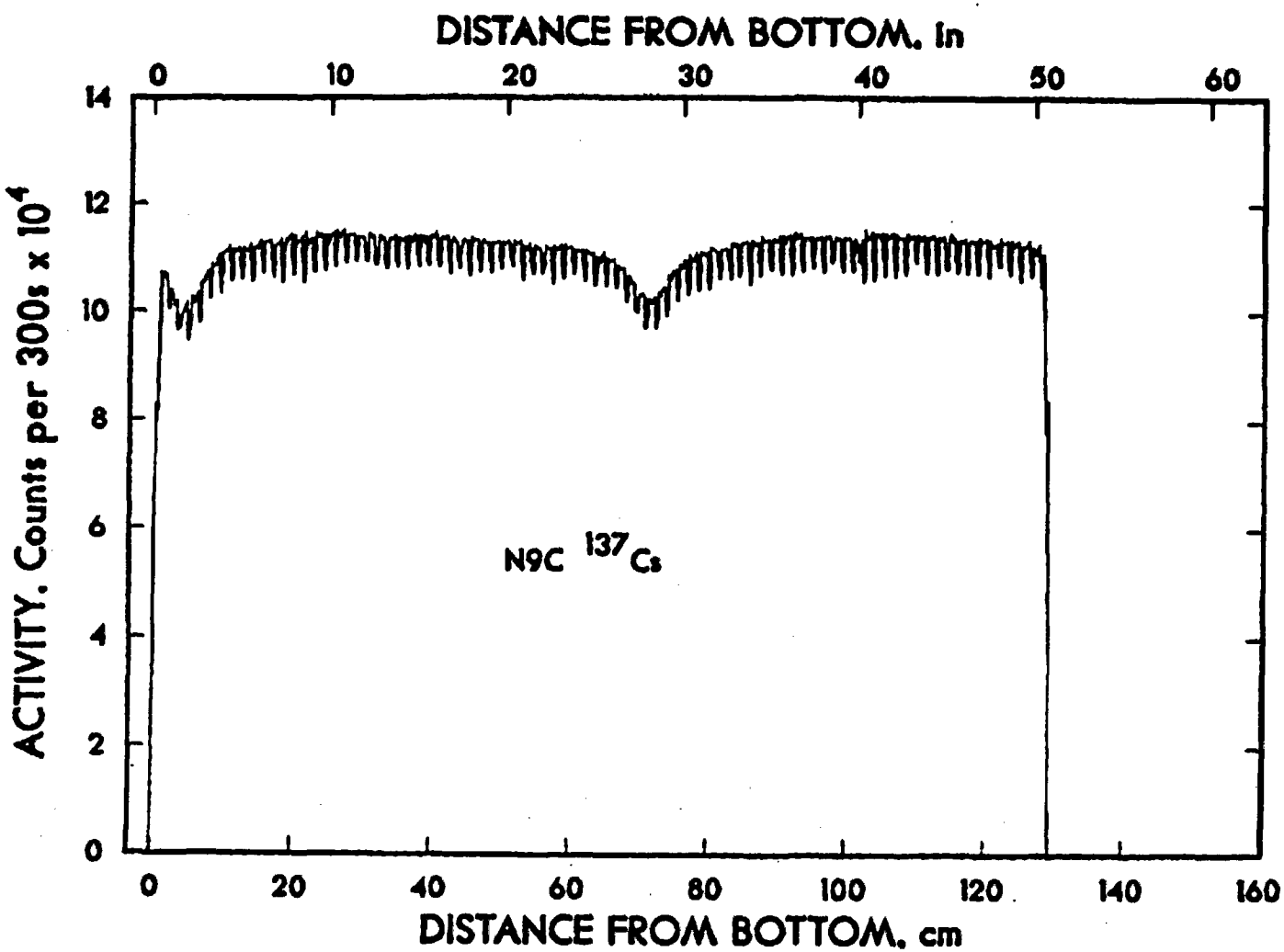


FIGURE D.10. Spectral Gamma Scan for ^{137}Cs - Segment N9C

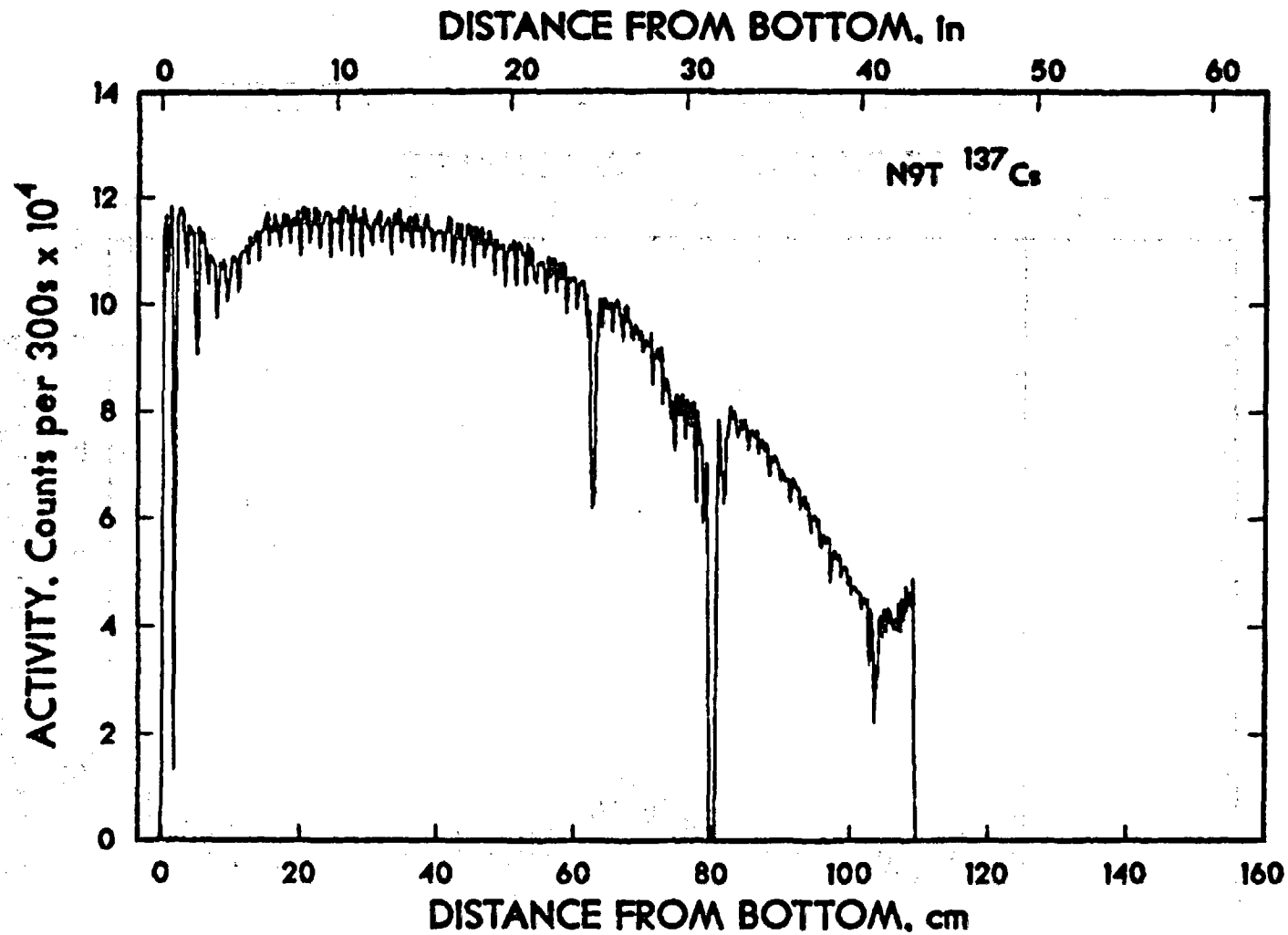


FIGURE D.11. Spectral Gamma Scan for ^{137}Cs - Segment N9T

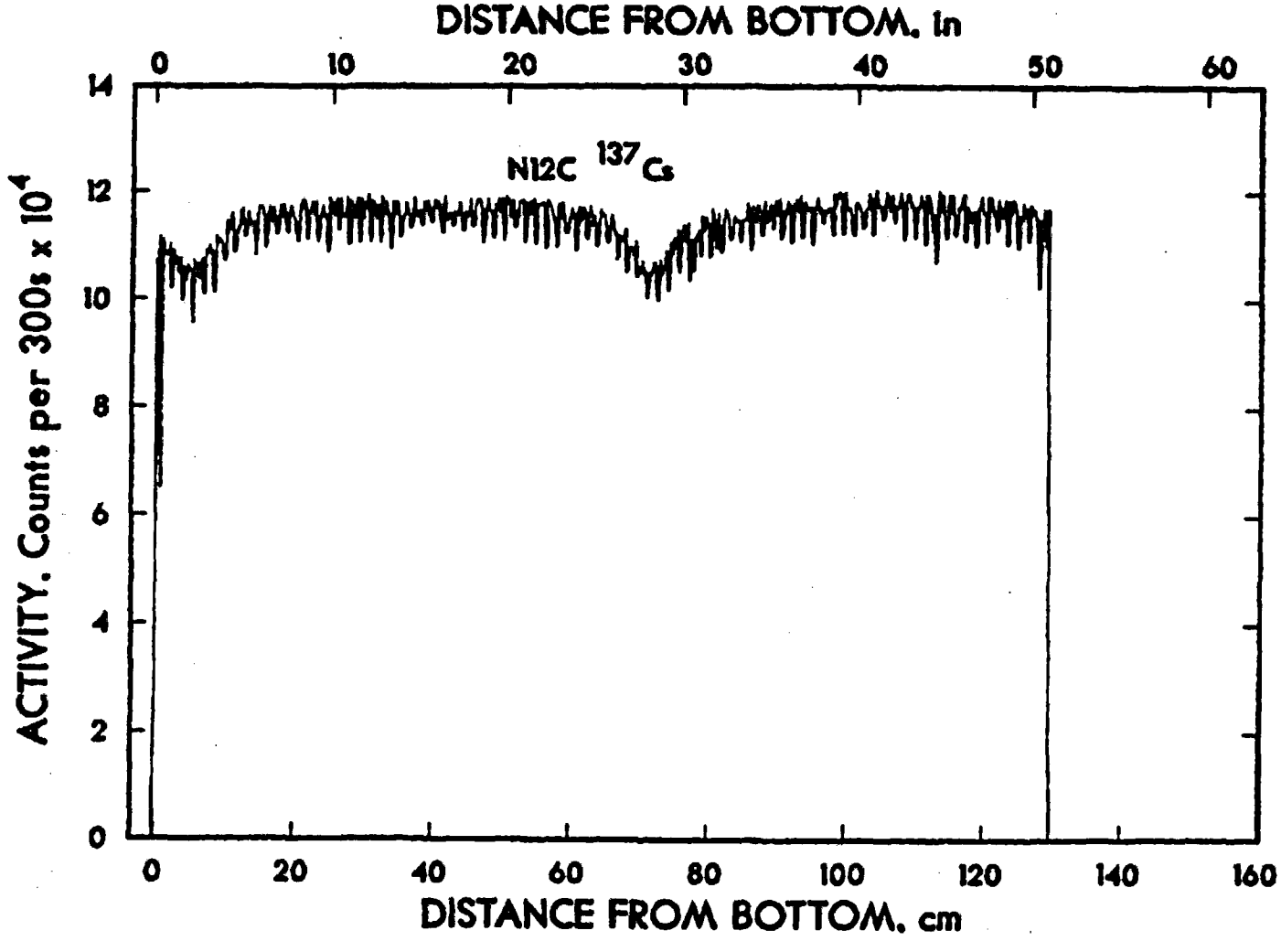


FIGURE D.12. Spectral Gamma Scan for ^{137}Cs - Segment N12C

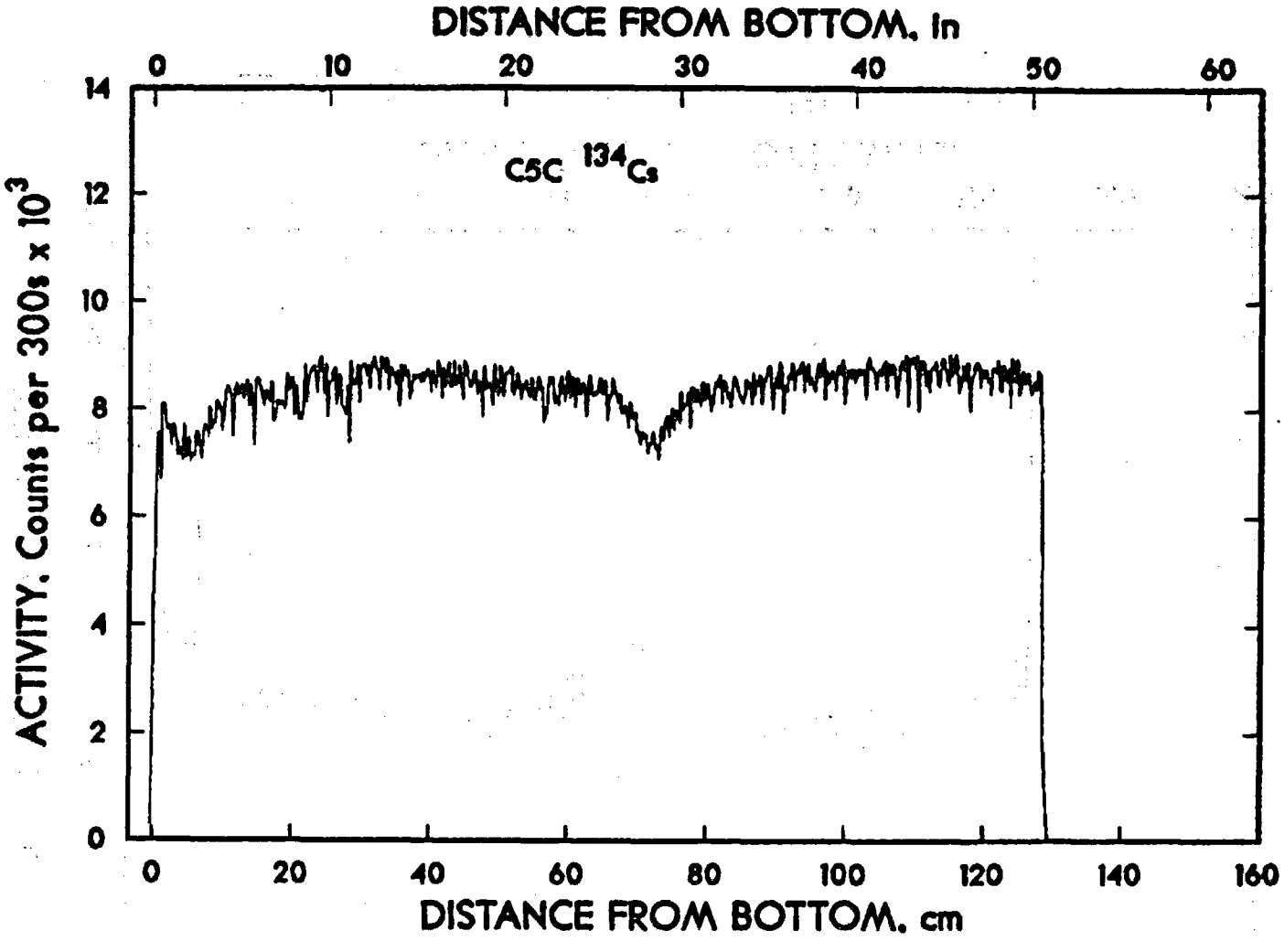


FIGURE D.13. Spectral Gamma Scan for ^{134}Cs - Segment C5C

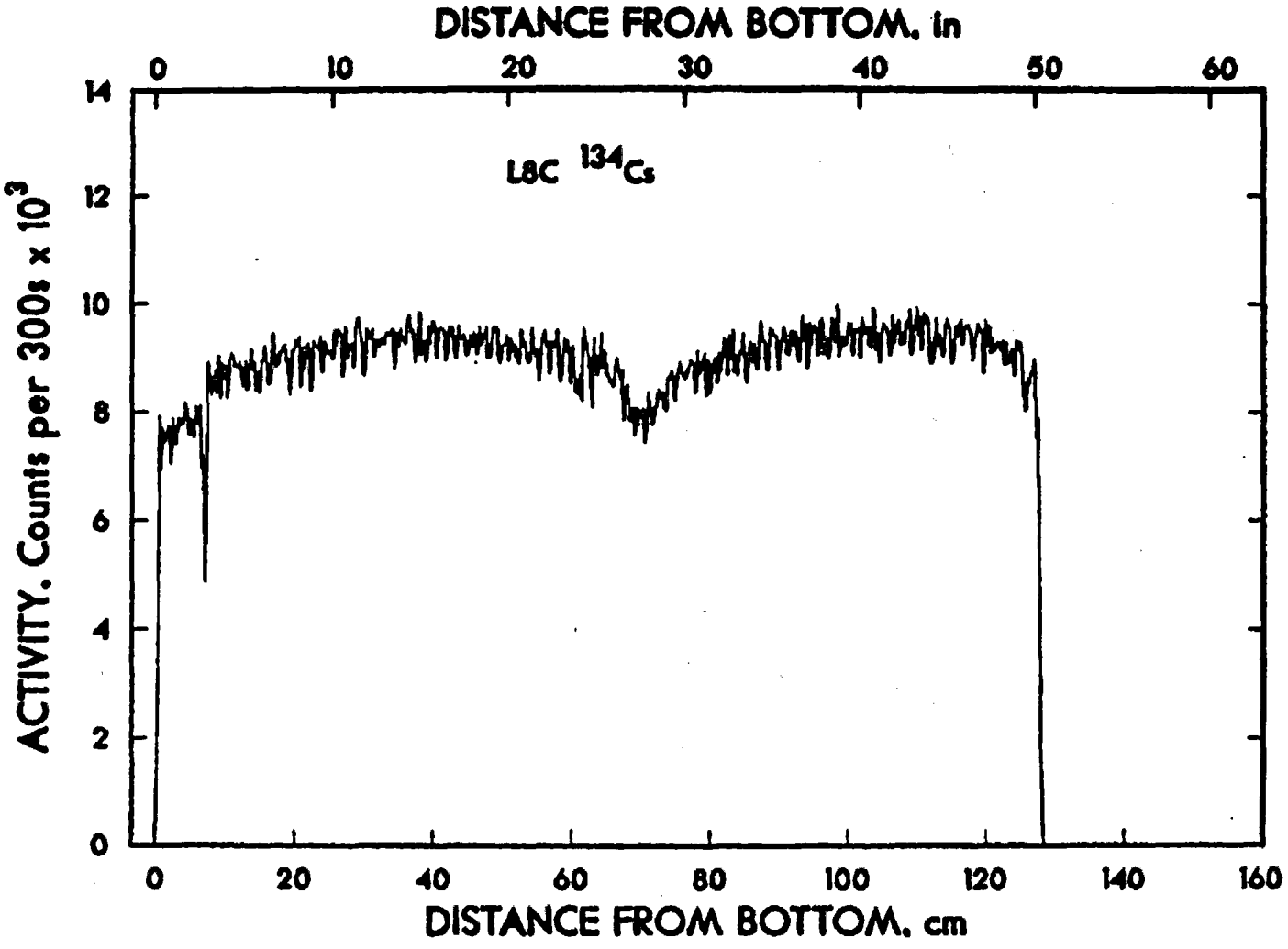


FIGURE D.14. Spectral Gamma Scan for ^{134}Cs - Segment L8C

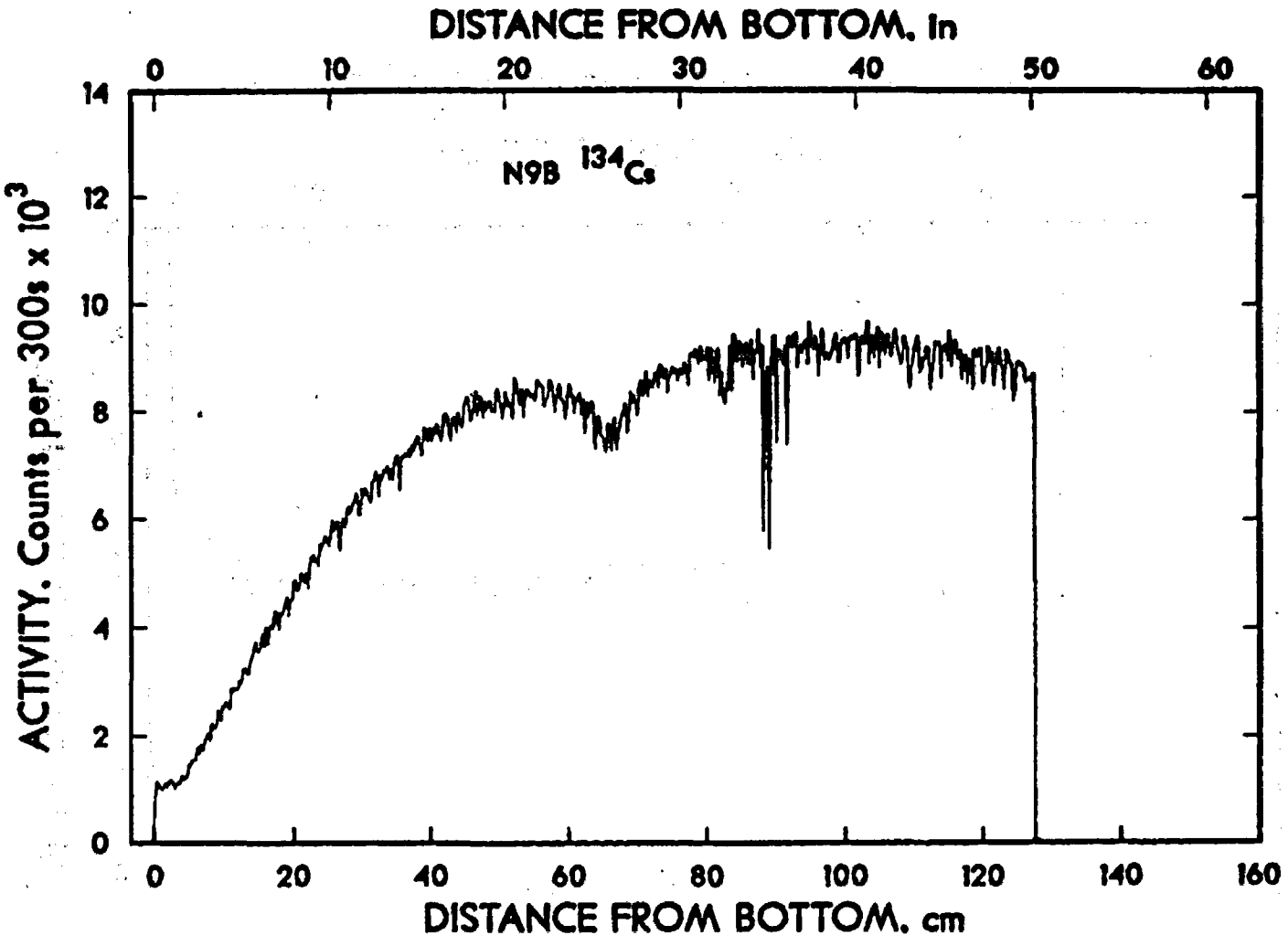


FIGURE D.15. Spectral Gamma Scan for ^{134}Cs - Segment N9B

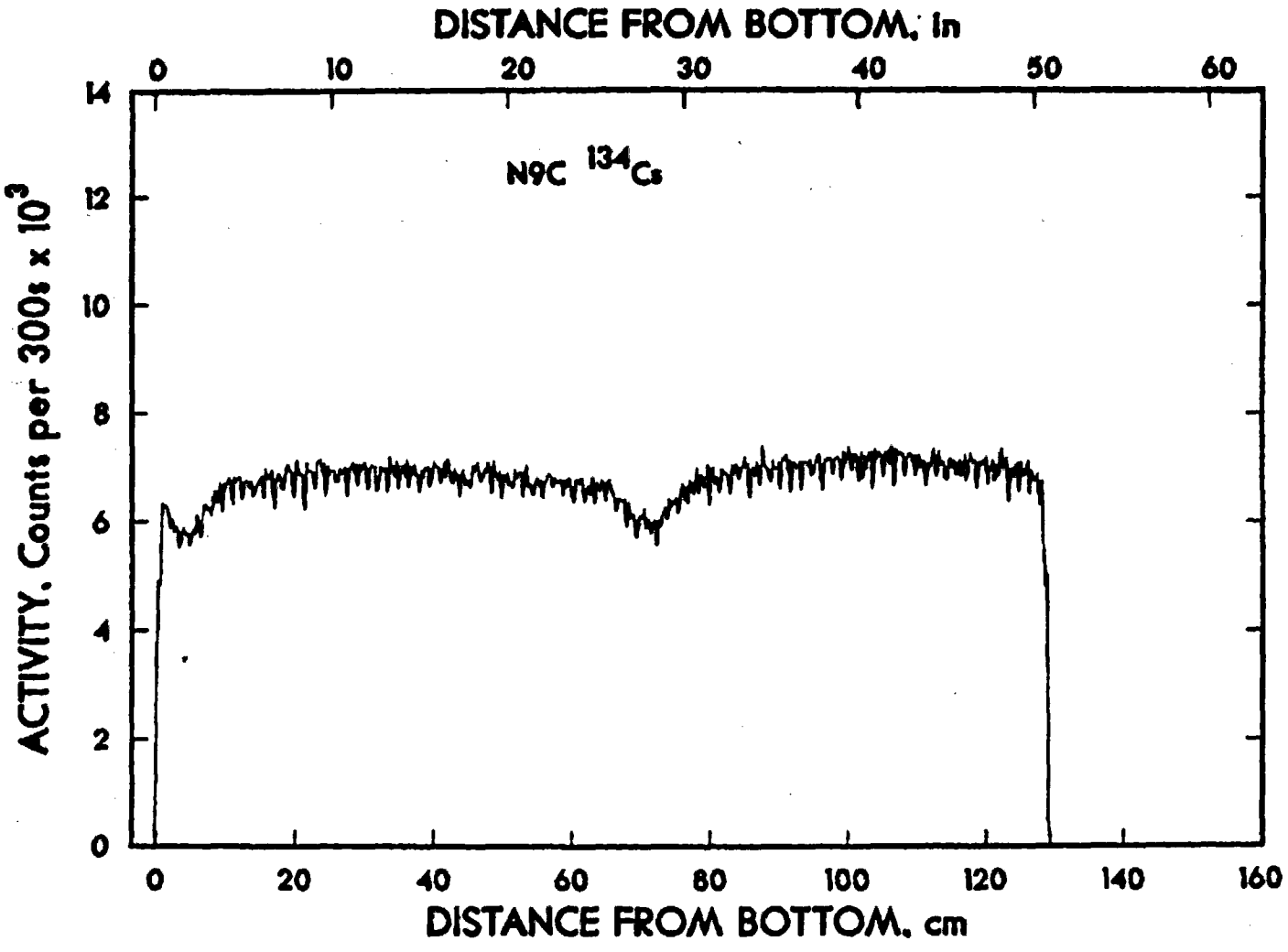


FIGURE D.16. Spectral Gamma Scan for ^{134}Cs - Segment N9C

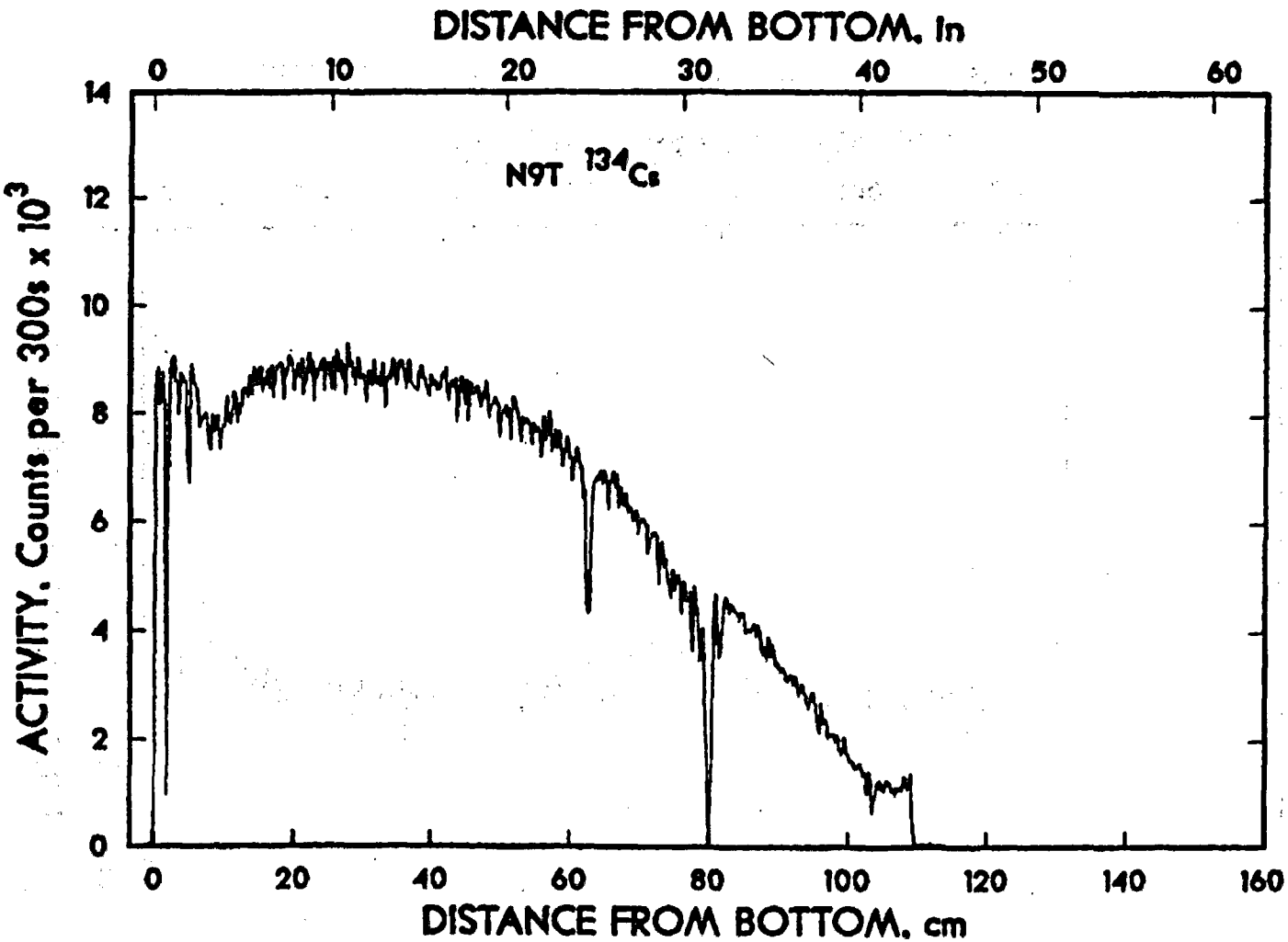


FIGURE D.17. Spectral Gamma Scan for ^{134}Cs - Segment N9T

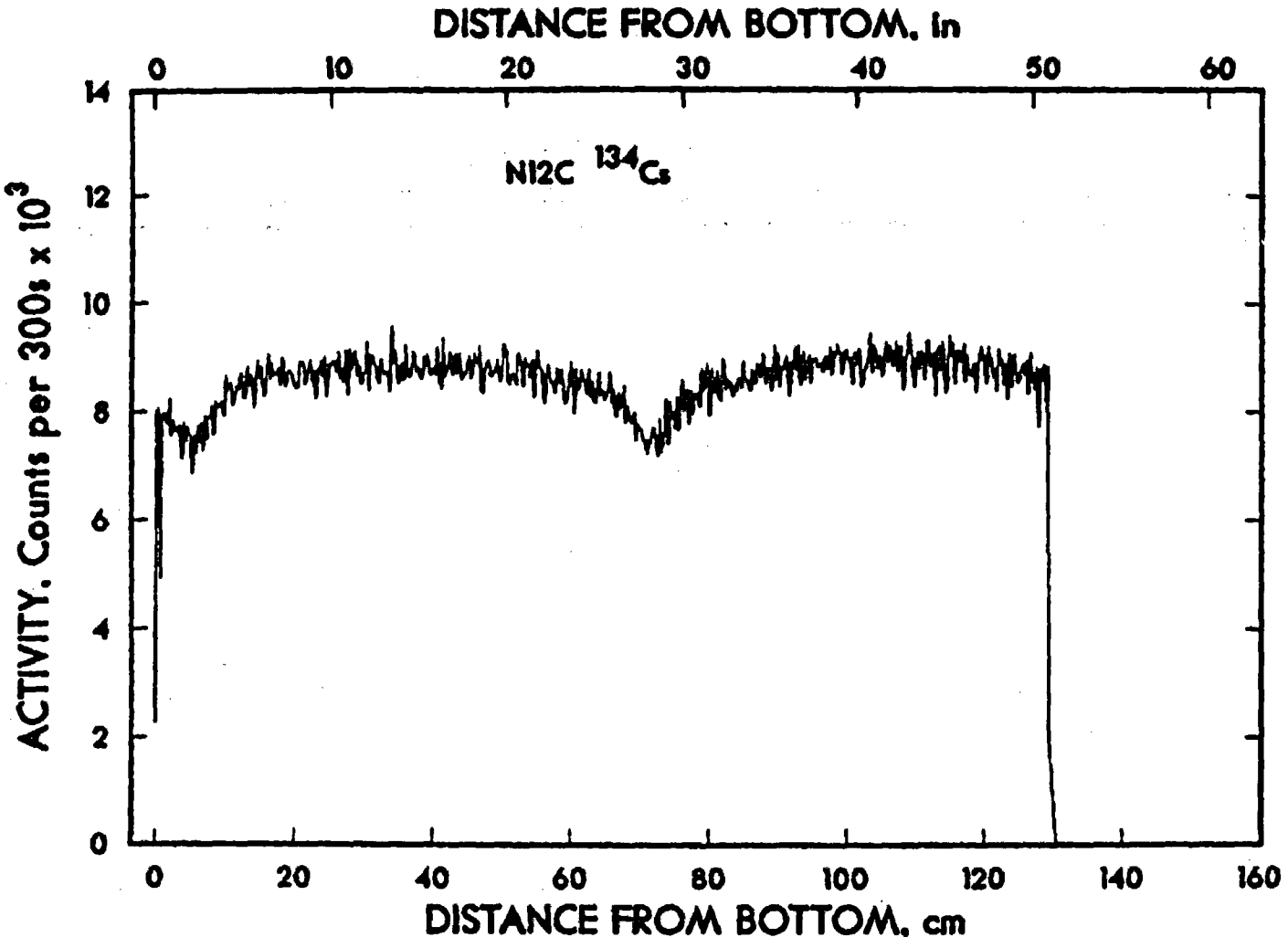


FIGURE D.18. Spectral Gamma Scan for ^{134}Cs - Segment N12C

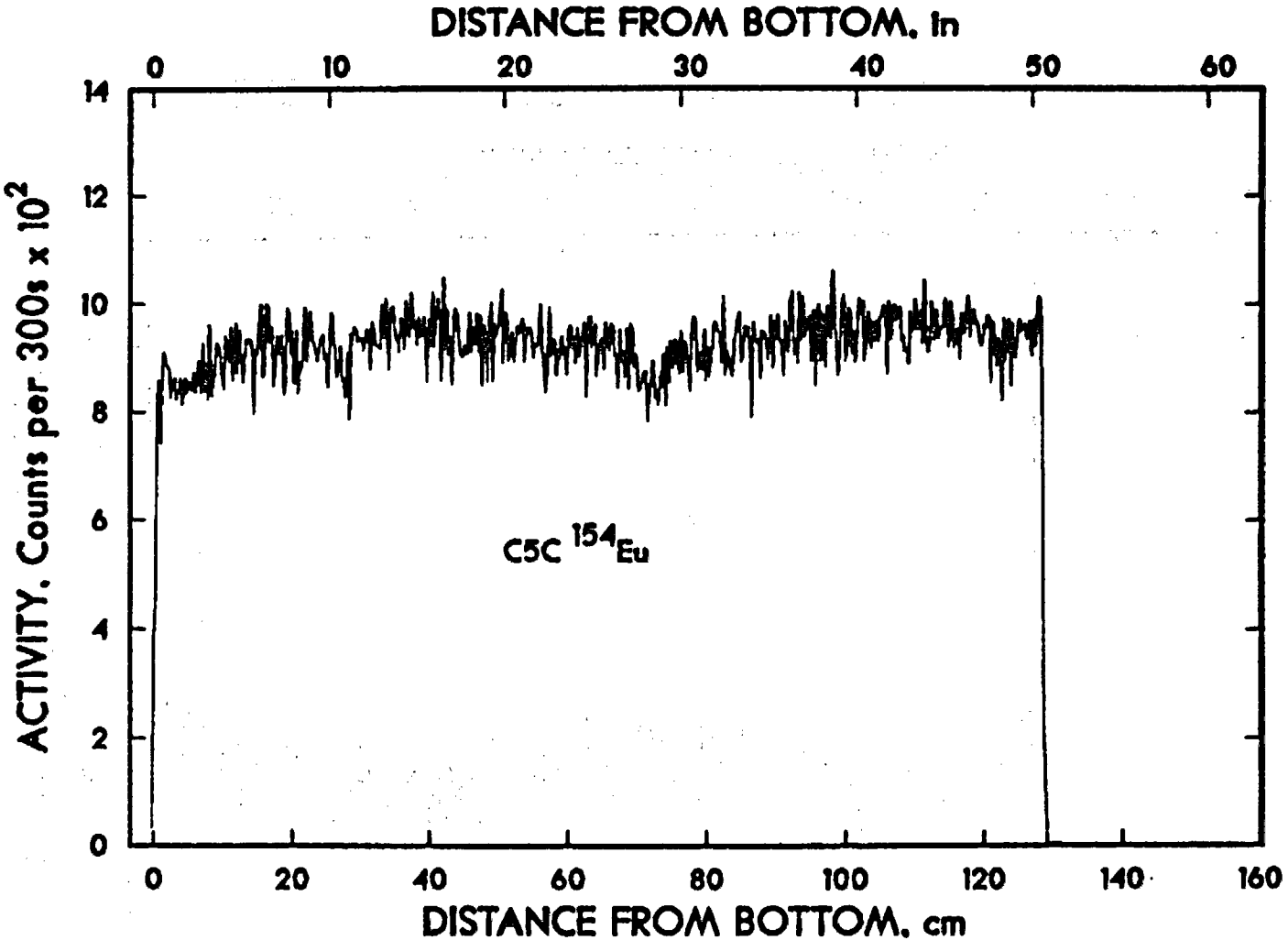


FIGURE D.19. Spectral Gamma Scan for ^{154}Eu - Segment C5C

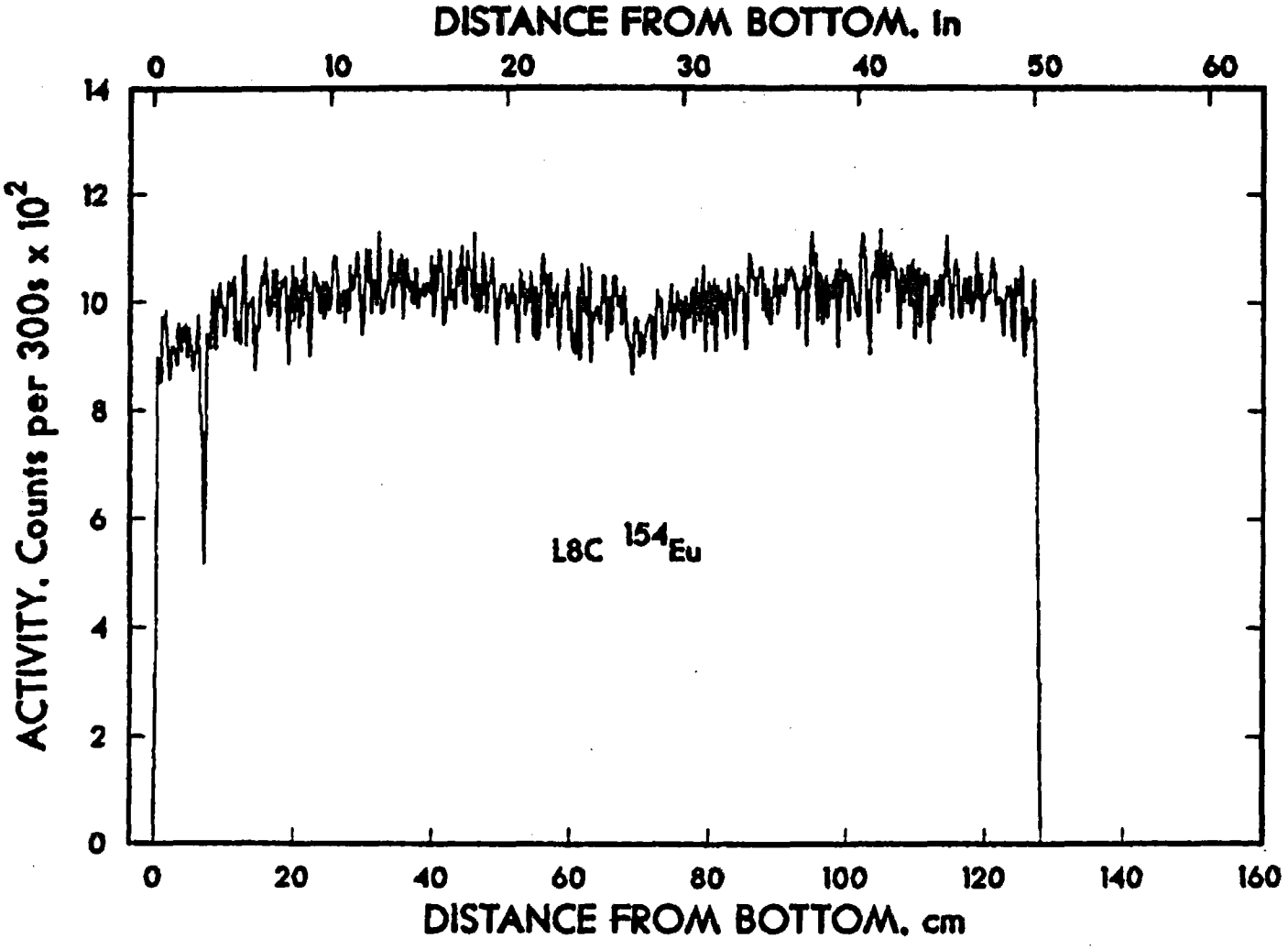


FIGURE D.20. Spectral Gamma Scan for ^{154}Eu - Segment L8C

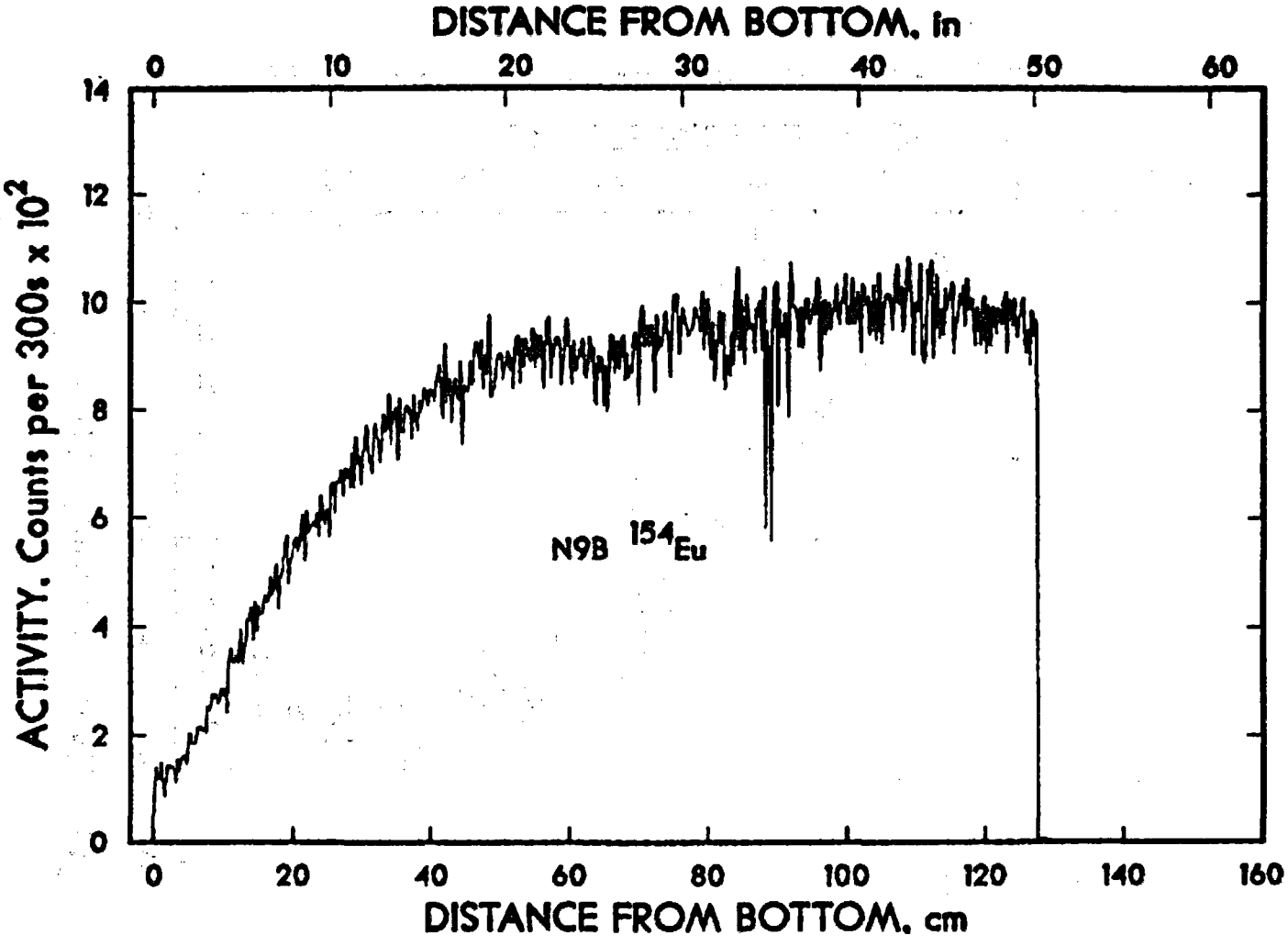


FIGURE D.21. Spectral Gamma Scan for ^{154}Eu - Segment N9B

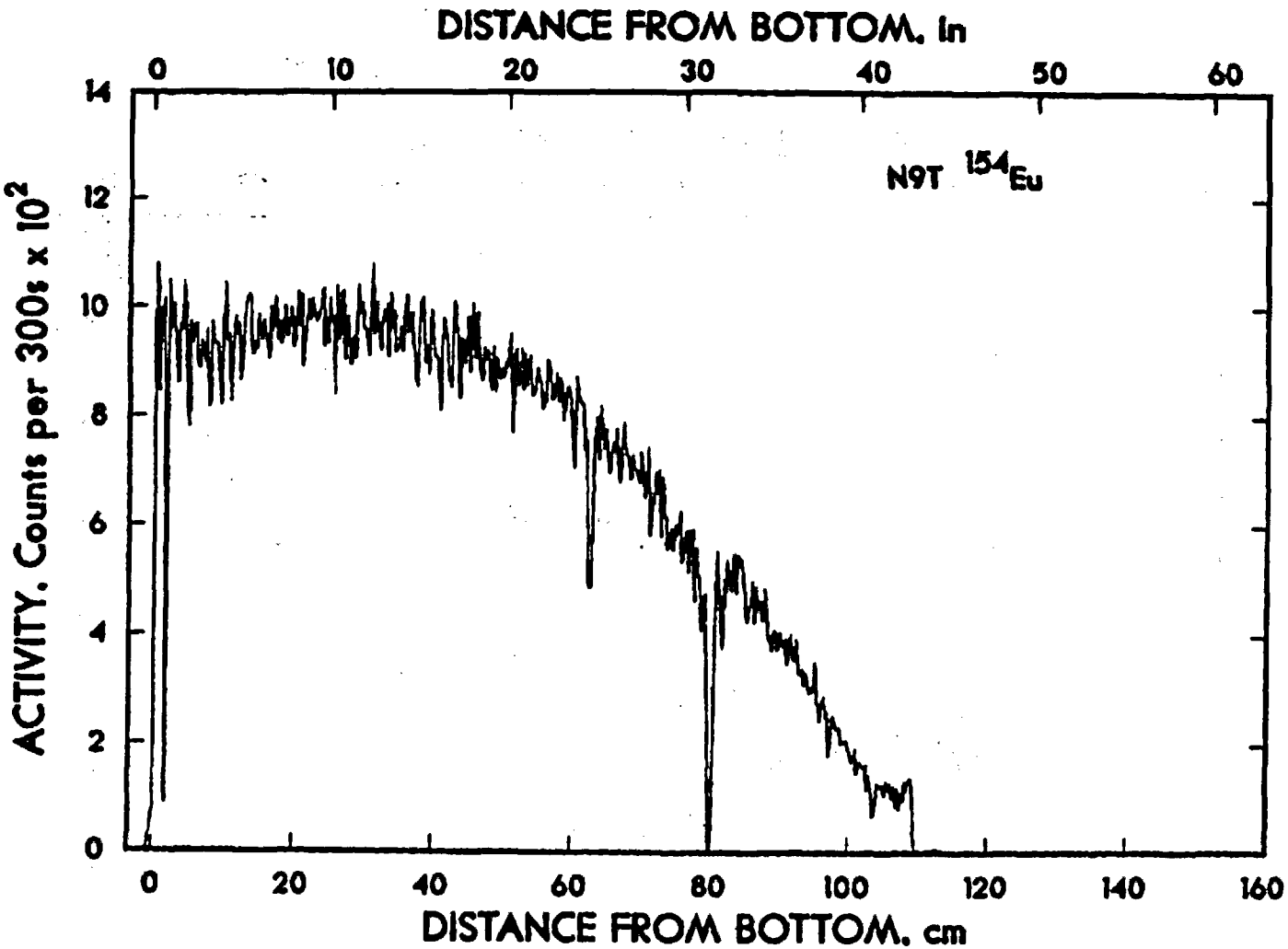


FIGURE D.22. Spectral Gamma Scan for ^{154}Eu - Segment N9T

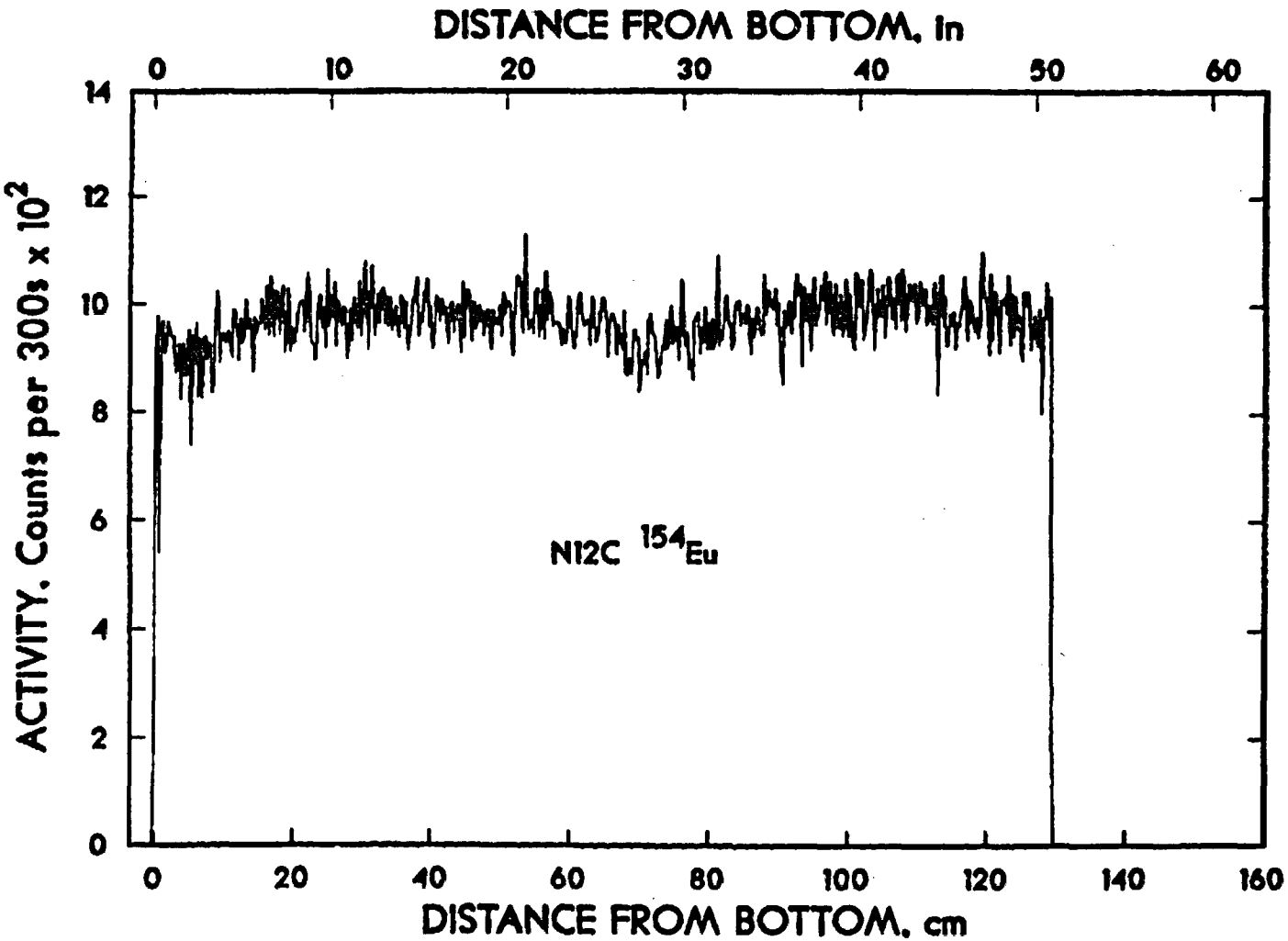


FIGURE D.23. Spectral Gamma Scan for ^{154}Eu - Segment N12C

APPENDIX E

RESULTS OF RADIONUCLIDE INVENTORY CALCULATIONS

TABLES

TABLE E.1. Radionuclide Inventories at 10 MWd/kgM as a Function of Decay Time

TABLE E.1.a. Actinides (Isotopic), g/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE 4	9.905-008	1.151-007	1.321-007	1.497-007
PB207	2.805-015	4.312-015	6.261-015	8.699-015
PB208	4.694-012	6.261-012	7.890-012	9.548-012
PB212	1.354-015	1.432-015	1.471-015	1.485-015
RA224	1.181-014	1.249-014	1.283-014	1.296-014
RA226	1.C48-015	1.562-015	2.213-015	3.016-015
AC227	2.258-014	2.979-014	3.783-014	4.665-014
TH228	2.295-012	2.421-012	2.487-012	2.511-012
TH229	2.400-014	2.815-014	3.281-014	3.798-014
TH230	2.550-011	3.287-011	4.108-011	5.011-011
TH231	6.650-014	6.650-014	6.650-014	6.651-014
TH232	5.409-010	6.359-010	7.308-010	8.258-010
TH234	1.404-011	1.404-011	1.404-011	1.404-011
PA231	1.975-010	2.292-010	2.609-010	2.926-010
PA233	3.025-012	3.039-012	3.056-012	3.073-012
U232	9.661-011	9.759-011	9.746-011	9.667-011
U233	4.512-010	5.110-010	5.712-010	6.317-010
U234	1.247-006	1.398-006	1.547-006	1.693-006
U235	1.636-002	1.636-002	1.636-002	1.636-002
U236	1.631-003	1.631-003	1.631-003	1.632-003
U237	5.958-012	5.411-012	4.914-012	4.463-012
U238	9.668-001	9.668-001	9.668-001	9.668-001
NP236	5.006-011	5.006-011	5.006-011	5.006-011
NP237	8.905-005	8.948-005	8.996-005	9.049-005
NP238	2.440-014	2.418-014	2.396-014	2.374-014
NP239	1.408-012	1.407-012	1.407-012	1.407-012
PU236	7.523-012	4.626-012	2.845-012	1.749-012
PU238	9.766-006	9.613-006	9.464-006	9.316-006
PU239	3.684-003	3.683-003	3.683-003	3.683-003
PU240	7.287-004	7.286-004	7.284-004	7.283-004
PU241	1.924-004	1.748-004	1.587-004	1.441-004
PU242	2.952-005	2.952-005	2.952-005	2.952-005
PU244	1.075-010	1.075-010	1.075-010	1.075-010
AM241	1.275-004	1.447-004	1.602-004	1.743-004
AM242M	1.302-007	1.290-007	1.278-007	1.266-007
AM242	1.557-012	1.543-012	1.529-012	1.515-012
AM243	1.638-006	1.638-006	1.637-006	1.637-006
CM242	3.150-010	3.125-010	3.097-010	3.069-010
CM243	6.081-009	5.792-009	5.517-009	5.255-009
CM244	8.023-008	7.432-008	6.884-008	6.377-008
CM245	1.656-009	1.656-009	1.656-009	1.656-009
CM246	5.281-011	5.279-011	5.277-011	5.276-011
CM247	1.423-013	1.423-013	1.423-013	1.423-013
CM248	1.994-015	1.994-015	1.994-015	1.994-015
SF250	2.287-013	2.461-013	2.628-013	2.790-013
SUMTOT	9.897-001	9.897-001	9.897-001	9.897-001
TOTAL	9.897-001	9.897-001	9.897-001	9.897-001

TABLE E.1.b. Actinides (Elemental), g/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE	9.905-008	1.151-007	1.321-007	1.497-007
SF	2.287-013	2.461-013	2.628-013	2.790-013
PB	4.698-012	6.266-012	7.897-012	9.558-012
RA	1.289-014	1.409-014	1.510-014	1.604-014
AC	2.258-014	2.979-014	3.783-014	4.665-014
TH	5.829-010	6.853-010	7.885-010	8.926-010
PA	2.005-010	2.322-010	2.640-010	2.957-010
U	9.848-001	9.848-001	9.848-001	9.848-001
NP	8.905-005	8.948-005	8.996-005	9.049-005
PU	4.644-003	4.626-003	4.609-003	4.594-003
AM	1.292-004	1.464-004	1.620-004	1.760-004
CM	8.833-008	8.213-008	7.638-008	7.104-008
SUMTOT	9.897-001	9.897-001	9.897-001	9.897-001
TOTAL	9.897-001	9.897-001	9.897-001	9.897-001

TABLE E.1.c. Actinides (Isotopic), Ci/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL207	1.630-012	2.153-012	2.734-012	3.372-012
TL208	6.760-010	7.150-010	7.345-010	7.418-010
TL209	1.103-016	1.294-016	1.508-016	1.746-016
PB209	5.108-015	5.990-015	6.981-015	8.083-015
PB210	1.300-016	1.993-016	2.991-016	4.362-016
PB211	1.634-012	2.159-012	2.742-012	3.382-012
PB212	1.882-009	1.990-009	2.044-009	2.064-009
PB214	1.036-015	1.545-015	2.189-015	2.983-015
BI210	1.300-016	1.994-016	2.992-016	4.363-016
BI211	1.634-012	2.159-012	2.742-012	3.382-012
BI212	1.882-009	1.990-009	2.044-009	2.064-009
BI213	5.108-015	5.990-015	6.981-015	8.083-015
BI214	1.036-015	1.545-015	2.189-015	2.983-015
PO210	1.300-016	1.776-016	2.675-016	3.929-016
PO211	4.576-015	6.045-015	7.678-015	9.469-015
PO212	1.206-009	1.275-009	1.310-009	1.323-009
PO213	4.998-015	5.861-015	6.831-015	7.908-015
PO214	1.036-015	1.544-015	2.188-015	2.982-015
PO215	1.634-012	2.159-012	2.742-012	3.382-012
PO216	1.882-009	1.990-009	2.044-009	2.064-009
PO218	1.036-015	1.545-015	2.189-015	2.983-015
AT217	5.108-015	5.990-015	6.981-015	8.083-015
RN219	1.634-012	2.159-012	2.742-012	3.382-012
RN220	1.882-009	1.990-009	2.044-009	2.064-009
RN222	1.036-015	1.545-015	2.189-015	2.983-015
FR221	5.108-015	5.990-015	6.981-015	8.083-015
FR223	2.255-014	2.975-014	3.778-014	4.659-014
RA223	1.634-012	2.159-012	2.742-012	3.382-012
RA224	1.882-009	1.990-009	2.044-009	2.064-009
RA225	5.108-015	5.990-015	6.981-015	8.083-015
RA226	1.036-015	1.545-015	2.189-015	2.983-015
RA228	2.454-017	3.205-017	4.011-017	4.860-017
AC225	5.108-015	5.990-015	6.981-015	8.083-015
AC227	1.634-012	2.156-012	2.737-012	3.376-012
AC228	2.454-017	3.205-017	4.011-017	4.861-017
TH227	1.612-012	2.129-012	2.704-012	3.335-012
TH228	1.881-009	1.985-009	2.039-009	2.059-009
TH229	5.108-015	5.990-015	6.981-015	8.083-015
TH230	5.150-013	6.639-013	8.296-013	1.012-012
TH231	3.537-008	3.537-008	3.537-008	3.537-008
TH232	5.935-017	6.977-017	8.019-017	9.060-017
TH234	3.252-007	3.252-007	3.252-007	3.252-007
PA231	9.331-012	1.083-011	1.233-011	1.383-011
PA233	6.280-008	6.310-008	6.344-008	6.381-008
PA234M	3.252-007	3.252-007	3.252-007	3.252-007
PA234	4.227-010	4.227-010	4.227-010	4.227-010
U232	2.069-009	2.090-009	2.087-009	2.070-009
U233	4.369-012	4.949-012	5.532-012	6.118-012
U234	7.798-009	8.741-009	9.668-009	1.058-008
U235	3.537-008	3.537-008	3.537-008	3.537-008
U236	1.056-007	1.056-007	1.056-007	1.056-007
U237	4.865-007	4.418-007	4.013-007	3.644-007

TABLE E.1.c. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
U238	3.252-007	3.252-007	3.252-007	3.252-007
U240	1.905-015	1.905-015	1.905-015	1.905-015
NP235	9.864-013	2.747-013	7.650-014	2.130-014
NP236	6.598-013	6.598-013	6.598-013	6.597-013
NP237	6.280-008	6.310-008	6.344-008	6.381-008
NP238	6.327-009	6.270-009	6.213-009	6.156-009
NP239	3.267-007	3.266-007	3.266-007	3.265-007
NP240M	1.905-015	1.905-015	1.905-015	1.905-015
PU236	3.599-009	2.459-009	1.512-009	9.299-010
PU238	1.672-004	1.646-004	1.621-004	1.596-004
PU239	2.291-004	2.291-004	2.290-004	2.290-004
PU240	1.661-004	1.661-004	1.660-004	1.660-004
PU241	1.983-002	1.801-002	1.636-002	1.486-002
PU242	1.128-007	1.128-007	1.128-007	1.128-007
PU244	1.908-015	1.908-015	1.908-015	1.908-015
AM241	4.376-004	4.968-004	5.501-004	5.983-004
AM242M	1.265-006	1.254-006	1.243-006	1.231-006
AM242	1.259-006	1.248-006	1.236-006	1.225-006
AM243	3.267-007	3.266-007	3.266-007	3.265-007
CM242	1.042-006	1.034-006	1.024-006	1.015-006
CM243	3.140-007	2.991-007	2.849-007	2.714-007
CM244	6.494-006	6.015-006	5.572-006	5.161-006
CM245	2.845-010	2.845-010	2.844-010	2.844-010
CM246	1.623-011	1.622-011	1.622-011	1.621-011
CF249	3.306-017	3.294-017	3.281-017	3.268-017
CF250	5.148-017	4.630-017	4.164-017	3.746-017
SUMTOT	2.084-002	1.908-002	1.748-002	1.602-002
TOTAL	2.084-002	1.908-002	1.748-002	1.602-002

TABLE E.1.d. Actinides (Elemental), Ci/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL	6.777-010	7.172-010	7.372-010	7.451-010
PB	1.883-009	1.992-009	2.047-009	2.068-009
BI	1.883-009	1.992-009	2.047-009	2.068-009
PO	3.089-009	3.267-009	3.357-009	3.391-009
AT	5.108-015	5.990-015	6.981-015	8.083-015
RN	1.883-009	1.992-009	2.047-009	2.068-009
FR	2.766-014	3.574-014	4.476-014	5.467-014
RA	1.883-009	1.992-009	2.047-009	2.068-009
AC	1.639-012	2.162-012	2.744-012	3.384-012
TH	3.624-007	3.625-007	3.626-007	3.626-007
PA	3.894-007	3.887-007	3.890-007	3.894-007
U	9.625-007	9.188-007	8.792-007	8.432-007
NP	3.958-007	3.960-007	3.962-007	3.965-007
PU	2.039-002	1.857-002	1.691-002	1.541-002
AM	4.405-004	4.996-004	5.530-004	6.011-004
CM	7.850-006	7.348-006	6.881-006	6.448-006
CF	8.578-017	8.008-017	7.505-017	7.060-017
SUMTOT	2.084-002	1.908-002	1.748-002	1.602-002
TOTAL	2.084-002	1.908-002	1.748-002	1.602-002

TABLE E.1.e. Fission Products (Isotopic), g/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	9.295-009	8.308-009	7.426-009	6.637-009
LI 6	9.662-011	9.662-011	9.662-011	9.662-011
LI 7	3.083-012	3.083-012	3.083-012	3.083-012
BE 9	5.940-012	5.940-012	5.940-012	5.940-012
BE 10	3.962-011	3.962-011	3.962-011	3.962-011
C 14	8.001-012	7.999-012	7.997-012	7.995-012
ZN 66	1.294-014	1.294-014	1.294-014	1.294-014
ZN 67	5.426-016	5.426-016	5.426-016	5.426-016
GA 71	2.422-013	2.422-013	2.422-013	2.422-013
GE 72	6.411-009	6.411-009	6.411-009	6.411-009
GE 73	1.419-008	1.419-008	1.419-008	1.419-008
GE 74	2.992-008	2.992-008	2.992-008	2.992-008
AS 75	6.455-008	6.455-008	6.455-008	6.455-008
GE 76	1.616-007	1.616-007	1.616-007	1.616-007
SE 76	5.753-010	5.753-010	5.753-010	5.753-010
SE 77	3.427-007	3.427-007	3.427-007	3.427-007
SE 78	7.391-007	7.391-007	7.391-007	7.391-007
SE 79	1.866-006	1.866-006	1.866-006	1.866-006
BR 79	2.268-010	2.667-010	3.065-010	3.463-010
SE 80	4.251-006	4.251-006	4.251-006	4.251-006
KR 80	5.255-011	5.255-011	5.255-011	5.255-011
BR 81	7.187-006	7.187-006	7.187-006	7.187-006
KR 81	3.078-012	3.078-012	3.078-012	3.078-012
SE 82	1.106-005	1.106-005	1.106-005	1.106-005
KR 82	1.177-007	1.177-007	1.177-007	1.177-007
KR 83	1.638-005	1.638-005	1.638-005	1.638-005
KR 84	3.508-005	3.508-005	3.508-005	3.508-005
KR 85	4.226-006	3.713-006	3.263-006	2.867-006
RB 85	3.685-005	3.736-005	3.781-005	3.821-005
KR 86	6.471-005	6.471-005	6.471-005	6.471-005
SR 86	4.453-008	4.453-008	4.453-008	4.453-008
RB 87	8.337-005	8.337-005	8.337-005	8.337-005
SR 87	3.856-010	3.856-010	3.856-010	3.856-010
SR 88	1.198-004	1.198-004	1.198-004	1.198-004
Y 89	1.572-004	1.572-004	1.572-004	1.572-004
SR 90	1.450-004	1.382-004	1.318-004	1.257-004
Y 90	3.636-008	3.467-008	3.306-008	3.152-008
ZR 90	4.524-005	5.198-005	5.841-005	6.454-005
ZR 91	2.004-004	2.004-004	2.004-004	2.004-004
ZR 92	2.129-004	2.129-004	2.129-004	2.129-004
ZR 93	2.371-004	2.371-004	2.371-004	2.371-004
NB 93	3.427-010	4.487-010	5.652-010	6.913-010
NB 93M	8.789-010	9.878-010	1.086-009	1.175-009
ZR 94	2.364-004	2.364-004	2.364-004	2.364-004
NB 94	1.649-010	1.649-010	1.649-010	1.648-010
MO 95	2.482-004	2.482-004	2.482-004	2.482-004
ZR 96	2.520-004	2.520-004	2.520-004	2.520-004
MO 96	3.284-006	3.284-006	3.284-006	3.284-006
MO 97	2.456-004	2.456-004	2.456-004	2.456-004
MO 98	2.514-004	2.514-004	2.514-004	2.514-004
TC 98	6.152-010	6.152-010	6.152-010	6.152-010
TC 99	2.528-004	2.528-004	2.528-004	2.528-004

TABLE E.1.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
RU 99	9.286-009	1.093-008	1.258-008	1.422-008
MO100	2.808-004	2.808-004	2.808-004	2.808-004
RU100	9.340-006	9.340-006	9.340-006	9.340-006
RU101	2.351-004	2.351-004	2.351-004	2.351-004
RU102	2.166-004	2.166-004	2.166-004	2.166-004
RH102	9.491-012	5.885-012	3.648-012	2.262-012
RH103	1.631-004	1.631-004	1.631-004	1.631-004
RU104	1.361-004	1.361-004	1.361-004	1.361-004
PD104	2.240-005	2.240-005	2.240-005	2.240-005
PD105	9.528-005	9.528-005	9.528-005	9.528-005
RU106	3.539-008	8.946-009	2.261-009	5.715-010
RH106	3.327-014	8.409-015	2.125-015	5.372-016
PD106	6.869-005	6.871-005	6.872-005	6.872-005
PD107	4.333-005	4.333-005	4.333-005	4.333-005
AG107	5.102-011	6.027-011	6.952-011	7.876-011
PD108	2.883-005	2.883-005	2.883-005	2.883-005
AG108M	1.946-013	1.925-013	1.904-013	1.884-013
CD108	2.654-011	2.654-011	2.654-011	2.654-011
AG109	1.719-005	1.719-005	1.719-005	1.719-005
CD109	4.805-017	1.614-017	5.419-018	1.820-018
PD110	9.788-006	9.788-006	9.788-006	9.788-006
AG110M	2.436-012	3.211-013	4.233-014	5.580-015
CD110	2.270-006	2.270-006	2.270-006	2.270-006
CD111	5.964-006	5.964-006	5.964-006	5.964-006
CD112	3.910-006	3.910-006	3.910-006	3.910-006
CD113	1.198-007	1.198-007	1.198-007	1.198-007
CD113M	3.616-008	3.288-008	2.990-008	2.719-008
IN113	2.521-008	2.849-008	3.147-008	3.417-008
CD114	5.857-006	5.857-006	5.857-006	5.857-006
SN114	9.795-011	9.795-011	9.795-011	9.795-011
IN115	1.540-006	1.540-006	1.540-006	1.540-006
SN115	9.422-008	9.422-008	9.422-008	9.422-008
CD116	2.411-006	2.411-006	2.411-006	2.411-006
SN116	1.218-006	1.218-006	1.218-006	1.218-006
SN117	2.453-006	2.453-006	2.453-006	2.453-006
SN118	2.476-006	2.476-006	2.476-006	2.476-006
SN119	2.458-006	2.458-006	2.458-006	2.458-006
SN119M	4.384-013	5.551-014	7.029-015	8.901-016
SN120	2.514-006	2.514-006	2.514-006	2.514-006
SN121M	7.386-010	7.184-010	6.987-010	6.796-010
SB121	2.570-006	2.570-006	2.570-006	2.570-006
SN122	2.782-006	2.782-006	2.782-006	2.782-006
TE122	5.412-008	5.412-008	5.412-008	5.412-008
SN123	3.943-016	7.822-018	1.552-019	3.083-021
SB123	3.119-006	3.119-006	3.119-006	3.119-006
TE123	3.590-010	3.590-010	3.590-010	3.590-010
SN124	3.775-006	3.775-006	3.775-006	3.775-006
TE124	4.014-008	4.014-008	4.014-008	4.014-008
SB125	3.273-007	1.984-007	1.203-007	7.292-008
TE125	5.002-006	5.133-006	5.212-006	5.260-006
TE125M	4.578-009	2.776-009	1.683-009	1.020-009
SN126	7.694-006	7.694-006	7.694-006	7.694-006

TABLE E.1.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
SB126	3.655-013	3.655-013	3.655-013	3.655-013
SB126M	2.779-015	2.779-015	2.779-015	2.779-015
TE126	1.677-007	1.678-007	1.679-007	1.680-007
TE127M	3.389-017	3.256-019	3.139-021	2.463-023
I127	1.551-005	1.551-005	1.551-005	1.551-005
TE128	3.117-005	3.117-005	3.117-005	3.117-005
XE128	2.559-007	2.559-007	2.559-007	2.559-007
I129	5.226-005	5.226-005	5.226-005	5.226-005
XE129	5.201-010	5.247-010	5.293-010	5.339-010
TE130	1.019-004	1.019-004	1.019-004	1.019-004
XE130	1.126-006	1.126-006	1.126-006	1.126-006
XE131	1.609-004	1.609-004	1.609-004	1.609-004
XE132	2.844-004	2.844-004	2.844-004	2.844-004
BA132	1.856-010	1.856-010	1.856-010	1.856-010
CS133	3.781-004	3.781-004	3.781-004	3.781-004
XE134	4.471-004	4.471-004	4.471-004	4.471-004
CS134	4.520-007	2.307-007	1.178-007	6.014-008
BA134	1.667-005	1.689-005	1.700-005	1.706-005
CS135	1.863-004	1.863-004	1.863-004	1.863-004
BA135	8.527-009	8.639-009	8.752-009	8.864-009
XE136	5.998-004	5.998-004	5.998-004	5.998-004
BA136	3.503-006	3.503-006	3.503-006	3.503-006
CS137	2.662-004	2.733-004	2.610-004	2.492-004
BA137	8.530-005	9.823-005	1.106-004	1.224-004
BA137M	4.379-011	4.181-011	3.993-011	3.812-011
BA138	3.954-004	3.954-004	3.954-004	3.954-004
LA138	2.492-009	2.492-009	2.492-009	2.492-009
LA139	3.797-004	3.797-004	3.797-004	3.797-004
CE140	3.753-004	3.753-004	3.753-004	3.753-004
PR141	3.515-004	3.515-004	3.515-004	3.515-004
CE142	3.509-004	3.509-004	3.509-004	3.509-004
ND142	2.468-006	2.468-006	2.468-006	2.468-006
ND143	3.116-004	3.116-004	3.116-004	3.116-004
CE144	1.643-008	2.767-009	4.661-010	7.850-011
PR144	6.938-013	1.168-013	1.968-014	3.314-015
PR144M	3.468-015	5.841-016	9.838-017	1.657-017
ND144	3.533-004	3.533-004	3.533-004	3.533-004
ND145	2.287-004	2.287-004	2.287-004	2.287-004
ND146	1.950-004	1.950-004	1.950-004	1.950-004
PM146	2.886-010	2.243-010	1.743-010	1.355-010
SM146	9.384-010	9.622-010	9.807-010	9.951-010
PM147	5.584-006	3.292-006	1.941-006	1.144-006
SM147	1.029-004	1.052-004	1.066-004	1.074-004
ND148	1.121-004	1.121-004	1.121-004	1.121-004
SM148	2.924-005	2.924-005	2.924-005	2.924-005
SM149	1.676-006	1.676-006	1.676-006	1.676-006
ND150	5.045-005	5.045-005	5.045-005	5.045-005
SM150	7.341-005	7.341-005	7.341-005	7.341-005
EU150	8.484-014	8.164-014	7.855-014	7.559-014
SM151	7.234-006	7.124-006	7.015-006	6.908-006
EU151	5.973-007	7.079-007	8.168-007	9.240-007
SM152	4.402-005	4.402-005	4.402-005	4.402-005

TABLE E.1.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	2.394-008	2.162-008	1.952-008	1.763-008
GD152	1.761-008	1.826-008	1.884-008	1.937-008
EU153	2.248-005	2.248-005	2.248-005	2.248-005
GD153	1.080-013	1.333-014	1.645-015	2.030-016
SM154	8.902-006	8.902-006	8.902-006	8.902-006
EU154	1.748-006	1.487-006	1.266-006	1.078-006
GD154	2.424-006	2.684-006	2.906-006	3.094-006
EU155	5.925-007	4.480-007	3.387-007	2.561-007
GD155	1.843-006	1.988-006	2.097-006	2.179-006
GD156	6.776-006	6.776-006	6.776-006	6.776-006
GD157	3.452-008	3.452-008	3.452-008	3.452-008
GD158	3.009-006	3.009-006	3.009-006	3.009-006
TB159	5.024-007	5.024-007	5.024-007	5.024-007
GD160	2.446-007	2.446-007	2.446-007	2.446-007
DY160	2.159-008	2.159-008	2.159-008	2.159-008
DY161	9.905-008	9.905-008	9.905-008	9.905-008
DY162	7.196-008	7.196-008	7.196-008	7.196-008
DY163	3.982-008	3.982-008	3.982-008	3.982-008
DY164	8.845-009	8.845-009	8.845-009	8.845-009
HO165	1.664-008	1.664-008	1.664-008	1.664-008
HO166M	6.274-011	6.267-011	6.260-011	6.253-011
ER166	5.152-009	5.152-009	5.152-009	5.152-009
ER167	1.095-009	1.095-009	1.095-009	1.095-009
ER168	9.718-010	9.718-010	9.718-010	9.718-010
TM169	2.558-012	2.558-012	2.558-012	2.558-012
ER170	3.729-016	3.729-016	3.729-016	3.729-016
YB170	2.536-013	2.536-013	2.536-013	2.536-013
TM171	9.298-017	4.517-017	2.194-017	1.066-017
YB171	5.542-015	5.590-015	5.613-015	5.625-015
YB172	5.019-017	5.019-017	5.019-017	5.019-017
SUMTOT	1.033-002	1.033-002	1.033-002	1.033-002
TOTAL	1.033-002	1.033-002	1.033-002	1.033-002

TABLE E.1.f. Fission Products (Elemental), g/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	9.295-009	8.368-009	7.426-009	6.637-009
LI	9.970-011	9.970-011	9.970-011	9.970-011
BE	4.556-011	4.556-011	4.556-011	4.556-011
C	8.001-012	7.999-012	7.997-012	7.995-012
ZN	1.348-014	1.348-014	1.348-014	1.348-014
GA	2.422-013	2.422-013	2.422-013	2.422-013
GE	2.121-007	2.121-007	2.121-007	2.121-007
AS	6.455-008	6.455-008	6.455-008	6.455-008
SE	1.826-005	1.826-005	1.826-005	1.826-005
BR	7.187-006	7.187-006	7.187-006	7.187-006
KR	1.205-004	1.200-004	1.196-004	1.192-004
RB	1.202-004	1.207-004	1.212-004	1.216-004
SR	2.649-004	2.581-004	2.517-004	2.456-004
Y	1.572-004	1.572-004	1.572-004	1.572-004
ZR	1.184-003	1.191-003	1.197-003	1.203-003
NB	1.387-009	1.601-009	1.816-009	2.031-009
MO	1.029-003	1.029-003	1.029-003	1.029-003
TC	2.528-004	2.528-004	2.528-004	2.528-004
RU	5.971-004	5.971-004	5.971-004	5.971-004
RH	1.631-004	1.631-004	1.631-004	1.631-004
PD	2.683-004	2.683-004	2.683-004	2.683-004
AG	1.719-005	1.719-005	1.719-005	1.719-005
CD	2.057-005	2.056-005	2.056-005	2.056-005
IN	1.565-006	1.569-006	1.571-006	1.574-006
SN	2.546-005	2.546-005	2.546-005	2.546-005
SB	6.017-006	5.888-006	5.810-006	5.763-006
TE	1.384-004	1.385-004	1.386-004	1.386-004
I	6.776-005	6.776-005	6.776-005	6.776-005
XE	1.494-003	1.494-003	1.494-003	1.494-003
CS	8.511-004	8.379-004	8.255-004	8.136-004
BA	5.009-004	5.140-004	5.265-004	5.383-004
LA	3.797-004	3.797-004	3.797-004	3.797-004
CE	7.262-004	7.261-004	7.261-004	7.261-004
PR	3.515-004	3.515-004	3.515-004	3.515-004
ND	1.254-003	1.254-003	1.254-003	1.254-003
PM	5.585-006	3.292-006	1.941-006	1.144-006
SM	2.674-004	2.696-004	2.708-004	2.715-004
EU	2.544-005	2.514-005	2.492-005	2.475-005
GD	1.435-005	1.475-005	1.508-005	1.536-005
TB	5.024-007	5.024-007	5.024-007	5.024-007
DY	2.413-007	2.413-007	2.413-007	2.413-007
HO	1.670-008	1.670-008	1.670-008	1.670-008
ER	7.219-009	7.219-009	7.219-009	7.219-009
TM	2.558-012	2.558-012	2.558-012	2.558-012
YB	2.593-013	2.593-013	2.593-013	2.593-013
SUMTOT	1.033-002	1.033-002	1.033-002	1.033-002
TOTAL	1.033-002	1.033-002	1.033-002	1.033-002

TABLE E.1.g. Fission Products (Isotopic), Ci/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	8.574-005	8.021-005	7.169-005	6.408-005
BE 10	8.857-013	8.857-013	8.857-013	8.857-013
C 14	3.568-011	3.567-011	3.566-011	3.565-011
SE 79	1.301-007	1.301-007	1.301-007	1.300-007
KR 81	6.475-014	6.475-014	6.475-014	6.475-014
KR 85	1.659-003	1.458-003	1.281-003	1.125-003
RB 87	7.298-012	7.298-012	7.298-012	7.298-012
SR 90	1.978-002	1.886-002	1.799-002	1.715-002
Y 90	1.979-002	1.887-002	1.799-002	1.716-002
ZR 93	5.961-007	5.961-007	5.961-007	5.961-007
NB 93M	2.485-007	2.793-007	3.071-007	3.322-007
NB 94	3.090-011	3.090-011	3.090-011	3.090-011
TC 98	5.347-013	5.347-013	5.347-013	5.347-013
TC 99	4.287-006	4.287-006	4.287-006	4.287-006
RH102	1.148-008	7.115-009	4.411-009	2.735-009
RU106	1.185-004	2.994-005	7.569-006	1.913-006
RH106	1.185-004	2.994-005	7.569-006	1.913-006
PD107	2.229-008	2.229-008	2.229-008	2.229-008
AG108	4.516-013	4.467-013	4.419-013	4.371-013
AG108M	5.075-012	5.019-012	4.965-012	4.911-012
AG109M	1.241-013	4.168-014	1.400-014	4.700-015
CD109	1.241-013	4.168-014	1.400-014	4.700-015
AG110	1.540-010	2.030-011	2.676-012	3.527-013
AG110M	1.158-008	1.526-009	2.012-010	2.652-011
CD113M	7.844-006	7.133-006	6.486-006	5.898-006
SN119M	1.964-009	2.487-010	3.149-011	3.988-012
SN121M	4.369-008	4.249-008	4.133-008	4.020-008
SN123	3.242-012	6.432-014	1.276-015	2.535-017
TE123M	2.748-016	4.022-018	1.273-019	.000
SB125	3.381-004	2.050-004	1.243-004	7.532-005
TE125M	8.249-005	5.002-005	3.032-005	1.838-005
SN126	2.184-007	2.184-007	2.184-007	2.184-007
SB126	3.057-008	3.057-008	3.057-008	3.057-008
SB126M	2.184-007	2.184-007	2.184-007	2.184-007
TE127	3.132-013	3.009-015	2.901-017	2.787-019
TE127M	3.198-013	3.072-015	2.962-017	2.325-019
I129	9.229-009	9.229-009	9.229-009	9.229-009
CS134	5.850-004	2.987-004	1.525-004	7.784-005
CS135	2.146-007	2.146-007	2.146-007	2.146-007
CS137	2.491-002	2.378-002	2.271-002	2.169-002
BA137M	2.356-002	2.250-002	2.148-002	2.051-002
CE142	8.423-012	8.423-012	8.423-012	8.423-012
CE144	5.243-005	8.831-006	1.487-006	2.505-007
PR144	5.244-005	8.831-006	1.487-006	2.505-007
PR144M	6.292-007	1.060-007	1.785-008	3.006-009
ND144	4.181-016	4.181-016	4.181-016	4.181-016
PM146	1.285-007	9.989-008	7.764-008	6.034-008
SM146	3.284-014	3.367-014	3.432-014	3.482-014
PM147	5.179-003	3.053-003	1.800-003	1.061-003
SM147	2.340-012	2.392-012	2.423-012	2.441-012
EU150	5.619-012	5.407-012	5.203-012	5.006-012
SM151	1.904-004	1.875-004	1.846-004	1.818-004

TABLE E.1.g. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	4.141-006	3.740-006	3.378-006	3.050-006
GD153	3.809-010	4.701-011	5.802-012	7.161-013
EU154	4.719-004	4.017-004	3.419-004	2.910-004
EU155	2.757-004	2.084-004	1.576-004	1.192-004
HO166M	1.126-010	1.125-010	1.124-010	1.123-010
TM171	1.013-013	4.920-014	2.390-014	1.161-014
SUMTOT	9.728-002	9.006-002	8.435-002	7.954-002
TOTAL	9.728-002	9.006-002	8.435-002	7.954-002

TABLE E.1.h. Fission Products (Elemental), Ci/gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	8.974-005	8.021-005	7.169-005	6.408-005
BE	8.857-013	8.857-013	8.857-013	8.857-013
C	3.568-011	3.567-011	3.566-011	3.565-011
SE	1.301-007	1.301-007	1.301-007	1.300-007
KR	1.659-003	1.458-003	1.281-003	1.125-003
RB	7.298-012	7.298-012	7.298-012	7.298-012
SR	1.978-002	1.866-002	1.799-002	1.715-002
Y	1.979-002	1.887-002	1.799-002	1.716-002
ZR	5.961-007	5.961-007	5.961-007	5.961-007
NB	2.486-007	2.794-007	3.072-007	3.323-007
TC	4.287-006	4.287-006	4.287-006	4.287-006
RU	1.185-004	2.994-005	7.569-006	1.913-006
RH	1.185-004	2.995-005	7.573-006	1.916-006
PD	2.229-008	2.229-008	2.229-008	2.229-008
AG	1.174-008	1.552-009	2.093-010	3.222-011
CD	7.844-006	7.133-006	6.486-006	5.898-006
SN	2.640-007	2.611-007	2.597-007	2.586-007
SB	3.383-004	2.052-004	1.245-004	7.557-005
TE	8.249-005	5.002-005	3.032-005	1.838-005
I	9.229-009	9.229-009	9.229-009	9.229-009
CS	2.550-002	2.408-002	2.286-002	2.176-002
BA	2.356-002	2.250-002	2.148-002	2.051-002
CE	5.243-005	8.831-006	1.487-006	2.505-007
PR	5.307-005	8.937-006	1.505-006	2.535-007
ND	4.181-016	4.181-016	4.181-016	4.181-016
PM	5.179-003	3.053-003	1.800-003	1.061-003
SM	1.904-004	1.875-004	1.846-004	1.818-004
EU	7.517-004	6.139-004	5.029-004	4.132-004
GD	3.809-010	4.701-011	5.802-012	7.161-013
HO	1.126-010	1.125-010	1.124-010	1.123-010
TM	1.013-013	4.920-014	2.390-014	1.161-014
SUMTOT	9.728-002	9.006-002	8.435-002	7.954-002
TOTAL	9.728-002	9.006-002	8.435-002	7.954-002

TABLE E.1.i. Neutron Source (Alpha-n), Neutrons/sec-gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	1.591-001	1.566-001	1.542-001	1.518-001
PU239	1.669-001	1.668-001	1.668-001	1.668-001
PU240	1.259-001	1.258-001	1.258-001	1.258-001
AM241	4.197-001	4.765-001	5.277-001	5.739-001
CM242	1.399-003	1.388-003	1.375-003	1.363-003
CM244	7.410-003	6.864-003	6.358-003	5.890-003

TABLE E.1.j. Neutron Source (Spontaneous fission), Neutrons/sec-gU, at 10 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
U238	1.227-002	1.227-002	1.227-002	1.227-002
PU238	2.595-002	2.555-002	2.515-002	2.476-002
PU240	6.635-001	6.634-001	6.632-001	6.631-001
PU242	4.976-002	4.976-002	4.976-002	4.976-002
CM242	6.786-003	6.733-003	6.672-003	6.611-003
CM244	8.522-001	8.264-001	7.655-001	7.091-001

TABLE E.2. Radionuclide Inventories at 15 MWd/kgM as a Function of Decay Time

TABLE E.2.a. Actinides (Isotopic), g/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE 4	2.259-007	2.555-007	2.867-007	3.191-007
PB207	2.219-015	3.412-015	4.955-015	6.888-015
PB208	1.078-011	1.449-011	1.836-011	2.231-011
PB212	3.200-015	3.399-015	3.500-015	3.541-015
RA224	2.791-014	2.965-014	3.053-014	3.089-014
RA226	1.893-015	2.917-015	4.250-015	5.930-015
AC227	1.787-014	2.359-014	2.997-014	3.698-014
TH228	5.424-012	5.747-012	5.919-012	5.987-012
TH229	4.593-014	5.243-014	5.983-014	6.813-014
TH230	4.996-011	6.638-011	8.500-011	1.058-010
TH231	5.292-014	5.292-014	5.292-014	5.292-014
TH232	7.274-010	8.546-010	9.819-010	1.109-009
TH234	1.398-011	1.398-011	1.398-011	1.398-011
PA231	1.566-010	1.818-010	2.071-010	2.323-010
PA233	5.275-012	5.302-012	5.332-012	5.366-012
U232	2.299-010	2.327-010	2.326-010	2.309-010
U233	7.026-010	8.070-010	9.120-010	1.018-009
U234	2.746-006	3.145-006	3.538-006	3.925-006
U235	1.302-002	1.302-002	1.302-002	1.302-002
U236	2.186-003	2.186-003	2.186-003	2.186-003
U237	1.108-011	1.006-011	9.136-012	8.297-012
U238	9.629-001	9.629-001	9.629-001	9.629-001
NP235	1.652-015	4.600-016	1.281-016	3.567-017
NP236	1.087-010	1.087-010	1.087-010	1.087-010
NP237	1.553-004	1.561-004	1.570-004	1.580-004
NP238	6.002-014	5.948-014	5.894-014	5.840-014
NP239	7.334-012	7.332-012	7.331-012	7.330-012
PU236	1.905-011	1.171-011	7.202-012	4.429-012
PU238	2.588-005	2.548-005	2.508-005	2.469-005
PU239	4.336-003	4.336-003	4.336-003	4.335-003
PU240	1.186-003	1.186-003	1.185-003	1.185-003
PU241	3.577-004	3.249-004	2.951-004	2.680-004
PU242	9.675-005	9.675-005	9.675-005	9.675-005
PU244	9.056-010	9.056-010	9.056-010	9.056-010
AM241	2.380-004	2.700-004	2.989-004	3.250-004
AM242M	3.201-007	3.172-007	3.143-007	3.115-007
AM242	3.829-012	3.795-012	3.760-012	3.726-012
AM243	8.534-006	8.532-006	8.530-006	8.529-006
CM242	7.749-010	7.686-010	7.617-010	7.548-010
CM243	3.053-008	2.908-008	2.770-008	2.639-008
CM244	6.818-007	6.316-007	5.851-007	5.419-007
CM245	2.006-008	2.005-008	2.005-008	2.005-008
CM246	1.001-009	1.001-009	1.001-009	1.000-009
CM247	4.124-012	4.124-012	4.124-012	4.124-012
CM248	8.952-014	8.952-014	8.952-014	8.952-014
SF250	9.617-013	1.047-012	1.128-012	1.203-012
SUMTOT	9.845-001	9.845-001	9.845-001	9.845-001
TOTAL	9.845-001	9.845-001	9.845-001	9.845-001

TABLE E.2.b. Actinides (Elemental), g/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE	2.259-007	2.555-007	2.867-007	3.191-007
SF	9.617-013	1.047-012	1.128-012	1.203-012
PB	1.078-011	1.450-011	1.837-011	2.232-011
RA	2.983-014	3.260-014	3.482-014	3.687-014
AC	1.787-014	2.359-014	2.997-014	3.698-014
TH	7.969-010	9.408-010	1.087-009	1.235-009
PA	1.619-010	1.871-010	2.124-010	2.377-010
U	9.781-001	9.781-001	9.781-001	9.781-001
NP	1.553-004	1.561-004	1.570-004	1.580-004
PU	6.002-003	5.969-003	5.938-003	5.910-003
AM	2.468-004	2.789-004	3.078-004	3.338-004
CM	7.342-007	6.825-007	6.346-007	5.901-007
SUMTOT	9.845-001	9.845-001	9.845-001	9.845-001
TOTAL	9.845-001	9.845-001	9.845-001	9.845-001

TABLE E.2.c. Actinides (Isotopic), Ci/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL207	1.290-012	1.705-012	2.167-012	2.673-012
TL208	1.598-009	1.697-009	1.748-009	1.768-009
TL209	2.111-016	2.410-016	2.750-016	3.132-016
PB209	9.774-015	1.116-014	1.273-014	1.450-014
PB210	2.547-016	3.813-016	5.703-016	8.375-016
PB211	1.293-012	1.710-012	2.173-012	2.681-012
PB212	4.447-009	4.724-009	4.865-009	4.922-009
PB214	1.872-015	2.885-015	4.202-015	5.864-015
BI210	2.548-016	3.815-016	5.705-016	8.379-016
BI211	1.293-012	1.710-012	2.173-012	2.681-012
BI212	4.447-009	4.724-009	4.865-009	4.922-009
BI213	9.774-015	1.116-014	1.273-014	1.450-014
BI214	1.872-015	2.885-015	4.202-015	5.864-015
PO210	2.548-016	3.411-016	5.101-016	7.529-016
PO211	3.621-015	4.787-015	6.083-015	7.506-015
PO212	2.849-009	3.027-009	3.117-009	3.153-009
PO213	9.563-015	1.092-014	1.246-014	1.419-014
PO214	1.872-015	2.884-015	4.202-015	5.863-015
PO215	1.293-012	1.710-012	2.173-012	2.681-012
PO216	4.447-009	4.724-009	4.865-009	4.922-009
PO218	1.873-015	2.885-015	4.203-015	5.865-015
AT217	9.774-015	1.116-014	1.273-014	1.450-014
RN219	1.293-012	1.710-012	2.173-012	2.681-012
RN220	4.447-009	4.724-009	4.865-009	4.922-009
RN222	1.873-015	2.885-015	4.203-015	5.865-015
FR221	9.774-015	1.116-014	1.273-014	1.450-014
FR223	1.784-014	2.356-014	2.993-014	3.693-014
RA223	1.293-012	1.710-012	2.173-012	2.681-012
RA224	4.447-009	4.724-009	4.865-009	4.922-009
RA225	9.774-015	1.116-014	1.273-014	1.450-014
RA226	1.873-015	2.885-015	4.203-015	5.865-015
AC225	9.774-015	1.116-014	1.273-014	1.450-014
AC227	1.293-012	1.707-012	2.169-012	2.676-012
TH227	1.275-012	1.686-012	2.143-012	2.644-012
TH228	4.447-009	4.713-009	4.853-009	4.909-009
TH229	9.774-015	1.116-014	1.273-014	1.450-014
TH230	1.009-012	1.340-012	1.716-012	2.136-012
TH231	2.814-008	2.815-008	2.815-008	2.815-008
TH232	7.981-017	9.377-017	1.077-016	1.217-016
TH234	3.238-007	3.238-007	3.238-007	3.238-007
PA231	7.399-012	8.592-012	9.785-012	1.098-011
PA233	1.095-007	1.101-007	1.107-007	1.114-007
PA234M	3.238-007	3.238-007	3.238-007	3.238-007
PA234	4.210-010	4.210-010	4.210-010	4.210-010
U232	4.923-009	4.982-009	4.981-009	4.944-009
U233	6.804-012	7.815-012	8.832-012	9.855-012
U234	1.716-008	1.966-008	2.211-008	2.453-008
U235	2.814-008	2.815-008	2.815-008	2.815-008
U236	1.415-007	1.415-007	1.415-007	1.415-007
U237	9.044-007	8.214-007	7.460-007	6.775-007
U238	3.238-007	3.238-007	3.238-007	3.238-007
U240	1.605-014	1.605-014	1.605-014	1.605-014

TABLE E.2.c. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
NP235	2.318-012	6.456-013	1.798-013	5.006-014
NP236	1.432-012	1.432-012	1.432-012	1.432-012
NP237	1.095-007	1.101-007	1.107-007	1.114-007
NP238	1.556-008	1.542-008	1.528-008	1.514-008
NP239	1.702-006	1.702-006	1.701-006	1.701-006
NP240M	1.605-014	1.605-014	1.605-014	1.605-014
PU236	1.012-008	6.226-009	3.828-009	2.354-009
PU238	4.432-004	4.363-004	4.295-004	4.228-004
PU239	2.696-004	2.696-004	2.696-004	2.696-004
PU240	2.703-004	2.703-004	2.702-004	2.702-004
PU241	3.687-002	3.348-002	3.041-002	2.762-002
PU242	3.696-007	3.696-007	3.696-007	3.696-007
PU243	3.828-016	3.828-016	3.828-016	3.828-016
PU244	1.607-014	1.607-014	1.607-014	1.607-014
AM241	8.171-004	9.270-004	1.026-003	1.116-003
AM242M	3.112-006	3.084-006	3.056-006	3.028-006
AM242	3.097-006	3.069-006	3.041-006	3.013-006
AM243	1.702-006	1.702-006	1.701-006	1.701-006
CM242	2.563-006	2.542-006	2.519-006	2.497-006
CM243	1.577-006	1.502-006	1.430-006	1.363-006
CM244	5.519-005	5.112-005	4.735-005	4.386-005
CM245	3.445-009	3.444-009	3.444-009	3.443-009
CM246	3.076-010	3.076-010	3.075-010	3.074-010
CM247	3.828-016	3.828-016	3.828-016	3.828-016
CM248	3.808-016	3.808-016	3.807-016	3.807-016
BK249	2.745-016	5.641-017	1.160-017	2.375-018
CF249	2.118-015	2.111-015	2.102-015	2.094-015
CF250	4.340-015	3.904-015	3.511-015	3.158-015
CF252	1.705-016	1.008-016	5.961-017	3.525-017
SUMTOT	3.874-002	3.545-002	3.247-002	2.976-002
TOTAL	3.874-002	3.545-002	3.247-002	2.976-002

TABLE E.2.d. Actinides (Elemental), Ci/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL	1.599-009	1.699-009	1.750-009	1.771-009
PB	4.449-009	4.726-009	4.867-009	4.924-009
BI	4.449-009	4.726-009	4.867-009	4.924-009
PO	7.298-009	7.752-009	7.984-009	8.078-009
AT	9.774-015	1.116-014	1.273-014	1.450-014
RN	4.449-009	4.726-009	4.867-009	4.924-009
FR	2.762-014	3.471-014	4.266-014	5.143-014
RA	4.449-009	4.726-009	4.867-009	4.924-009
AC	1.303-012	1.718-012	2.182-012	2.690-012
TH	3.564-007	3.567-007	3.569-007	3.569-007
PA	4.338-007	4.344-007	4.350-007	4.357-007
U	1.420-006	1.340-006	1.267-006	1.201-006
NP	1.827-006	1.827-006	1.827-006	1.827-006
PU	3.785-002	3.446-002	3.138-002	2.858-002
AM	8.250-004	9.349-004	1.034-003	1.124-003
CM	5.933-005	5.517-005	5.131-005	4.773-005
BK	2.745-016	5.641-017	1.160-017	2.375-018
CF	6.657-015	6.143-015	5.701-015	5.316-015
SUMTOT	3.874-002	3.545-002	3.247-002	2.976-002
TOTAL	3.874-002	3.545-002	3.247-002	2.976-002

TABLE E.2.e. Fission Products (Isotopic), g/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	1.435-008	1.283-008	1.147-008	1.025-008
LI 6	1.246-010	1.246-010	1.246-010	1.246-010
LI 7	4.613-012	4.613-012	4.613-012	4.613-012
BE 9	8.887-012	8.887-012	8.887-012	8.887-012
BE 10	5.929-011	5.929-011	5.929-011	5.929-011
C 14	1.197-011	1.197-011	1.197-011	1.196-011
ZN 66	1.816-014	1.816-014	1.816-014	1.816-014
ZN 67	7.586-016	7.586-016	7.586-016	7.58[illegible]6
GA 71	3.852-013	3.852-013	3.852-013	3.852-[illegible]3
GE 72	9.897-009	9.897-009	9.897-009	9.897-009
GE 73	2.129-008	2.129-008	2.129-008	2.129-008
GE 74	4.495-008	4.495-008	4.495-008	4.495-008
AS 75	9.566-008	9.566-008	9.566-008	9.566-008
GE 76	2.369-007	2.369-007	2.369-007	2.369-007
SE 76	1.270-009	1.270-009	1.270-009	1.270-009
SE 77	4.985-007	4.985-007	4.985-007	4.985-007
SE 78	1.107-006	1.107-006	1.107-006	1.107-006
SE 79	2.756-006	2.756-006	2.756-006	2.756-006
BR 79	3.357-010	3.945-010	4.533-010	5.122-010
SE 80	6.266-006	6.266-006	6.266-006	6.266-006
KR 80	9.084-011	9.084-011	9.084-011	9.084-011
BR 81	1.047-005	1.047-005	1.047-005	1.047-005
KR 81	6.335-012	6.335-012	6.335-012	6.335-012
SE 82	1.606-005	1.606-005	1.606-005	1.606-005
KR 82	2.474-007	2.474-007	2.474-007	2.474-007
KR 83	2.269-005	2.269-005	2.269-005	2.269-005
KR 84	5.150-005	5.150-005	5.150-005	5.150-005
KR 85	6.063-006	5.328-006	4.682-006	4.114-006
RB 85	5.279-005	5.352-005	5.417-005	5.474-005
KR 86	9.236-005	9.236-005	9.236-005	9.236-005
SR 86	9.459-008	9.459-008	9.459-008	9.459-008
RB 87	1.188-004	1.188-004	1.188-004	1.188-004
SR 87	7.577-010	7.577-010	7.577-010	7.577-010
SR 88	1.707-004	1.707-004	1.707-004	1.707-004
Y 89	2.234-004	2.234-004	2.234-004	2.234-004
SR 90	2.062-004	1.966-004	1.875-004	1.788-004
Y 90	5.171-008	4.931-008	4.701-008	4.483-008
ZR 90	6.451-005	7.410-005	8.324-005	9.196-005
ZR 91	2.866-004	2.866-004	2.866-004	2.866-004
ZR 92	3.069-004	3.069-004	3.069-004	3.069-004
ZR 93	3.438-004	3.438-004	3.438-004	3.438-004
NB 93	4.989-010	6.527-010	8.218-010	1.005-009
NB 93M	1.276-009	1.433-009	1.576-009	1.705-009
ZR 94	3.464-004	3.464-004	3.464-004	3.464-004
NB 94	2.963-010	2.963-010	2.962-010	2.962-010
MO 95	3.624-004	3.624-004	3.624-004	3.624-004
ZR 96	3.718-004	3.718-004	3.718-004	3.718-004
MO 96	7.317-006	7.317-006	7.317-006	7.317-006
MO 97	3.650-004	3.650-004	3.650-004	3.650-004
MO 98	3.761-004	3.761-004	3.761-004	3.761-004
TC 98	1.383-009	1.383-009	1.383-009	1.383-009
TC 99	3.721-004	3.721-004	3.721-004	3.721-004

TABLE E.2.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
RU 99	1.367-008	1.609-008	1.851-008	2.093-008
MO100	4.221-004	4.221-004	4.221-004	4.221-004
RU100	2.098-005	2.098-005	2.098-005	2.098-005
RU101	3.537-004	3.537-004	3.537-004	3.537-004
RU102	3.342-004	3.342-004	3.342-004	3.342-004
RH102	2.160-011	1.339-011	8.304-012	5.148-012
RH103	2.423-004	2.423-004	2.423-004	2.423-004
RU104	2.223-004	2.223-004	2.223-004	2.223-004
PD104	5.091-005	5.091-005	5.091-005	5.091-005
PD105	1.584-004	1.584-004	1.584-004	1.584-004
RU106	6.348-008	1.605-008	4.056-009	1.025-009
RH106	5.967-014	1.508-014	3.812-015	9.636-016
PD106	1.254-004	1.254-004	1.254-004	1.254-004
PD107	7.950-005	7.950-005	7.950-005	7.950-005
AG107	9.348-011	1.104-010	1.274-010	1.444-010
PD108	5.380-005	5.380-005	5.380-005	5.380-005
AG108M	3.745-013	3.704-013	3.664-013	3.624-013
CD108	7.274-011	7.274-011	7.274-011	7.274-011
AG109	3.082-005	3.082-005	3.082-005	3.082-005
CD109	1.916-016	6.435-017	2.161-017	7.256-018
PD110	1.785-005	1.785-005	1.785-005	1.785-005
AG110M	6.644-012	8.759-013	1.155-013	1.522-014
CD110	6.218-006	6.218-006	6.218-006	6.218-006
CD111	1.040-005	1.040-005	1.040-005	1.040-005
CD112	6.525-006	6.525-006	6.525-006	6.525-006
CD113	1.315-007	1.315-007	1.315-007	1.315-007
CD113M	6.059-008	5.510-008	5.010-008	4.556-008
IN113	4.201-008	4.750-008	5.249-008	5.703-008
CD114	9.454-006	9.454-006	9.454-006	9.454-006
SN114	2.357-010	2.357-010	2.357-010	2.357-010
IN115	1.896-006	1.896-006	1.896-006	1.896-006
SN115	1.456-007	1.456-007	1.456-007	1.456-007
CD116	3.724-006	3.724-006	3.724-006	3.724-006
SN116	2.406-006	2.406-006	2.406-006	2.406-006
SN117	3.782-006	3.782-006	3.782-006	3.782-006
SN118	3.815-006	3.815-006	3.815-006	3.815-006
SN119	3.793-006	3.793-006	3.793-006	3.793-006
SN119M	7.027-013	8.899-014	1.127-014	1.427-015
SN120	3.875-006	3.875-006	3.875-006	3.875-006
SN121M	1.242-009	1.208-009	1.175-009	1.142-009
SB121	3.916-006	3.916-006	3.916-006	3.916-006
SN122	4.280-006	4.280-006	4.280-006	4.280-006
TE122	1.243-007	1.243-007	1.243-007	1.243-007
SN123	6.107-016	1.212-017	2.404-019	4.776-021
SB123	4.769-006	4.769-006	4.769-006	4.769-006
TE123	1.111-009	1.111-009	1.111-009	1.111-009
SN124	5.799-006	5.799-006	5.799-006	5.799-006
TE124	9.196-008	9.196-008	9.196-008	9.196-008
SB125	5.171-007	3.135-007	1.901-007	1.152-007
TE125	7.886-006	8.092-006	8.218-006	8.293-006
TE125M	7.233-009	4.386-009	2.659-009	1.612-009
SN126	1.211-005	1.211-005	1.211-005	1.211-005

TABLE E.2.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
SB126	5.756-013	5.756-013	5.756-013	5.755-013
SB126M	4.376-015	4.376-015	4.376-015	4.376-015
TE126	2.848-007	2.849-007	2.851-007	2.853-007
TE127M	5.441-017	5.228-019	5.019-021	3.940-023
I127	2.458-005	2.458-005	2.458-005	2.458-005
TE128	4.863-005	4.863-005	4.863-005	4.863-005
XE128	6.117-007	6.117-007	6.117-007	6.117-007
I129	8.089-005	8.089-005	8.089-005	8.089-005
XE129	1.719-009	1.726-009	1.734-009	1.741-009
TE130	1.570-004	1.570-004	1.570-004	1.570-004
XE130	2.602-006	2.602-006	2.602-006	2.602-006
XE131	2.313-004	2.313-004	2.313-004	2.313-004
XE132	4.450-004	4.450-004	4.450-004	4.450-004
BA132	4.162-010	4.162-010	4.162-010	4.162-010
CS133	5.538-004	5.538-004	5.538-004	5.538-004
XE134	6.684-004	6.684-004	6.684-004	6.684-004
CS134	9.875-007	5.041-007	2.574-007	1.314-007
BA134	3.644-005	3.692-005	3.717-005	3.729-005
CS135	2.221-004	2.221-004	2.221-004	2.221-004
BA135	2.695-008	2.709-008	2.722-008	2.735-008
XE136	9.630-004	9.630-004	9.630-004	9.630-004
BA136	6.313-006	6.313-006	6.313-006	6.313-006
CS137	4.302-004	4.108-004	3.922-004	3.745-004
BA137	1.282-004	1.476-004	1.662-004	1.839-004
BA137M	6.581-011	6.284-011	6.000-011	5.729-011
BA138	5.865-004	5.865-004	5.865-004	5.865-004
LA138	3.327-009	3.327-009	3.327-009	3.327-009
LA139	5.628-004	5.628-004	5.628-004	5.628-004
CE140	5.599-004	5.599-004	5.599-004	5.599-004
PR141	5.203-004	5.203-004	5.203-004	5.203-004
CE142	5.197-004	5.197-004	5.197-004	5.197-004
ND142	5.554-006	5.554-006	5.554-006	5.554-006
ND143	4.342-004	4.342-004	4.342-004	4.342-004
CE144	2.398-008	4.039-009	6.803-010	1.146-010
PR144	1.013-012	1.705-013	2.872-014	4.838-015
PR144M	5.062-015	8.525-016	1.436-016	2.418-017
ND144	5.438-004	5.438-004	5.438-004	5.438-004
ND145	3.314-004	3.314-004	3.314-004	3.314-004
ND146	2.956-004	2.956-004	2.956-004	2.956-004
PM146	5.916-010	4.598-010	3.574-010	2.778-010
SM146	1.930-009	1.979-009	2.017-009	2.046-009
PM147	7.221-006	4.257-006	2.510-006	1.479-006
SM147	1.335-004	1.365-004	1.382-004	1.392-004
ND148	1.681-004	1.681-004	1.681-004	1.681-004
SM148	5.610-005	5.610-005	5.610-005	5.610-005
SM149	1.862-006	1.862-006	1.862-006	1.862-006
ND150	7.778-005	7.778-005	7.778-005	7.778-005
SM150	1.113-004	1.113-004	1.113-004	1.113-004
EU150	1.068-013	1.027-013	9.884-014	9.511-014
SM151	8.296-006	8.169-006	8.044-006	7.921-006
EU151	6.780-007	8.048-007	9.297-007	1.053-006
SM152	6.626-005	6.626-005	6.627-005	6.627-005

TABLE E.2.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	2.360-008	2.131-008	1.925-008	1.738-008
GD152	1.763-008	1.826-008	1.884-008	1.936-008
EU153	3.982-005	3.982-005	3.982-005	3.982-005
GD153	1.791-013	2.211-014	2.728-015	3.367-016
SM154	1.479-005	1.479-005	1.479-005	1.479-005
EU154	4.115-006	3.503-006	2.981-006	2.537-006
GD154	5.699-006	6.312-006	6.833-006	7.277-006
EU155	1.022-006	7.730-007	5.845-007	4.419-007
GD155	3.159-006	3.408-006	3.597-006	3.739-006
GD156	1.391-005	1.391-005	1.391-005	1.391-005
GD157	4.561-008	4.561-008	4.561-008	4.561-008
GD158	5.601-006	5.601-006	5.601-006	5.601-006
TB159	9.232-007	9.232-007	9.232-007	9.232-007
GD160	4.509-007	4.509-007	4.509-007	4.509-007
DY160	5.607-008	5.607-008	5.607-008	5.607-008
DY161	1.704-007	1.704-007	1.704-007	1.704-007
DY162	1.334-007	1.334-007	1.334-007	1.334-007
DY163	8.117-008	8.117-008	8.117-008	8.117-008
DY164	1.483-008	1.483-008	1.483-008	1.483-008
HO165	3.495-008	3.495-008	3.495-008	3.495-008
HO166M	1.881-010	1.878-010	1.876-010	1.874-010
ER166	1.051-008	1.051-008	1.051-008	1.051-008
ER167	1.546-009	1.546-009	1.546-009	1.546-009
ER168	2.120-009	2.120-009	2.120-009	2.120-009
TM169	8.139-012	8.139-012	8.139-012	8.139-012
ER170	1.806-015	1.806-015	1.806-015	1.806-015
YB170	1.225-012	1.225-012	1.225-012	1.225-012
TM171	6.871-016	3.338-016	1.621-016	7.876-017
YB171	4.079-014	4.114-014	4.131-014	4.140-014
YB172	5.619-016	5.619-016	5.619-016	5.619-016
SUMTOT	1.547-002	1.547-002	1.547-002	1.547-002
TOTAL	1.547-002	1.547-002	1.547-002	1.547-002

TABLE E.2.f. Fission Products (Elemental), g/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	1.435-008	1.283-008	1.147-008	1.025-008
LI	1.292-010	1.292-010	1.292-010	1.292-010
BE	6.817-011	6.817-011	6.817-011	6.817-011
C	1.197-011	1.197-011	1.197-011	1.196-011
ZN	1.892-014	1.892-014	1.892-014	1.892-014
GA	3.852-013	3.852-013	3.852-013	3.852-013
GE	3.130-007	3.130-007	3.130-007	3.130-007
AS	9.566-008	9.566-008	9.566-008	9.566-008
SE	2.669-005	2.669-005	2.669-005	2.669-005
BR	1.047-005	1.047-005	1.047-005	1.047-005
KR	1.729-004	1.721-004	1.715-004	1.709-004
RB	1.716-004	1.724-004	1.730-004	1.736-004
SR	3.770-004	3.674-004	3.582-004	3.495-004
Y	2.235-004	2.235-004	2.235-004	2.235-004
ZR	1.720-003	1.730-003	1.739-003	1.747-003
NB	2.071-009	2.382-009	2.694-009	3.005-009
MO	1.533-003	1.533-003	1.533-003	1.533-003
TC	3.721-004	3.721-004	3.721-004	3.721-004
RU	9.313-004	9.313-004	9.312-004	9.312-004
RH	2.423-004	2.423-004	2.423-004	2.423-004
PD	4.858-004	4.859-004	4.859-004	4.859-004
AG	3.082-005	3.082-005	3.082-005	3.082-005
CD	3.651-005	3.651-005	3.650-005	3.650-005
IN	1.938-006	1.943-006	1.948-006	1.953-006
SN	4.001-005	4.001-005	4.001-005	4.001-005
SB	9.202-006	8.999-006	8.875-006	8.800-006
TE	2.140-004	2.142-004	2.143-004	2.144-004
I	1.055-004	1.055-004	1.055-004	1.055-004
XE	2.311-003	2.311-003	2.311-003	2.311-003
CS	1.207-003	1.187-003	1.168-003	1.151-003
BA	7.575-004	7.774-004	7.962-004	8.140-004
LA	5.628-004	5.628-004	5.628-004	5.628-004
CE	1.080-003	1.080-003	1.080-003	1.080-003
PR	5.203-004	5.203-004	5.203-004	5.203-004
ND	1.856-003	1.856-003	1.856-003	1.856-003
PM	7.221-006	4.257-006	2.510-006	1.480-006
SM	3.921-004	3.950-004	3.966-004	3.975-004
EU	4.566-005	4.492-005	4.433-005	4.387-005
GD	2.888-005	2.974-005	3.045-005	3.104-005
TB	9.232-007	9.232-007	9.232-007	9.232-007
DY	4.559-007	4.559-007	4.559-007	4.559-007
HO	3.514-008	3.514-008	3.514-008	3.514-008
ER	1.418-008	1.418-008	1.418-008	1.418-008
TM	8.140-012	8.140-012	8.139-012	8.139-012
YB	1.266-012	1.266-012	1.266-012	1.266-012
SUMTOT	1.547-002	1.547-002	1.547-002	1.547-002
TOTAL	1.547-002	1.547-002	1.547-002	1.547-002

TABLE E.2.g. Fission Products (Isotopic), Ci/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	1.386-004	1.239-004	1.107-004	9.895-005
BE 10	1.325-012	1.325-012	1.325-012	1.325-012
C 14	5.339-011	5.337-011	5.336-011	5.335-011
SE 79	1.921-007	1.921-007	1.921-007	1.921-007
KR 81	1.333-013	1.333-013	1.333-013	1.333-013
KR 85	2.380-003	2.091-003	1.838-003	1.615-003
RB 87	1.040-011	1.040-011	1.040-011	1.040-011
SR 90	2.814-002	2.683-002	2.558-002	2.439-002
Y 90	2.815-002	2.684-002	2.559-002	2.440-002
ZR 93	8.642-007	8.642-007	8.642-007	8.642-007
NB 93M	3.607-007	4.053-007	4.456-007	4.820-007
NB 94	5.553-011	5.553-011	5.552-011	5.552-011
TC 98	1.203-012	1.203-012	1.203-012	1.203-012
TC 99	6.310-006	6.310-006	6.310-006	6.310-006
RH102	2.612-008	1.619-008	1.004-008	6.225-009
RU106	2.125-004	5.371-005	1.358-005	3.431-006
RH106	2.125-004	5.371-005	1.358-005	3.431-006
PD107	4.090-008	4.090-008	4.090-008	4.090-008
AG108	8.690-013	8.596-013	8.502-013	8.410-013
AG108M	9.764-012	9.658-012	9.553-012	9.449-012
AG109M	4.950-013	1.662-013	5.581-014	1.874-014
CD109	4.950-013	1.662-013	5.581-014	1.874-014
AG110	4.200-010	5.536-011	7.298-012	9.620-013
AG110M	3.158-008	4.162-009	5.487-010	7.233-011
CD113M	1.314-005	1.195-005	1.087-005	9.884-006
SN119M	3.148-009	3.987-010	5.048-011	6.392-012
SN121M	7.344-008	7.143-008	6.948-008	6.757-008
SN123	5.021-012	9.962-014	1.976-015	3.927-017
TE123M	9.623-016	1.397-017	1.297-019	.000
SB125	5.342-004	3.238-004	1.963-004	1.190-004
TE125M	1.303-004	7.904-005	4.791-005	2.905-005
SN126	3.439-007	3.438-007	3.438-007	3.438-007
SB126	4.814-008	4.814-008	4.814-008	4.814-008
SB126M	3.439-007	3.438-007	3.438-007	3.438-007
TE127	5.029-013	4.832-015	4.643-017	4.457-019
TE127M	5.134-013	4.933-015	4.736-017	3.717-019
I129	1.429-008	1.429-008	1.429-008	1.429-008
CS134	1.278-003	6.525-004	3.331-004	1.701-004
CS135	2.559-007	2.559-007	2.559-007	2.559-007
CS137	3.744-002	3.575-002	3.413-002	3.259-002
BA137M	3.541-002	3.382-002	3.229-002	3.083-002
CE142	1.248-011	1.248-011	1.248-011	1.248-011
CE144	7.653-005	1.289-005	2.171-006	3.656-007
PR144	7.653-005	1.289-005	2.171-006	3.656-007
PR144M	9.184-007	1.547-007	2.605-008	4.388-009
ND144	6.436-016	6.436-016	6.436-016	6.436-016
PM146	2.635-007	2.048-007	1.592-007	1.237-007
SM146	6.754-014	6.925-014	7.057-014	7.160-014
PM147	6.697-003	3.948-003	2.327-003	1.372-003
SM147	3.035-012	3.102-012	3.142-012	3.166-012
EU150	7.071-012	6.804-012	6.547-012	6.299-012
SM151	2.183-004	2.150-004	2.117-004	2.085-004

TABLE E.2.g. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	4.083-006	3.687-006	3.330-006	3.007-006
GD153	6.319-010	7.799-011	9.625-012	1.188-012
EU154	1.111-003	9.459-004	8.050-004	6.852-004
EU155	4.756-004	3.596-004	2.719-004	2.056-004
HO166M	3.376-010	3.373-010	3.369-010	3.365-010
TM171	7.485-013	3.636-013	1.766-013	8.579-014
SUMTOT	1.427-001	1.321-001	1.238-001	1.167-001
TOTAL	1.427-001	1.321-001	1.238-001	1.167-001

TABLE E.2.h. Fission Products (Elemental), Ci/gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	1.386-004	1.239-004	1.107-004	9.895-005
BE	1.325-012	1.325-012	1.325-012	1.325-012
C	5.339-011	5.337-011	5.336-011	5.335-011
SE	1.921-007	1.921-007	1.921-007	1.921-007
KR	2.380-003	2.091-003	1.838-003	1.615-003
RB	1.040-011	1.040-011	1.040-011	1.040-011
SR	2.814-002	2.683-002	2.558-002	2.439-002
Y	2.815-002	2.684-002	2.559-002	2.440-002
ZR	8.642-007	8.642-007	8.642-007	8.642-007
NB	3.608-007	4.054-007	4.456-007	4.820-007
TC	6.310-006	6.310-006	6.310-006	6.310-006
RU	2.125-004	5.371-005	1.358-005	3.431-006
RH	2.125-004	5.372-005	1.359-005	3.438-006
PD	4.090-008	4.090-008	4.090-008	4.090-008
AG	3.201-008	4.229-009	5.665-010	8.360-011
CD	1.314-005	1.195-005	1.087-005	9.884-006
SN	4.204-007	4.157-007	4.134-007	4.114-007
SB	5.346-004	3.242-004	1.967-004	1.194-004
TE	1.303-004	7.904-005	4.791-005	2.905-005
I	1.429-008	1.429-008	1.429-008	1.429-008
CS	3.871-002	3.640-002	3.446-002	3.276-002
BA	3.541-002	3.382-002	3.229-002	3.083-002
CE	7.653-005	1.289-005	2.171-006	3.656-007
PR	7.745-005	1.304-005	2.197-006	3.700-007
ND	6.436-016	6.436-016	6.436-016	6.436-016
PM	6.697-003	3.948-003	2.328-003	1.372-003
SM	2.183-004	2.150-004	2.117-004	2.085-004
EU	1.591-003	1.309-003	1.080-003	8.938-004
GD	6.319-010	7.799-011	9.625-012	1.188-012
HO	3.376-010	3.373-010	3.369-010	3.365-010
TM	7.485-013	3.636-013	1.766-013	8.579-014
SUMTOT	1.427-001	1.321-001	1.238-001	1.167-001
TOTAL	1.427-001	1.321-001	1.238-001	1.167-001

TABLE E.2.i. Neutron Source (Alpha-n), Neutrons/sec-gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	4.217-001	4.151-001	4.087-001	4.023-001
PU239	1.964-001	1.964-001	1.964-001	1.964-001
PU240	2.048-001	2.048-001	2.048-001	2.047-001
AM241	7.838-001	8.852-001	9.844-001	1.070+000
CM242	3.441-003	3.413-003	3.382-003	3.351-003
CM243	2.099-003	1.999-003	1.905-003	1.814-003
CM244	6.298-002	5.834-002	5.404-002	5.006-002

TABLE E.2.j. Neutron Source (Spontaneous fission), Neutrons/sec-gU, at 15 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
U238	1.222-002	1.222-002	1.222-002	1.222-002
PU238	6.877-002	6.770-002	6.664-002	6.561-002
PU240	1.080+000	1.080+000	1.079+000	1.079+000
PU242	1.631-001	1.631-001	1.631-001	1.631-001
CM242	1.669-002	1.656-002	1.641-002	1.626-002
CM244	7.583+000	7.024+000	6.506+000	6.027+000
CM246	8.909-003	8.906-003	8.904-003	8.901-003

TABLE E.3. Radionuclide Inventories at 20 MWd/kgM as a Function of Decay Time

TABLE E.3.a. Actinides (Isotopic), g/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE 4	4.121-007	4.592-007	5.083-007	5.590-007
PB207	1.736-015	2.669-015	3.877-015	5.391-015
PB208	2.000-011	2.700-011	3.431-011	4.178-011
PB212	6.027-015	6.416-015	6.616-015	6.699-015
RA224	5.257-014	5.596-014	5.771-014	5.843-014
RA226	3.027-015	4.772-015	7.080-015	1.003-014
AC227	1.398-014	1.846-014	2.347-014	2.897-014
TH228	1.022-011	1.085-011	1.119-011	1.133-011
TH229	7.698-014	8.795-014	9.825-014	1.099-013
TH230	8.431-011	1.141-010	1.481-010	1.865-010
TH231	4.160-014	4.160-014	4.160-014	4.161-014
TH232	8.745-010	1.027-009	1.179-009	1.332-009
TH234	1.392-011	1.392-011	1.392-011	1.392-011
PA231	1.227-010	1.425-010	1.624-010	1.822-010
PA233	7.817-012	7.857-012	7.902-012	7.951-012
U232	4.346-010	4.402-010	4.403-010	4.372-010
U233	9.641-010	1.119-009	1.274-009	1.431-009
U234	4.948-006	5.729-006	6.498-006	7.256-006
U235	1.023-002	1.023-002	1.023-002	1.023-002
U236	2.618-003	2.618-003	2.619-003	2.619-003
U237	1.633-011	1.483-011	1.347-011	1.224-011
U238	9.588-001	9.588-001	9.588-001	9.588-001
NP235	2.994-015	8.338-016	2.322-016	6.466-017
NP236	1.840-010	1.840-010	1.840-010	1.840-010
NP237	2.301-004	2.313-004	2.326-004	2.341-004
NP238	9.199-014	9.115-014	9.032-014	8.950-014
NP239	2.136-011	2.135-011	2.135-011	2.134-011
PU236	3.710-011	2.281-011	1.403-011	8.626-012
PU238	5.068-005	4.989-005	4.911-005	4.835-005
PU239	4.718-003	4.718-003	4.717-003	4.717-003
PU240	1.604-003	1.603-003	1.603-003	1.603-003
PU241	5.275-004	4.791-004	4.351-004	3.952-004
PU242	1.987-004	1.987-004	1.987-004	1.987-004
PU244	3.841-009	3.841-009	3.841-009	3.841-009
AM241	3.489-004	3.961-004	4.387-004	4.772-004
AM242M	4.906-007	4.862-007	4.817-007	4.774-007
AM242	5.869-012	5.815-012	5.763-012	5.710-012
AM243	2.485-005	2.485-005	2.484-005	2.484-005
CM242	1.188-009	1.178-009	1.167-009	1.157-009
CM243	8.530-008	8.125-008	7.739-008	7.372-008
CM244	2.876-006	2.664-006	2.468-006	2.286-006
CM245	1.102-007	1.102-007	1.102-007	1.102-007
CM246	7.895-009	7.893-009	7.891-009	7.888-009
CM247	4.492-011	4.492-011	4.492-011	4.492-011
CM248	1.358-012	1.358-012	1.358-012	1.358-012
CF249	1.003-014	9.991-015	9.952-015	9.913-015
SF250	2.932-012	3.249-012	3.544-012	3.819-012
SUMTOT	9.794-001	9.794-001	9.794-001	9.794-001
TOTAL	9.794-001	9.794-001	9.794-001	9.794-001

TABLE E.3.b. Actinides (Elemental), g/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE	4.121-007	4.592-007	5.083-007	5.590-007
SF	2.932-012	3.249-012	3.544-012	3.819-012
PB	2.000-011	2.700-011	3.432-011	4.179-011
RA	5.562-014	6.076-014	6.483-014	6.850-014
AC	1.398-014	1.846-014	2.347-014	2.897-014
TH	9.830-010	1.166-009	1.353-009	1.544-009
PA	1.305-010	1.504-010	1.703-010	1.902-010
U	9.717-001	9.717-001	9.717-001	9.717-001
NP	2.301-004	2.313-004	2.326-004	2.341-004
PU	7.098-003	7.049-003	7.004-003	6.963-003
AM	3.742-004	4.214-004	4.640-004	5.025-004
CM	3.081-006	2.865-006	2.665-006	2.479-006
CF	1.144-014	1.131-014	1.118-014	1.107-014
SUMTOT	9.794-001	9.794-001	9.794-001	9.794-001
TOTAL	9.794-001	9.794-001	9.794-001	9.794-001

TABLE E.3.c. Actinides (Isotopic), Ci/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL207	1.C09-012	1.334-012	1.696-012	2.094-012
TL208	3.C10-009	3.2C4-009	3.304-009	3.346-009
TL209	3.631-016	4.043-016	4.516-016	5.052-016
PB209	1.681-014	1.872-014	2.091-014	2.339-014
PB210	4.484-016	6.513-016	9.624-016	1.411-015
PB211	1.C12-012	1.338-012	1.701-012	2.100-012
PB212	8.378-009	8.918-009	9.196-009	9.311-009
PB214	2.994-015	4.719-015	7.002-015	9.915-015
BI210	4.486-016	6.516-016	9.628-016	1.411-015
BI211	1.C12-012	1.338-012	1.701-012	2.100-012
BI212	8.378-009	8.918-009	9.196-009	9.311-009
BI213	1.681-014	1.872-014	2.091-014	2.339-014
BI214	2.994-015	4.719-015	7.002-015	9.915-015
PO210	4.486-016	5.86C-016	8.626-016	1.268-015
PO211	2.833-015	3.747-015	4.764-015	5.880-015
PO212	5.367-009	5.714-009	5.892-009	5.966-009
PO213	1.644-014	1.831-014	2.046-014	2.288-014
PO214	2.993-015	4.718-015	7.000-015	9.913-015
PO215	1.C12-012	1.338-012	1.701-012	2.100-012
PO216	8.378-009	8.918-009	9.196-009	9.311-009
PO218	2.994-015	4.72C-015	7.003-015	9.917-015
AT217	1.681-014	1.872-014	2.091-014	2.339-014
RN219	1.C12-012	1.338-012	1.701-012	2.100-012
RN220	8.378-009	8.918-009	9.196-009	9.311-009
RN222	2.994-015	4.72C-015	7.003-015	9.917-015
FR221	1.681-014	1.872-014	2.091-014	2.339-014
FR223	1.396-014	1.844-014	2.344-014	2.893-014
RA223	1.C12-012	1.338-012	1.701-012	2.100-012
RA224	8.378-009	8.918-009	9.196-009	9.311-009
RA225	1.681-014	1.872-014	2.091-014	2.339-014
RA226	2.994-015	4.72C-015	7.003-015	9.917-015
AC225	1.681-014	1.872-014	2.091-014	2.339-014
AC227	1.C11-012	1.336-012	1.698-012	2.096-012
TH227	9.577-013	1.32C-012	1.678-012	2.071-012
TH228	8.377-009	8.896-009	9.174-009	9.288-009
TH229	1.681-014	1.872-014	2.091-014	2.339-014
TH230	1.703-012	2.303-012	2.991-012	3.765-012
TH231	2.213-008	2.213-008	2.213-008	2.213-008
TH232	9.595-017	1.127-016	1.294-016	1.461-016
TH234	3.225-007	3.225-007	3.225-007	3.225-007
PA231	5.798-012	6.735-012	7.673-012	8.611-012
PA233	1.623-007	1.631-007	1.641-007	1.651-007
PA234M	3.225-007	3.225-007	3.225-007	3.225-007
PA234	4.192-010	4.192-010	4.192-010	4.192-010
U232	9.305-009	9.425-009	9.428-009	9.361-009
U233	9.336-012	1.084-011	1.234-011	1.386-011
U234	3.C93-008	3.581-008	4.062-008	4.535-008
U235	2.213-008	2.213-008	2.213-008	2.213-008
U236	1.695-007	1.695-007	1.695-007	1.695-007
U237	1.334-006	1.211-006	1.100-006	9.992-007
U238	3.225-007	3.225-007	3.225-007	3.225-007
U240	6.807-014	6.807-014	6.807-014	6.807-014

TABLE E.3.c. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
NP235	4.203-012	1.17C-012	3.259-013	9.075-014
NP236	2.425-012	2.425-012	2.425-012	2.425-012
NP237	1.623-007	1.631-007	1.641-007	1.651-007
NP238	2.385-008	2.363-008	2.342-008	2.321-008
NP239	4.956-006	4.955-006	4.954-006	4.953-006
NP240M	6.807-014	6.807-014	6.807-014	6.807-014
PU236	1.972-008	1.213-008	7.456-009	4.585-009
PU238	8.680-004	8.544-004	8.411-004	8.280-004
PU239	2.934-004	2.934-004	2.934-004	2.933-004
PU240	3.656-004	3.655-004	3.655-004	3.655-004
PU241	5.437-002	4.938-002	4.485-002	4.073-002
PU242	7.590-007	7.590-007	7.590-007	7.590-007
PU243	4.169-015	4.169-015	4.169-015	4.169-015
PU244	6.816-014	6.816-014	6.816-014	6.816-014
AM241	1.198-003	1.36C-003	1.506-003	1.638-003
AM242M	4.770-006	4.727-006	4.684-006	4.641-006
AM242	4.746-006	4.703-006	4.660-006	4.618-006
AM243	4.956-006	4.955-006	4.954-006	4.953-006
CM242	3.929-006	3.896-006	3.861-006	3.826-006
CM243	4.405-006	4.196-006	3.997-006	3.807-006
CM244	2.328-004	2.157-004	1.998-004	1.850-004
CM245	1.894-008	1.893-008	1.893-008	1.893-008
CM246	2.426-009	2.425-009	2.425-009	2.424-009
CM247	4.169-015	4.169-015	4.169-015	4.169-015
CM248	5.777-015	5.777-015	5.777-015	5.777-015
BK249	5.374-015	1.105-015	2.270-016	4.668-017
CF249	4.110-014	4.095-014	4.079-014	4.063-014
CF250	1.005-013	9.042-014	8.133-014	7.315-014
CF251	7.691-016	7.679-016	7.667-016	7.655-016
CF252	6.538-015	3.866-015	2.286-015	1.351-015
SUMTOT	5.736-002	5.25C-002	4.808-002	4.407-002
TOTAL	5.736-002	5.25C-002	4.808-002	4.407-002

TABLE E.3.d. Actinides (Elemental), Ci/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL	3.C11-009	3.2C6-009	3.306-009	3.348-009
PB	8.379-009	8.919-009	9.198-C09	9.313-009
BI	8.379-009	8.919-0C9	9.198-009	9.313-009
PO	1.375-008	1.463-008	1.509-008	1.528-008
AT	1.681-014	1.872-014	2.091-014	2.339-014
RN	8.379-009	8.919-009	9.198-009	9.313-009
FR	3.C77-014	3.715-014	4.435-014	5.231-014
RA	8.379-009	8.919-009	9.198-009	9.313-009
AC	1.C28-012	1.355-012	1.719-012	2.120-012
TH	3.530-007	3.535-007	3.538-007	3.539-007
PA	4.852-007	4.86C-007	4.870-007	4.880-007
U	1.888-006	1.771-006	1.664-006	1.568-006
NP	5.142-006	5.142-006	5.142-006	5.141-006
PU	5.590-002	5.089-002	4.635-002	4.222-002
AM	1.212-003	1.374-003	1.521-003	1.653-003
CM	2.412-004	2.238-004	2.076-004	1.927-004
BK	5.374-015	1.1C5-015	2.270-016	4.668-017
CF	1.489-013	1.360-013	1.252-013	1.159-013
SUMTOT	5.736-002	5.250-002	4.808-002	4.407-002
TOTAL	5.736-002	5.250-002	4.808-002	4.407-002

TABLE E.3.e. Fission Products (Isotopic), g/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	1.960-008	1.752-008	1.566-008	1.400-008
LI 6	1.425-010	1.425-010	1.425-010	1.425-010
LI 7	6.139-012	6.139-012	6.139-012	6.139-012
BE 9	1.182-011	1.182-011	1.182-011	1.182-011
BE 10	7.888-011	7.888-011	7.888-011	7.888-011
C 14	1.593-011	1.593-011	1.592-011	1.592-011
ZN 66	2.282-014	2.282-014	2.282-014	2.282-014
ZN 67	9.492-016	9.492-016	9.492-016	9.492-016
GA 71	5.345-013	5.345-013	5.345-013	5.345-013
GE 72	1.357-008	1.357-008	1.357-008	1.357-008
GE 73	2.845-008	2.845-008	2.845-008	2.845-008
GE 74	6.013-008	6.013-008	6.013-008	6.013-008
AS 75	1.262-007	1.262-007	1.262-007	1.262-007
GE 76	3.098-007	3.098-007	3.098-007	3.098-007
SE 76	2.252-009	2.252-009	2.252-009	2.252-009
SE 77	6.456-007	6.456-007	6.456-007	6.456-007
SE 78	1.472-006	1.472-006	1.472-006	1.472-006
SE 79	3.623-006	3.623-006	3.623-006	3.623-006
BR 79	4.419-010	5.192-010	5.965-010	6.738-010
SE 80	8.217-006	8.217-006	8.217-006	8.217-006
KR 80	1.329-010	1.329-010	1.329-010	1.329-010
BR 81	1.357-005	1.357-005	1.357-005	1.357-005
KR 81	1.068-011	1.068-011	1.068-011	1.068-011
SE 82	2.081-005	2.081-005	2.081-005	2.081-005
KR 82	4.215-007	4.215-007	4.215-007	4.215-007
KR 83	2.798-005	2.798-005	2.798-005	2.798-005
KR 84	6.758-005	6.758-005	6.758-005	6.758-005
KR 85	7.774-006	6.831-006	6.003-006	5.274-006
RB 85	6.758-005	6.852-005	6.935-005	7.008-005
KR 86	1.179-004	1.179-004	1.179-004	1.179-004
SR 86	1.635-007	1.635-007	1.635-007	1.635-007
RB 87	1.515-004	1.515-004	1.515-004	1.515-004
SR 87	1.285-009	1.285-009	1.285-009	1.285-009
SR 88	2.174-004	2.174-004	2.174-004	2.174-004
Y 89	2.840-004	2.840-004	2.840-004	2.840-004
SR 90	2.623-004	2.501-004	2.385-004	2.274-004
Y 90	6.577-008	6.271-008	5.980-008	5.702-008
ZR 90	8.225-005	9.445-005	1.061-004	1.172-004
ZR 91	3.664-004	3.664-004	3.664-004	3.664-004
ZR 92	3.951-004	3.951-004	3.951-004	3.951-004
ZR 93	4.447-004	4.447-004	4.447-004	4.447-004
NB 93	6.477-010	8.468-010	1.066-009	1.302-009
NB 93M	1.652-009	1.856-009	2.040-009	2.206-009
ZR 94	4.525-004	4.525-004	4.525-004	4.525-004
NB 94	4.432-010	4.431-010	4.431-010	4.431-010
MO 95	4.713-004	4.713-004	4.713-004	4.713-004
ZR 96	4.886-004	4.886-004	4.886-004	4.886-004
MO 96	1.310-005	1.310-005	1.310-005	1.310-005
MO 97	4.827-004	4.827-004	4.827-004	4.827-004
MO 98	5.003-004	5.003-004	5.003-004	5.003-004
TC 98	2.490-009	2.490-009	2.490-009	2.490-009
TC 99	4.863-004	4.863-004	4.863-004	4.862-004

TABLE E.3.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
RU 99	1.787-008	2.103-008	2.420-008	2.736-008
MO100	5.635-004	5.635-004	5.635-004	5.635-004
RU100	3.772-005	3.772-005	3.772-005	3.772-005
RU101	4.722-004	4.722-004	4.722-004	4.722-004
RU102	4.567-004	4.567-004	4.567-004	4.567-004
RH102	3.501-011	2.419-011	1.500-011	9.297-012
RH103	3.157-004	3.157-004	3.157-004	3.157-004
RU104	3.170-004	3.170-004	3.170-004	3.170-004
PD104	9.179-005	9.179-005	9.179-005	9.179-005
PD105	2.271-004	2.271-004	2.271-004	2.271-004
RU106	9.647-008	2.438-008	6.163-009	1.558-009
RH106	9.067-014	2.292-014	5.793-015	1.464-015
PD106	1.941-004	1.942-004	1.942-004	1.942-004
PD107	1.224-004	1.224-004	1.224-004	1.224-004
AG107	1.438-010	1.699-010	1.960-010	2.222-010
PD108	8.371-005	8.371-005	8.371-005	8.371-005
AG108M	5.890-013	5.826-013	5.763-013	5.700-013
CD108	1.504-010	1.504-010	1.504-010	1.504-010
AG109	4.602-005	4.602-005	4.602-005	4.602-005
CD109	5.214-016	1.751-016	5.879-017	1.974-017
PD110	2.751-005	2.751-005	2.751-005	2.751-005
AG110M	1.365-011	1.799-012	2.371-013	3.126-014
CD110	1.283-005	1.283-005	1.283-005	1.283-005
CD111	1.562-005	1.562-005	1.562-005	1.562-005
CD112	9.548-006	9.548-006	9.548-006	9.548-006
CD113	1.399-007	1.399-007	1.399-007	1.399-007
CD113M	8.977-008	8.163-008	7.423-008	6.750-008
IN113	6.190-008	7.003-008	7.743-008	8.415-008
CD114	1.343-005	1.343-005	1.343-005	1.343-005
SN114	4.541-010	4.541-010	4.541-010	4.541-010
IN115	2.117-006	2.117-006	2.117-006	2.117-006
SN115	2.000-007	2.000-007	2.000-007	2.000-007
CD116	5.111-006	5.111-006	5.111-006	5.111-006
SN116	3.846-006	3.846-006	3.846-006	3.846-006
SN117	5.182-006	5.182-006	5.182-006	5.182-006
SN118	5.224-006	5.224-006	5.224-006	5.224-006
SN119	5.201-006	5.201-006	5.201-006	5.201-006
SN119M	1.004-012	1.271-013	1.610-014	2.038-015
SN120	5.307-006	5.307-006	5.307-006	5.307-006
SN121M	1.791-009	1.742-009	1.695-009	1.648-009
SB121	5.299-006	5.299-006	5.299-006	5.299-006
SN122	5.852-006	5.852-006	5.852-006	5.852-006
TE122	2.281-007	2.281-007	2.281-007	2.281-007
SN123	8.421-016	1.671-017	3.315-019	6.585-021
SB123	6.473-006	6.473-006	6.473-006	6.473-006
TE123	2.487-009	2.487-009	2.487-009	2.487-009
SN124	7.909-006	7.909-006	7.909-006	7.909-006
TE124	1.693-007	1.693-007	1.693-007	1.693-007
SB125	7.196-007	4.362-007	2.645-007	1.603-007
TE125	1.095-005	1.124-005	1.141-005	1.152-005
TE125M	1.007-008	6.103-009	3.700-009	2.243-009
SN126	1.679-005	1.679-005	1.679-005	1.679-005

TABLE E.3.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
SB126	7.978-013	7.978-013	7.978-013	7.978-013
SB126M	6.066-015	6.066-015	6.066-015	6.066-015
TE126	4.203-007	4.205-007	4.207-007	4.210-007
TE127M	7.677-017	7.376-019	7.082-021	7.149-023
I127	3.412-005	3.412-005	3.412-005	3.412-005
TE128	6.682-005	6.682-005	6.682-005	6.682-005
XE128	1.157-006	1.157-006	1.157-006	1.157-006
I129	1.102-004	1.102-004	1.102-004	1.102-004
XE129	4.258-009	4.267-009	4.277-009	4.287-009
TE130	2.137-004	2.137-004	2.137-004	2.137-004
XE130	4.797-006	4.797-006	4.797-006	4.797-006
XE131	2.938-004	2.938-004	2.938-004	2.938-004
XE132	6.170-004	6.170-004	6.170-004	6.170-004
BA132	7.465-010	7.465-010	7.465-010	7.465-010
CS133	7.198-004	7.198-004	7.198-004	7.198-004
XE134	8.890-004	8.890-004	8.890-004	8.890-004
CS134	1.726-006	8.813-007	4.499-007	2.297-007
BA134	6.365-005	6.450-005	6.493-005	6.515-005
CS135	2.459-004	2.459-004	2.459-004	2.459-004
BA135	6.352-008	6.367-008	6.382-008	6.396-008
XE136	1.342-003	1.342-003	1.342-003	1.342-003
BA136	9.532-006	9.532-006	9.532-006	9.532-006
CS137	5.744-004	5.484-004	5.237-004	5.000-004
BA137	1.712-004	1.971-004	2.219-004	2.455-004
BA137M	8.787-011	8.391-011	8.012-011	7.650-011
BA138	7.748-004	7.748-004	7.748-004	7.748-004
LA138	3.954-009	3.954-009	3.954-009	3.954-009
LA139	7.427-004	7.427-004	7.427-004	7.427-004
CE140	7.440-004	7.440-004	7.440-004	7.440-004
PR141	6.852-004	6.852-004	6.852-004	6.852-004
CE142	6.855-004	6.855-004	6.855-004	6.855-004
ND142	1.002-005	1.002-005	1.002-005	1.002-005
ND143	5.372-004	5.372-004	5.372-004	5.372-004
CE144	3.123-008	5.260-009	8.858-010	1.492-010
PR144	1.319-012	2.221-013	3.740-014	6.300-015
PR144M	6.592-015	1.110-015	1.870-016	3.149-017
ND144	7.452-004	7.452-004	7.453-004	7.453-004
ND145	4.275-004	4.275-004	4.275-004	4.275-004
ND146	3.992-004	3.992-004	3.992-004	3.992-004
PM146	9.731-010	7.563-010	5.878-010	4.568-010
SM146	3.186-009	3.266-009	3.328-009	3.377-009
PM147	8.305-006	4.896-006	2.886-006	1.702-006
SM147	1.539-004	1.573-004	1.593-004	1.605-004
ND148	2.240-004	2.240-004	2.240-004	2.240-004
SM148	8.698-005	8.698-005	8.698-005	8.698-005
SM149	2.047-006	2.047-006	2.047-006	2.047-006
ND150	1.061-004	1.061-004	1.061-004	1.061-004
SM150	1.501-004	1.501-004	1.501-004	1.501-004
EU150	1.231-013	1.185-013	1.140-013	1.097-013
SM151	9.149-006	9.009-006	8.871-006	8.735-006
EU151	7.434-007	8.832-007	1.021-006	1.157-006
SM152	8.621-005	8.621-005	8.622-005	8.622-005

TABLE E.3.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	2.159-008	1.950-008	1.761-008	1.590-008
GD152	1.626-008	1.684-008	1.737-008	1.784-008
EU153	5.946-005	5.946-005	5.946-005	5.946-005
GD153	2.434-013	3.004-014	3.707-015	4.575-016
SM154	2.139-005	2.139-005	2.139-005	2.139-005
EU154	7.483-006	6.369-006	5.421-006	4.614-006
GD154	1.035-005	1.147-005	1.242-005	1.322-005
EU155	1.620-006	1.225-006	9.262-007	7.003-007
GD155	4.988-006	5.383-006	5.681-006	5.907-006
GD156	2.466-005	2.466-005	2.466-005	2.466-005
GD157	5.933-008	5.933-008	5.933-008	5.933-008
GD158	8.934-006	8.934-006	8.934-006	8.934-006
TB159	1.428-006	1.428-006	1.428-006	1.428-006
GD160	6.988-007	6.988-007	6.988-007	6.988-007
DY160	1.111-007	1.111-007	1.111-007	1.111-007
DY161	2.488-007	2.488-007	2.488-007	2.488-007
DY162	2.068-007	2.068-007	2.068-007	2.068-007
DY163	1.385-007	1.385-007	1.385-007	1.385-007
DY164	2.255-008	2.255-008	2.255-008	2.255-008
HO165	6.181-008	6.181-008	6.181-008	6.181-008
HO166M	4.331-010	4.326-010	4.321-010	4.316-010
ER166	1.870-008	1.870-008	1.870-008	1.870-008
ER167	1.992-009	1.992-009	1.992-009	1.992-009
ER168	3.722-009	3.722-009	3.722-009	3.722-009
TM169	1.861-011	1.861-011	1.861-011	1.861-011
ER170	5.626-015	5.626-015	5.626-015	5.626-015
YB170	3.803-012	3.803-012	3.803-012	3.803-012
TM171	2.947-015	1.431-015	6.953-016	3.378-016
YB171	1.735-013	1.750-013	1.758-013	1.761-013
YB172	3.256-015	3.256-015	3.256-015	3.256-015
SUMTOT	2.061-002	2.061-002	2.061-002	2.061-002
TOTAL	2.061-002	2.061-002	2.061-002	2.061-002

TABLE E.3.f. Fission Products (Elemental), g/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	1.960-008	1.752-008	1.566-008	1.400-008
LI	1.486-010	1.486-010	1.486-010	1.486-010
BE	9.070-011	9.070-011	9.070-011	9.070-011
C	1.593-011	1.593-011	1.592-011	1.592-011
ZN	2.378-014	2.378-014	2.378-014	2.378-014
GA	5.345-013	5.345-013	5.345-013	5.345-013
GE	4.120-007	4.120-007	4.120-007	4.120-007
AS	1.262-007	1.262-007	1.262-007	1.262-007
SE	3.477-005	3.477-005	3.477-005	3.477-005
BR	1.358-005	1.358-005	1.358-005	1.358-005
KR	2.216-004	2.207-004	2.199-004	2.191-004
RB	2.190-004	2.200-004	2.208-004	2.215-004
SR	4.798-004	4.676-004	4.560-004	4.449-004
Y	2.841-004	2.841-004	2.841-004	2.841-004
ZR	2.230-003	2.242-003	2.253-003	2.264-003
NB	2.743-009	3.146-009	3.549-009	3.951-009
MO	2.031-003	2.031-003	2.031-003	2.031-003
TC	4.863-004	4.863-004	4.863-004	4.863-004
RU	1.284-003	1.284-003	1.284-003	1.284-003
RH	3.157-004	3.157-004	3.157-004	3.157-004
PD	7.466-004	7.467-004	7.467-004	7.467-004
AG	4.602-005	4.602-005	4.602-005	4.602-005
CD	5.678-005	5.677-005	5.676-005	5.675-005
IN	2.179-006	2.187-006	2.195-006	2.202-006
SN	5.552-005	5.552-005	5.552-005	5.552-005
SB	1.249-005	1.221-005	1.204-005	1.193-005
TE	2.923-004	2.926-004	2.927-004	2.928-004
I	1.443-004	1.443-004	1.443-004	1.443-004
XE	3.148-003	3.148-003	3.148-003	3.148-003
CS	1.542-003	1.515-003	1.490-003	1.466-003
BA	1.019-003	1.046-003	1.071-003	1.095-003
LA	7.427-004	7.427-004	7.427-004	7.427-004
CE	1.429-003	1.429-003	1.429-003	1.429-003
PR	6.852-004	6.852-004	6.852-004	6.852-004
ND	2.449-003	2.449-003	2.449-003	2.449-003
PM	8.306-006	4.897-006	2.887-006	1.702-006
SM	5.098-004	5.130-004	5.149-004	5.160-004
EU	6.933-005	6.796-005	6.684-005	6.595-005
GD	4.971-005	5.122-005	5.247-005	5.350-005
TB	1.428-006	1.428-006	1.428-006	1.428-006
DY	7.277-007	7.277-007	7.277-007	7.277-007
HO	6.224-008	6.224-008	6.224-008	6.224-008
ER	2.442-008	2.442-008	2.442-008	2.442-008
TM	1.862-011	1.861-011	1.861-011	1.861-011
YB	3.980-012	3.982-012	3.982-012	3.983-012
SUMTOT	2.061-002	2.061-002	2.061-002	2.061-002
TOTAL	2.061-002	2.061-002	2.061-002	2.061-002

TABLE E.3.g. Fission Products (Isotopic), Ci/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	1.893-004	1.692-004	1.512-004	1.351-004
BE 10	1.763-012	1.763-012	1.763-012	1.763-012
C 14	7.103-011	7.101-011	7.100-011	7.098-011
SE 79	2.525-007	2.525-007	2.525-007	2.525-007
KR 81	2.246-013	2.246-013	2.246-013	2.246-013
KR 85	3.051-003	2.681-003	2.356-003	2.070-003
RB 87	1.326-011	1.326-011	1.326-011	1.326-011
SR 90	3.579-002	3.413-002	3.254-002	3.103-002
Y 90	3.580-002	3.413-002	3.255-002	3.103-002
ZR 93	1.118-006	1.118-006	1.118-006	1.118-006
NB 93M	4.671-007	5.247-007	5.768-007	6.238-007
NB 94	8.306-011	8.306-011	8.305-011	8.305-011
TC 98	2.164-012	2.164-012	2.164-012	2.164-012
TC 99	8.247-006	8.247-006	8.247-006	8.247-006
RH102	4.717-008	2.924-008	1.813-008	1.124-008
RU106	3.229-004	8.162-005	2.063-005	5.214-006
RH106	3.229-004	8.162-005	2.063-005	5.215-006
PD107	6.299-008	6.299-008	6.299-008	6.299-008
AG108	1.367-012	1.352-012	1.337-012	1.323-012
AG108M	1.536-011	1.519-011	1.503-011	1.486-011
AG109M	1.347-012	4.522-013	1.518-013	5.099-014
CD109	1.347-012	4.522-013	1.518-013	5.099-014
AG110	8.625-010	1.137-010	1.499-011	1.976-012
AG110M	6.485-008	8.548-009	1.127-009	1.485-010
CD113M	1.947-005	1.771-005	1.610-005	1.464-005
SN119M	4.497-009	5.695-010	7.211-011	9.131-012
SN121M	1.060-007	1.031-007	1.002-007	9.749-008
SN123	6.924-012	1.374-013	2.725-015	5.415-017
TE123M	2.440-015	3.541-017	5.681-019	.000
SB125	7.433-004	4.506-004	2.732-004	1.656-004
TE125M	1.814-004	1.100-004	6.667-005	4.042-005
SN126	4.766-007	4.766-007	4.766-007	4.766-007
SB126	6.673-008	6.673-008	6.673-008	6.672-008
SB126M	4.766-007	4.766-007	4.766-007	4.766-007
TE127	7.096-013	6.818-015	6.550-017	6.606-019
TE127M	7.244-013	6.960-015	6.682-017	6.746-019
I129	1.945-008	1.945-008	1.945-008	1.945-008
CS134	2.235-003	1.141-003	5.824-004	2.973-004
CS135	2.832-007	2.832-007	2.832-007	2.832-007
CS137	4.998-002	4.773-002	4.557-002	4.351-002
BA137M	4.728-002	4.515-002	4.311-002	4.116-002
CE142	1.646-011	1.646-011	1.646-011	1.646-011
CE144	9.966-005	1.678-005	2.827-006	4.761-007
PR144	9.966-005	1.679-005	2.827-006	4.761-007
PR144M	1.196-006	2.014-007	3.392-008	5.714-009
ND144	8.819-016	8.820-016	8.820-016	8.820-016
PM146	4.334-007	3.368-007	2.618-007	2.035-007
SM146	1.115-013	1.143-013	1.165-013	1.182-013
PM147	7.702-003	4.540-003	2.677-003	1.578-003
SM147	3.499-012	3.577-012	3.623-012	3.650-012
EU150	8.153-012	7.845-012	7.549-012	7.264-012
SM151	2.408-004	2.371-004	2.335-004	2.299-004

TABLE E.3.g. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	3.735-006	3.373-006	3.046-006	2.751-006
GD153	8.587-010	1.060-010	1.308-011	1.614-012
EU154	2.021-003	1.720-003	1.464-003	1.246-003
EU155	7.538-004	5.699-004	4.309-004	3.259-004
HO166M	7.776-010	7.767-010	7.758-010	7.749-010
TM171	3.210-012	1.559-012	7.574-013	3.679-013
SUMTOT	1.869-001	1.730-001	1.621-001	1.529-001
TOTAL	1.869-001	1.730-001	1.621-001	1.529-001

TABLE E.3.h. Fission Products (Elemental), Ci/gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	1.693-004	1.692-004	1.512-004	1.351-004
BE	1.763-012	1.763-012	1.763-012	1.763-012
C	7.103-011	7.101-011	7.100-011	7.098-011
SE	2.525-007	2.525-007	2.525-007	2.525-007
KR	3.051-003	2.681-003	2.356-003	2.070-003
RB	1.326-011	1.326-011	1.326-011	1.326-011
SR	3.579-002	3.413-002	3.254-002	3.103-002
Y	3.580-002	3.413-002	3.255-002	3.103-002
ZR	1.118-006	1.118-006	1.118-006	1.118-006
NB	4.671-007	5.248-007	5.769-007	6.239-007
TC	8.247-006	8.247-006	8.247-006	8.247-006
RU	3.229-004	8.162-005	2.063-005	5.214-006
RH	3.229-004	8.165-005	2.065-005	5.226-006
PD	6.299-008	6.299-008	6.299-008	6.299-008
AG	6.573-008	8.679-009	1.158-009	1.667-010
CD	1.947-005	1.771-005	1.610-005	1.464-005
SN	5.871-007	5.802-007	5.769-007	5.741-007
SB	7.439-004	4.512-004	2.737-004	1.662-004
TE	1.814-004	1.100-004	6.667-005	4.042-005
I	1.945-008	1.945-008	1.945-008	1.945-008
CS	5.222-002	4.887-002	4.615-002	4.381-002
BA	4.728-002	4.515-002	4.311-002	4.116-002
CE	9.566-005	1.678-005	2.827-006	4.761-007
PR	1.009-004	1.699-005	2.861-006	4.819-007
ND	8.819-016	8.820-016	8.820-016	8.820-016
PM	7.702-003	4.541-003	2.677-003	1.578-003
SM	2.408-004	2.371-004	2.335-004	2.299-004
EU	2.778-003	2.293-003	1.898-003	1.574-003
GD	8.587-010	1.060-010	1.308-011	1.614-012
HO	7.776-010	7.767-010	7.758-010	7.749-010
TM	3.210-012	1.559-012	7.574-013	3.679-013
SUMTOT	1.869-001	1.730-001	1.621-001	1.529-001
TOTAL	1.869-001	1.730-001	1.621-001	1.529-001

TABLE E.3.i. Neutron Source (Alpha-n), Neutrons/sec-gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	8.258-001	8.129-001	8.002-001	7.878-001
PU239	2.137-001	2.137-001	2.137-001	2.137-001
PU240	2.770-001	2.770-001	2.769-001	2.769-001
AM241	1.149+000	1.304+000	1.445+000	1.571+000
AM243	4.228-003	4.227-003	4.226-003	4.226-003
CM242	5.274-003	5.230-003	5.183-003	5.136-003
CM243	5.865-003	5.586-003	5.321-003	5.068-003
CM244	2.657-001	2.461-001	2.280-001	2.112-001

TABLE E.3.j. Neutron Source (Spontaneous fission), Neutrons/sec-gU, at 20 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	1.347-001	1.326-001	1.305-001	1.285-001
PU240	1.460+000	1.460+000	1.460+000	1.460+000
PU242	3.349-001	3.349-001	3.349-001	3.349-001
CM244	3.199+001	2.963+001	2.745+001	2.542+001
CM246	7.026-002	7.024-002	7.022-002	7.020-002

TABLE E.4. Radionuclide Inventories at 25 MWd/kgM as a Function of Decay Time

TABLE E.4.a. Actinides (Isotopic), g/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE 4	6.595-007	7.291-007	8.005-007	8.738-007
PB207	1.344-015	2.067-015	3.002-015	4.175-015
PB208	3.240-011	4.385-011	5.583-011	6.807-011
PB212	9.853-015	1.050-014	1.084-014	1.098-014
RA224	8.595-014	9.161-014	9.454-014	9.577-014
RA226	4.439-015	7.106-015	1.067-014	1.525-014
AC227	1.082-014	1.429-014	1.817-014	2.244-014
TH228	1.670-011	1.776-011	1.833-011	1.856-011
TH229	1.257-013	1.371-013	1.503-013	1.654-013
TH230	1.281-010	1.752-010	2.295-010	2.907-010
TH231	3.230-014	3.230-014	3.230-014	3.230-014
TH232	9.868-010	1.158-009	1.329-009	1.501-009
TH234	1.386-011	1.386-011	1.386-011	1.386-011
PA231	9.505-011	1.105-010	1.259-010	1.413-010
PA233	1.048-011	1.053-011	1.059-011	1.065-011
U232	7.119-010	7.214-010	7.219-010	7.169-010
U233	1.225-009	1.433-009	1.642-009	1.851-009
U234	7.813-006	9.102-006	1.037-005	1.162-005
U235	7.944-003	7.944-003	7.944-003	7.945-003
U236	2.943-003	2.943-003	2.944-003	2.944-003
U237	2.095-011	1.902-011	1.728-011	1.569-011
U238	9.545-001	9.545-001	9.545-001	9.545-001
NP235	4.650-015	1.295-015	3.606-016	1.004-016
NP236	2.703-010	2.703-010	2.703-010	2.703-010
NP237	3.087-004	3.102-004	3.118-004	3.137-004
NP238	1.173-013	1.162-013	1.152-013	1.141-013
NP239	4.615-011	4.614-011	4.613-011	4.612-011
PU236	6.179-011	3.800-011	2.337-011	1.437-011
PU238	8.361-005	8.230-005	8.102-005	7.975-005
PU239	4.918-003	4.918-003	4.917-003	4.917-003
PU240	1.961-003	1.961-003	1.961-003	1.962-003
PU241	6.765-004	6.144-004	5.580-004	5.068-004
PU242	3.362-004	3.362-004	3.362-004	3.362-004
PU244	1.125-008	1.125-008	1.125-008	1.125-008
AM241	4.451-004	5.057-004	5.604-004	6.097-004
AM242M	6.256-007	6.200-007	6.143-007	6.087-007
AM242	7.484-012	7.416-012	7.349-012	7.282-012
AM243	5.370-005	5.369-005	5.368-005	5.367-005
CM242	1.515-009	1.502-009	1.489-009	1.475-009
CM243	1.749-007	1.666-007	1.587-007	1.511-007
CM244	8.306-006	7.694-006	7.127-006	6.602-006
CM245	3.836-007	3.835-007	3.834-007	3.834-007
CM246	3.686-008	3.685-008	3.684-008	3.683-008
CM247	2.728-010	2.728-010	2.728-010	2.728-010
CM248	1.087-011	1.087-011	1.087-011	1.087-011
CF249	9.685-014	9.649-014	9.611-014	9.574-014
CF250	1.006-014	9.052-015	8.141-015	7.323-015
CF251	5.969-015	5.960-015	5.951-015	5.942-015
SF250	7.227-012	8.105-012	8.922-012	9.680-012
SUMTOT	9.742-001	9.742-001	9.742-001	9.742-001
TOTAL	9.742-001	9.742-001	9.742-001	9.742-001

TABLE E.4.b. Actinides (Elemental), g/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE	6.595-007	7.291-007	8.005-007	8.738-007
SF	7.227-012	8.105-012	8.922-012	9.680-012
PB	3.241-011	4.387-011	5.585-011	6.809-011
BI	1.048-015	1.133-015	1.189-015	1.230-015
RA	9.041-014	9.874-014	1.052-013	1.111-013
AC	1.082-014	1.429-014	1.818-014	2.244-014
TH	1.146-009	1.365-009	1.591-009	1.824-009
PA	1.055-010	1.210-010	1.365-010	1.519-010
U	9.654-001	9.654-001	9.654-001	9.654-001
NP	3.087-004	3.102-004	3.118-004	3.137-004
PU	7.975-003	7.912-003	7.854-003	7.801-003
AM	4.595-004	5.600-004	6.147-004	6.640-004
CM	8.903-006	8.283-006	7.708-006	7.175-006
CF	1.131-013	1.116-013	1.103-013	1.090-013
SUMTOT	9.742-001	9.742-001	9.742-001	9.742-001
TOTAL	9.742-001	9.742-001	9.742-001	9.742-001

TABLE E.4.c. Actinides (Isotopic), Ci/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL207	7.807-013	1.033-012	1.314-012	1.622-012
TL208	4.921-009	5.245-009	5.413-009	5.483-009
TL209	5.777-016	6.303-016	6.911-016	7.602-016
PB209	2.674-014	2.918-014	3.200-014	3.519-014
PB210	7.300-016	1.026-015	1.489-015	2.167-015
PB211	7.829-013	1.036-012	1.317-012	1.627-012
PB212	1.370-008	1.460-008	1.507-008	1.526-008
PB214	4.390-015	7.028-015	1.055-014	1.508-014
BI210	7.302-016	1.027-015	1.490-015	2.168-015
BI211	7.829-013	1.036-012	1.317-012	1.627-012
BI212	1.370-008	1.460-008	1.507-008	1.526-008
BI213	2.674-014	2.918-014	3.200-014	3.519-014
BI214	4.390-015	7.028-015	1.055-014	1.508-014
PO210	7.302-016	9.297-016	1.340-015	1.950-015
PO211	2.192-015	2.901-015	3.689-015	4.554-015
PO212	8.775-009	9.353-009	9.652-009	9.778-009
PO213	2.617-014	2.855-014	3.130-014	3.443-014
PO214	4.389-015	7.026-015	1.055-014	1.508-014
PO215	7.829-013	1.036-012	1.317-012	1.627-012
PO216	1.370-008	1.460-008	1.507-008	1.526-008
PO218	4.391-015	7.029-015	1.055-014	1.508-014
AT217	2.674-014	2.918-014	3.200-014	3.519-014
RN219	7.829-013	1.036-012	1.317-012	1.627-012
RN220	1.370-008	1.460-008	1.507-008	1.526-008
RN222	4.391-015	7.029-015	1.055-014	1.508-014
FR221	2.674-014	2.918-014	3.200-014	3.519-014
FR223	1.080-014	1.427-014	1.815-014	2.241-014
RA223	7.829-013	1.036-012	1.317-012	1.627-012
RA224	1.370-008	1.460-008	1.507-008	1.526-008
RA225	2.674-014	2.918-014	3.200-014	3.519-014
RA226	4.391-015	7.029-015	1.055-014	1.508-014
AC225	2.674-014	2.918-014	3.200-014	3.519-014
AC227	7.827-013	1.034-012	1.315-012	1.624-012
TH227	7.721-013	1.022-012	1.299-012	1.604-012
TH228	1.370-008	1.456-008	1.503-008	1.522-008
TH229	2.674-014	2.918-014	3.199-014	3.519-014
TH230	2.586-012	3.538-012	4.634-012	5.871-012
TH231	1.718-008	1.718-008	1.718-008	1.718-008
TH232	1.083-016	1.271-016	1.459-016	1.647-016
TH234	3.210-007	3.210-007	3.210-007	3.210-007
PA231	4.491-012	5.219-012	5.947-012	6.676-012
PA233	2.177-007	2.187-007	2.199-007	2.212-007
PA234M	3.210-007	3.210-007	3.210-007	3.210-007
PA234	4.174-010	4.174-010	4.174-010	4.174-010
U232	1.524-008	1.545-008	1.546-008	1.535-008
U233	1.187-011	1.388-011	1.590-011	1.793-011
U234	4.884-008	5.690-008	6.483-008	7.264-008
U235	1.718-008	1.718-008	1.718-008	1.718-008
U236	1.905-007	1.905-007	1.905-007	1.905-007
U237	1.710-006	1.553-006	1.411-006	1.281-006
U238	3.210-007	3.210-007	3.210-007	3.210-007
U240	1.994-013	1.994-013	1.994-013	1.994-013

TABLE E.4.c. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
NP235	6.526-012	1.817-012	5.061-C13	1.409-013
NP236	3.562-012	3.562-012	3.562-012	3.562-012
NP237	2.177-007	2.187-0C7	2.199-C07	2.212-007
NP238	3.C41-008	3.014-0C8	2.986-008	2.959-0C8
NP239	1.C71-005	1.071-005	1.C70-C05	1.070-005
NP240M	1.994-013	1.994-013	1.994-013	1.994-013
PU236	3.285-008	2.02C-0C8	1.242-C08	7.638-009
PU238	1.432-003	1.41C-0C3	1.388-003	1.366-003
PU239	3.C58-004	3.058-0C4	3.C58-004	3.058-004
PU240	4.470-004	4.471-0C4	4.471-C04	4.471-0C4
PU241	6.973-002	6.333-0C2	5.751-C02	5.223-0C2
PU242	1.284-006	1.284-CC6	1.284-006	1.284-006
PU243	2.532-C14	2.532-014	2.532-C14	2.532-014
PU244	1.997-013	1.997-013	1.997-013	1.997-013
AM241	1.528-003	1.736-003	1.924-C03	2.093-0C3
AM242M	6.C83-006	6.027-006	5.973-C06	5.918-0C6
AM242	6.C52-006	5.997-0C6	5.943-006	5.889-0C6
AM243	1.C71-005	1.071-0C5	1.C70-005	1.070-0C5
CM242	5.C11-006	4.969-0C6	4.924-C06	4.879-006
CM243	9.C31-C06	8.6C3-0C6	8.194-C06	7.805-0C6
CM244	6.723-004	6.227-0C4	5.769-C04	5.343-0C4
CM245	6.588-008	6.587-008	6.586-C08	6.585-008
CM246	1.133-008	1.132-008	1.132-C08	1.132-008
CM247	2.532-014	2.532-014	2.532-C14	2.532-014
CM248	4.625-014	4.625-014	4.625-C14	4.625-014
BK249	5.224-014	1.074-014	2.206-C15	4.535-016
CF249	3.969-013	3.954-013	3.939-C13	3.924-013
CF250	1.101-012	9.899-013	8.904-013	8.009-013
CF251	9.471-015	9.457-015	9.442-C15	9.428-015
CF252	1.C61-013	6.275-014	3.710-014	2.194-014
SUMTOT	7.416-002	6.79C-0C2	6.221-C02	5.703-0C2
TOTAL	7.416-002	6.79C-0C2	6.221-002	5.703-0C2

TABLE E.4.d. Actinides (Elemental), Ci/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL	4.522-009	5.246-009	5.414-009	5.485-009
PB	1.370-008	1.460-008	1.507-008	1.526-008
BI	1.370-008	1.460-008	1.507-008	1.526-008
PO	2.247-008	2.395-008	2.472-008	2.504-008
AT	2.674-014	2.918-014	3.200-014	3.519-014
RN	1.370-008	1.460-008	1.507-008	1.526-008
FR	3.755-014	4.345-014	5.014-014	5.760-014
RA	1.370-008	1.460-008	1.507-008	1.526-008
AC	8.095-013	1.063-012	1.347-012	1.659-012
TH	3.519-007	3.528-007	3.533-007	3.534-007
PA	5.391-007	5.402-007	5.414-007	5.427-007
U	2.303-006	2.155-006	2.020-006	1.898-006
NP	1.096-005	1.096-005	1.095-005	1.095-005
PU	7.191-002	6.549-002	5.966-002	5.435-002
AM	1.551-003	1.759-003	1.947-003	2.116-003
CM	6.864-004	6.364-004	5.900-004	5.471-004
BK	5.224-014	1.074-014	2.206-015	4.535-016
CF	1.613-012	1.458-012	1.331-012	1.225-012
SUMTOT	7.416-002	6.790-002	6.221-002	5.703-002
TOTAL	7.416-002	6.790-002	6.221-002	5.703-002

TABLE E.4.e. Fission Products (Isotopic), g/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	2.502-008	2.236-008	1.999-008	1.787-008
LI 6	1.531-010	1.531-010	1.531-010	1.531-010
LI 7	7.660-012	7.660-012	7.660-012	7.660-012
BE 9	1.475-011	1.475-011	1.475-011	1.475-011
BE 10	9.842-011	9.842-011	9.842-011	9.842-011
C 14	1.988-011	1.987-011	1.987-011	1.986-011
ZN 66	2.700-014	2.700-014	2.700-014	2.700-014
ZN 67	1.117-015	1.117-015	1.117-015	1.117-015
GA 71	6.876-013	6.876-013	6.876-013	6.876-013
GE 72	1.739-008	1.739-008	1.739-008	1.739-008
GE 73	3.563-008	3.563-008	3.563-008	3.563-008
GE 74	7.543-008	7.543-008	7.543-008	7.543-008
AS 75	1.562-007	1.562-007	1.562-007	1.562-007
GE 76	3.804-007	3.804-007	3.804-007	3.804-007
SE 76	3.520-009	3.520-009	3.520-009	3.520-009
SE 77	7.841-007	7.841-007	7.841-007	7.841-007
SE 78	1.834-006	1.834-006	1.834-006	1.834-006
SE 79	4.466-006	4.466-006	4.466-006	4.466-006
BR 79	5.452-010	6.405-010	7.358-010	8.311-010
SE 80	1.010-005	1.010-005	1.010-005	1.010-005
KR 80	1.777-010	1.777-010	1.777-010	1.777-010
BR 81	1.651-005	1.651-005	1.651-005	1.651-005
KR 81	1.615-011	1.615-011	1.615-011	1.615-011
SE 82	2.533-005	2.533-005	2.533-005	2.533-005
KR 82	6.371-007	6.371-007	6.371-007	6.371-007
KR 83	3.233-005	3.233-005	3.233-005	3.233-005
KR 84	8.335-005	8.335-005	8.335-005	8.335-005
KR 85	9.370-006	8.234-006	7.235-006	6.357-006
RB 85	8.132-005	8.246-005	8.346-005	8.434-005
KR 86	1.415-004	1.415-004	1.415-004	1.415-004
SR 86	2.508-007	2.508-007	2.508-007	2.508-007
RB 87	1.815-004	1.815-004	1.815-004	1.815-004
SR 87	2.010-009	2.010-009	2.010-009	2.010-009
SR 88	2.603-004	2.603-004	2.603-004	2.603-004
Y 89	3.395-004	3.395-004	3.395-004	3.395-004
SR 90	3.137-004	2.991-004	2.852-004	2.719-004
Y 90	7.866-008	7.500-008	7.151-008	6.819-008
ZR 90	9.862-005	1.132-004	1.271-004	1.404-004
ZR 91	4.404-004	4.404-004	4.404-004	4.404-004
ZR 92	4.781-004	4.781-004	4.781-004	4.781-004
ZR 93	5.403-004	5.403-004	5.403-004	5.403-004
NB 93	7.896-010	1.032-009	1.298-009	1.585-009
NB 93M	2.009-009	2.256-009	2.480-009	2.682-009
ZR 94	5.551-004	5.551-004	5.551-004	5.551-004
NB 94	6.008-010	6.007-010	6.007-010	6.007-010
MO 95	5.750-004	5.750-004	5.750-004	5.750-004
ZR 96	6.026-004	6.026-004	6.026-004	6.026-004
MO 96	2.065-005	2.065-005	2.065-005	2.065-005
MO 97	5.986-004	5.986-004	5.986-004	5.986-004
MO 98	6.239-004	6.239-004	6.239-004	6.239-004
TC 98	3.942-009	3.942-009	3.942-009	3.942-009
TC 99	5.953-004	5.953-004	5.953-004	5.953-004

TABLE E.4.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
RU 99	2.188-008	2.575-008	2.963-008	3.350-008
MO100	7.048-004	7.048-004	7.048-004	7.048-004
RU100	5.963-005	5.963-005	5.963-005	5.963-005
RU101	5.902-004	5.902-004	5.902-004	5.902-004
RU102	5.840-004	5.840-004	5.840-004	5.840-004
RH102	6.149-011	3.813-011	2.364-011	1.466-011
RH103	3.827-004	3.827-004	3.827-004	3.827-004
RU104	4.194-004	4.194-004	4.194-004	4.194-004
PD104	1.446-004	1.446-004	1.446-004	1.446-004
PD105	3.000-004	3.000-004	3.000-004	3.000-004
RU106	1.340-007	3.388-008	8.564-009	2.165-009
RH106	1.260-013	3.185-014	8.050-015	2.035-015
PD106	2.749-004	2.750-004	2.750-004	2.750-004
PD107	1.715-004	1.715-004	1.715-004	1.715-004
AG107	2.013-010	2.379-010	2.745-010	3.111-010
PD108	1.182-004	1.182-004	1.182-004	1.182-004
AG108M	8.336-013	8.246-013	8.156-013	8.068-013
CD108	2.645-010	2.645-010	2.645-010	2.645-010
AG109	6.235-005	6.235-005	6.235-005	6.235-005
CD109	1.131-015	3.798-016	1.275-016	4.283-017
PD110	3.869-005	3.869-005	3.869-005	3.869-005
AG110M	2.372-011	3.127-012	4.122-013	5.434-014
CD110	2.252-005	2.252-005	2.252-005	2.252-005
CD111	2.162-005	2.162-005	2.162-005	2.162-005
CD112	1.298-005	1.298-005	1.298-005	1.298-005
CD113	1.475-007	1.475-007	1.475-007	1.475-007
CD113M	1.241-007	1.129-007	1.026-007	9.334-008
IN113	8.517-008	9.641-008	1.066-007	1.159-007
CD114	1.775-005	1.775-005	1.775-005	1.775-005
SN114	7.661-010	7.661-010	7.661-010	7.661-010
IN115	2.266-006	2.266-006	2.266-006	2.266-006
SN115	2.570-007	2.570-007	2.570-007	2.570-007
CD116	6.565-006	6.565-006	6.565-006	6.565-006
SN116	5.468-006	5.468-006	5.468-006	5.468-006
SN117	6.646-006	6.646-006	6.646-006	6.646-006
SN118	6.696-006	6.696-006	6.696-006	6.696-006
SN119	6.673-006	6.673-006	6.673-006	6.673-006
SN119M	1.339-012	1.696-013	2.147-014	2.719-015
SN120	6.802-006	6.802-006	6.802-006	6.802-006
SN121M	2.377-009	2.312-009	2.248-009	2.187-009
SB121	6.706-006	6.706-006	6.706-006	6.706-006
SN122	7.487-006	7.487-006	7.487-006	7.487-006
TE122	3.679-007	3.679-007	3.679-007	3.679-007
SN123	1.081-015	2.146-017	4.257-019	8.442-021
SB123	8.219-006	8.219-006	8.219-006	8.219-006
TE123	4.641-009	4.641-009	4.641-009	4.641-009
SN124	1.009-005	1.009-005	1.009-005	1.009-005
TE124	2.746-007	2.746-007	2.746-007	2.746-007
SB125	9.319-007	5.650-007	3.425-007	2.076-007
TE125	1.416-005	1.453-005	1.475-005	1.489-005
TE125M	1.303-008	7.904-009	4.792-009	2.905-009
SN126	2.168-005	2.168-005	2.168-005	2.168-005

TABLE E.4.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
SB126	1.030-012	1.030-012	1.030-012	1.030-012
SB126M	7.831-015	7.830-015	7.830-015	7.830-015
TE126	5.737-007	5.740-007	5.743-007	5.746-007
TE127M	1.002-016	9.630-019	9.245-021	9.333-023
I127	4.400-005	4.400-005	4.400-005	4.400-005
TE128	8.559-005	8.559-005	8.559-005	8.559-005
XE128	1.913-006	1.913-006	1.913-006	1.913-006
I129	1.397-004	1.397-004	1.397-004	1.397-004
XE129	8.797-009	8.810-009	8.822-009	8.835-009
TE130	2.717-004	2.717-004	2.717-004	2.717-004
XE130	7.763-006	7.763-006	7.763-006	7.763-006
XE131	3.488-004	3.488-004	3.488-004	3.488-004
XE132	7.996-004	7.996-004	7.996-004	7.996-004
BA132	1.177-009	1.177-009	1.177-009	1.177-009
CS133	8.761-004	8.761-004	8.761-004	8.761-004
XE134	1.109-003	1.109-003	1.109-003	1.109-003
CS134	2.647-006	1.351-006	6.898-007	3.522-007
BA134	9.765-005	9.894-005	9.961-005	9.994-005
CS135	2.644-004	2.644-004	2.644-004	2.644-004
BA135	1.248-007	1.250-007	1.251-007	1.253-007
XE136	1.731-003	1.731-003	1.731-003	1.731-003
BA136	1.308-005	1.308-005	1.308-005	1.308-005
CS137	7.188-004	6.863-004	6.553-004	6.257-004
BA137	2.142-004	2.467-004	2.776-004	3.072-004
BA137M	1.100-010	1.050-010	1.003-010	9.573-011
BA138	9.607-004	9.607-004	9.607-004	9.607-004
LA138	4.397-009	4.397-009	4.397-009	4.397-009
LA139	9.197-004	9.197-004	9.197-004	9.197-004
CE140	9.280-004	9.280-004	9.280-004	9.280-004
PR141	8.461-004	8.461-004	8.461-004	8.461-004
CE142	8.485-004	8.485-004	8.485-004	8.485-004
ND142	1.590-005	1.590-005	1.590-005	1.590-005
ND143	6.228-004	6.228-004	6.228-004	6.228-004
CE144	3.821-008	6.436-009	1.084-009	1.826-010
PR144	1.613-012	2.717-013	4.577-014	7.708-015
PR144M	8.066-015	1.358-015	2.288-016	3.853-017
ND144	9.565-004	9.566-004	9.566-004	9.566-004
ND145	5.171-004	5.171-004	5.171-004	5.171-004
ND146	5.060-004	5.060-004	5.060-004	5.060-004
PM146	1.411-009	1.097-009	8.524-010	6.625-010
SM146	4.627-009	4.743-009	4.833-009	4.904-009
PM147	9.002-006	5.307-006	3.129-006	1.844-006
SM147	1.670-004	1.707-004	1.728-004	1.741-004
ND148	2.801-004	2.801-004	2.801-004	2.801-004
SM148	1.197-004	1.197-004	1.197-004	1.197-004
SM149	2.258-006	2.258-006	2.258-006	2.258-006
ND150	1.354-004	1.354-004	1.354-004	1.354-004
SM150	1.891-004	1.891-004	1.891-004	1.891-004
EU150	1.363-013	1.311-013	1.262-013	1.214-013
SM151	1.001-005	9.857-006	9.707-006	9.558-006
EU151	8.106-007	9.637-007	1.114-006	1.263-006
SM152	1.039-004	1.039-004	1.039-004	1.039-004

TABLE E.4.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	1.943-008	1.754-008	1.584-008	1.431-008
GD152	1.466-008	1.518-008	1.566-008	1.608-008
EU153	8.009-005	8.009-005	8.009-005	8.009-005
GD153	2.966-013	3.661-014	4.518-015	5.576-016
SM154	2.869-005	2.869-005	2.869-005	2.869-005
EU154	1.163-005	9.899-006	8.425-006	7.171-006
GD154	1.610-005	1.783-005	1.930-005	2.056-005
EU155	2.386-006	1.804-006	1.364-006	1.032-006
GD155	7.336-006	7.918-006	8.358-006	8.690-006
GD156	4.031-005	4.031-005	4.031-005	4.031-005
GD157	7.708-008	7.708-008	7.708-008	7.708-008
GD158	1.319-005	1.319-005	1.319-005	1.319-005
TB159	2.015-006	2.015-006	2.015-006	2.015-006
GD160	9.858-007	9.858-007	9.858-007	9.858-007
DY160	1.883-007	1.883-007	1.883-007	1.883-007
DY161	3.353-007	3.353-007	3.353-007	3.353-007
DY162	2.903-007	2.903-007	2.903-007	2.903-007
DY163	2.125-007	2.125-007	2.125-007	2.125-007
DY164	3.241-008	3.241-008	3.241-008	3.241-008
HO165	9.948-008	9.948-008	9.948-008	9.948-008
HO166M	8.571-010	8.561-010	8.551-010	8.542-010
ER166	3.084-008	3.084-008	3.084-008	3.084-008
ER167	2.509-009	2.509-009	2.509-009	2.509-009
ER168	5.837-009	5.837-009	5.837-009	5.837-009
TM169	3.541-011	3.541-011	3.541-011	3.541-011
ER170	1.365-014	1.365-014	1.365-014	1.365-014
YB170	9.194-012	9.194-012	9.194-012	9.194-012
TM171	9.216-015	4.477-015	2.175-015	1.056-015
YB171	5.390-013	5.437-013	5.460-013	5.471-013
YB172	1.294-014	1.294-014	1.294-014	1.294-014
SUMTOT	2.574-002	2.574-002	2.574-002	2.574-002
TOTAL	2.574-002	2.574-002	2.574-002	2.574-002

TABLE E.4.f. Fission Products (Elemental), g/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	2.502-008	2.236-008	1.999-008	1.787-008
LI	1.607-010	1.607-010	1.607-010	1.607-010
BE	1.132-010	1.132-010	1.132-010	1.132-010
C	1.988-011	1.987-011	1.987-011	1.986-011
ZN	2.813-014	2.813-014	2.813-014	2.813-014
GA	6.876-013	6.876-013	6.876-013	6.876-013
GE	5.089-007	5.089-007	5.089-007	5.089-007
AS	1.562-007	1.562-007	1.562-007	1.562-007
SE	4.252-005	4.252-005	4.252-005	4.252-005
BR	1.651-005	1.651-005	1.651-005	1.651-005
KR	2.672-004	2.660-004	2.650-004	2.641-004
RB	2.629-004	2.640-004	2.650-004	2.659-004
SR	5.743-004	5.597-004	5.458-004	5.325-004
Y	3.396-004	3.396-004	3.396-004	3.396-004
ZR	2.715-003	2.730-003	2.744-003	2.757-003
NB	3.399-009	3.889-009	4.378-009	4.868-009
MO	2.523-003	2.523-003	2.523-003	2.523-003
TC	5.953-004	5.953-004	5.953-004	5.953-004
RU	1.653-003	1.653-003	1.653-003	1.653-003
RH	3.827-004	3.827-004	3.827-004	3.827-004
PD	1.048-003	1.048-003	1.048-003	1.048-003
AG	6.235-005	6.235-005	6.235-005	6.235-005
CD	8.171-005	8.170-005	8.169-005	8.168-005
IN	2.351-006	2.363-006	2.373-006	2.382-006
SN	7.180-005	7.180-005	7.180-005	7.180-005
SB	1.586-005	1.549-005	1.527-005	1.513-005
TE	3.726-004	3.730-004	3.732-004	3.734-004
I	1.837-004	1.837-004	1.837-004	1.837-004
XE	3.998-003	3.998-003	3.998-003	3.998-003
CS	1.862-003	1.828-003	1.797-003	1.767-003
BA	1.286-003	1.319-003	1.351-003	1.381-003
LA	9.197-004	9.197-004	9.197-004	9.197-004
CE	1.776-003	1.776-003	1.776-003	1.776-003
PR	8.461-004	8.461-004	8.461-004	8.461-004
ND	3.034-003	3.034-003	3.034-003	3.034-003
PM	9.003-006	5.308-006	3.129-006	1.845-006
SM	6.207-004	6.242-004	6.262-004	6.274-004
EU	9.494-005	9.278-005	9.101-005	8.957-005
GD	7.801-005	8.033-005	8.224-005	8.383-005
TB	2.015-006	2.015-006	2.015-006	2.015-006
DY	1.059-006	1.059-006	1.059-006	1.059-006
HO	1.003-007	1.003-007	1.003-007	1.003-007
ER	3.918-008	3.918-008	3.918-008	3.919-008
TM	3.542-011	3.541-011	3.541-011	3.541-011
YB	9.746-012	9.751-012	9.753-012	9.754-012
SUMTOT	2.574-002	2.574-002	2.574-002	2.574-002
TOTAL	2.574-002	2.574-002	2.574-002	2.574-002

TABLE E.4.g. Fission Products (Isotopic), Ci/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	2.416-004	2.159-004	1.930-004	1.725-004
BE 10	2.200-012	2.200-012	2.200-012	2.200-012
C 14	8.862-011	8.860-011	8.858-011	8.856-011
SE 79	3.112-007	3.112-007	3.112-007	3.112-007
KR 81	3.399-013	3.399-013	3.399-013	3.399-013
KR 85	3.678-003	3.232-003	2.840-003	2.495-003
RB 87	1.589-011	1.589-011	1.589-011	1.589-011
SR 90	4.280-002	4.081-002	3.892-002	3.711-002
Y 90	4.281-002	4.082-002	3.892-002	3.712-002
ZR 93	1.358-006	1.358-006	1.358-006	1.358-006
NB 93M	5.680-007	6.380-007	7.012-007	7.583-007
NB 94	1.126-010	1.126-010	1.126-010	1.126-010
TC 98	3.426-012	3.426-012	3.426-012	3.426-012
TC 99	1.010-005	1.010-005	1.010-005	1.010-005
RH102	7.435-008	4.610-008	2.858-008	1.772-008
RU106	4.487-004	1.134-004	2.867-005	7.246-006
RH106	4.487-004	1.134-004	2.867-005	7.246-006
PD107	8.826-008	8.826-008	8.826-008	8.826-008
AG108	1.935-012	1.914-012	1.893-012	1.872-012
AG108M	2.174-011	2.150-011	2.127-011	2.104-011
AG109M	2.922-012	9.811-013	3.294-013	1.106-013
CD109	2.922-012	9.811-013	3.294-013	1.106-013
AG110	1.499-009	1.977-010	2.605-011	3.435-012
AG110M	1.127-007	1.486-008	1.959-009	2.582-010
CD113M	2.693-005	2.449-005	2.227-005	2.025-005
SN119M	5.999-009	7.597-010	9.619-011	1.218-011
SN121M	1.406-007	1.367-007	1.330-007	1.293-007
SN123	8.892-012	1.764-013	3.500-015	6.941-017
TE123M	5.074-015	7.379-017	1.043-018	.000
SB125	9.627-004	5.836-004	3.538-004	2.145-004
TE125M	2.349-004	1.424-004	8.634-005	5.234-005
SN126	6.153-007	6.153-007	6.153-007	6.153-007
SB126	8.614-008	8.614-008	8.614-008	8.614-008
SB126M	6.153-007	6.153-007	6.153-007	6.153-007
TE127	9.263-013	8.900-015	8.551-017	8.624-019
TE127M	9.457-013	9.087-015	8.724-017	8.807-019
I129	2.467-008	2.467-008	2.467-008	2.467-008
CS134	3.426-003	1.749-003	8.929-004	4.558-004
CS135	3.046-007	3.046-007	3.046-007	3.046-007
CS137	6.255-002	5.973-002	5.703-002	5.445-002
BA137M	5.917-002	5.650-002	5.395-002	5.151-002
CE142	2.037-011	2.037-011	2.037-011	2.037-011
CE144	1.219-004	2.054-005	3.459-006	5.826-007
PR144	1.219-004	2.054-005	3.459-006	5.826-007
PR144M	1.463-006	2.465-007	4.151-008	6.991-009
ND144	1.132-015	1.132-015	1.132-015	1.132-015
PM146	6.285-007	4.885-007	3.797-007	2.951-007
SM146	1.619-013	1.660-013	1.691-013	1.716-013
PM147	8.348-003	4.921-003	2.901-003	1.710-003
SM147	3.796-012	3.880-012	3.929-012	3.959-012
EU150	9.027-012	8.686-012	8.358-012	8.042-012
SM151	2.635-004	2.594-004	2.555-004	2.516-004

TABLE E.4.g. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	3.361-006	3.035-006	2.741-006	2.475-006
GD153	1.046-009	1.292-010	1.594-011	1.967-012
EU154	3.141-003	2.673-003	2.275-003	1.936-003
EU155	1.110-003	8.395-004	6.348-004	4.800-004
HO166M	1.539-009	1.537-009	1.535-009	1.534-009
TM171	1.004-011	4.877-012	2.369-012	1.151-012
SUMTOT	2.299-001	2.128-001	1.994-001	1.880-001
TOTAL	2.299-001	2.128-001	1.994-001	1.880-001

TABLE E.4.h. Fission Products (Elemental), Ci/gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	2.416-004	2.159-004	1.930-004	1.725-004
BE	2.200-012	2.200-012	2.200-012	2.200-012
C	8.862-011	8.860-011	8.858-011	8.856-011
SE	3.112-007	3.112-007	3.112-007	3.112-007
KR	3.678-003	3.232-003	2.840-003	2.495-003
RB	1.589-011	1.589-011	1.589-011	1.589-011
SR	4.280-002	4.081-002	3.892-002	3.711-002
Y	4.281-002	4.082-002	3.892-002	3.712-002
ZR	1.358-006	1.358-006	1.358-006	1.358-006
NB	5.681-007	6.381-007	7.014-007	7.584-007
TC	1.010-005	1.010-005	1.010-005	1.010-005
RU	4.487-004	1.134-004	2.867-005	7.246-006
RH	4.488-004	1.135-004	2.869-005	7.264-006
PD	8.826-008	8.826-008	8.826-008	8.826-008
AG	1.143-007	1.508-008	2.009-009	2.847-010
CD	2.693-005	2.449-005	2.227-005	2.025-005
SN	7.619-007	7.528-007	7.483-007	7.446-007
SB	9.634-004	5.843-004	3.545-004	2.152-004
TE	2.349-004	1.424-004	8.634-005	5.234-005
I	2.467-008	2.467-008	2.467-008	2.467-008
CS	6.598-002	6.148-002	5.792-002	5.491-002
BA	5.517-002	5.650-002	5.395-002	5.151-002
CE	1.219-004	2.054-005	3.459-006	5.826-007
PR	1.234-004	2.079-005	3.501-006	5.896-007
ND	1.132-015	1.132-015	1.132-015	1.132-015
PM	8.349-003	4.922-003	2.902-003	1.711-003
SM	2.635-004	2.594-004	2.555-004	2.516-004
EU	4.254-003	3.516-003	2.913-003	2.419-003
GD	1.046-009	1.292-010	1.594-011	1.967-012
HO	1.539-009	1.537-009	1.535-009	1.534-009
TM	1.004-011	4.877-012	2.369-012	1.151-012
SUMTOT	2.299-001	2.128-001	1.994-001	1.880-001
TOTAL	2.299-001	2.128-001	1.994-001	1.880-001

TABLE E.4.i. Neutron Source (Alpha-n), neutrons/sec-gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	1.362+000	1.341+000	1.320+000	1.300+000
PU239	2.228-001	2.227-001	2.227-001	2.227-001
PU240	3.387-001	3.388-001	3.388-001	3.388-001
AM241	1.466+000	1.665+000	1.845+000	2.008+000
AM243	9.136-003	9.134-003	9.132-003	9.130-003
CM242	6.727-003	6.670-003	6.610-003	6.550-003
CM243	1.202-002	1.145-002	1.091-002	1.039-002
CM244	7.672-001	7.107-001	6.583-001	6.098-001

TABLE E.4.j. Neutron Source (Spontaneous fission), neutrons/sec-gU, at 25 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	2.222-001	2.187-001	2.153-001	2.119-001
PU240	1.786+000	1.786+000	1.786+000	1.786+000
PU242	5.668-001	5.668-001	5.668-001	5.668-001
CM244	9.237+001	8.556+001	7.926+001	7.342+001
CM246	3.280-001	3.279-001	3.279-001	3.278-001

TABLE E.5. Radionuclide Inventories at 30 MWd/kgM as a Function of Decay Time

TABLE E.5.a. Actinides (Isotopic), g/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE 4	9.714-007	1.070-006	1.170-006	1.271-006
PB207	1.029-015	1.580-015	2.295-015	3.190-015
PB208	4.785-011	6.487-011	8.268-011	1.009-010
PB212	1.464-014	1.561-014	1.612-014	1.634-014
BI212	1.388-015	1.481-015	1.529-015	1.550-015
RA224	1.277-013	1.362-013	1.406-013	1.425-013
RA226	6.091-015	9.852-015	1.490-014	2.143-014
AC227	8.260-015	1.091-014	1.388-014	1.713-014
TH228	2.481-011	2.640-011	2.726-011	2.762-011
TH229	1.889-013	2.028-013	2.189-013	2.372-013
TH230	1.799-010	2.478-010	3.263-010	4.152-010
TH231	2.468-014	2.468-014	2.468-014	2.468-014
TH232	1.070-009	1.255-009	1.440-009	1.625-009
TH234	1.379-011	1.379-011	1.379-011	1.379-011
PA231	7.257-011	8.435-011	9.612-011	1.079-010
PA233	1.315-011	1.320-011	1.327-011	1.334-011
U232	1.059-009	1.073-009	1.074-009	1.067-009
U233	1.478-009	1.739-009	2.000-009	2.263-009
U234	1.124-005	1.315-005	1.502-005	1.686-005
U235	6.070-003	6.070-003	6.070-003	6.070-003
U236	3.177-003	3.177-003	3.178-003	3.178-003
U237	2.419-011	2.197-011	1.995-011	1.812-011
U238	9.501-001	9.501-001	9.501-001	9.501-001
NP235	6.534-015	1.819-015	5.067-016	1.411-016
NP236	3.620-010	3.620-010	3.620-010	3.620-010
NP237	3.870-004	3.888-004	3.907-004	3.928-004
NP238	1.313-013	1.301-013	1.289-013	1.278-013
NP239	8.312-011	8.310-011	8.308-011	8.307-011
PU236	9.292-011	5.714-011	3.514-011	2.161-011
PU238	1.234-004	1.215-004	1.196-004	1.177-004
PU239	5.047-003	5.047-003	5.046-003	5.046-003
PU240	2.303-003	2.304-003	2.305-003	2.306-003
PU241	7.813-004	7.096-004	6.445-004	5.853-004
PU242	4.948-004	4.948-004	4.948-004	4.948-004
PU244	2.652-008	2.652-008	2.652-008	2.652-008
AM241	5.116-004	5.816-004	6.447-004	7.017-004
AM242M	7.003-007	6.939-007	6.876-007	6.814-007
AM242	8.377-012	8.301-012	8.226-012	8.151-012
AM243	9.671-005	9.670-005	9.668-005	9.666-005
CM242	1.696-009	1.681-009	1.666-009	1.651-009
CM243	2.987-007	2.845-007	2.710-007	2.581-007
CM244	1.921-005	1.780-005	1.648-005	1.527-005
CM245	1.023-006	1.023-006	1.023-006	1.022-006
CM246	1.262-007	1.262-007	1.262-007	1.261-007
CM247	1.161-009	1.161-009	1.161-009	1.161-009
CM248	5.855-011	5.855-011	5.855-011	5.855-011
CF249	6.037-013	6.015-013	5.991-013	5.968-013
CF250	6.891-014	6.198-014	5.575-014	5.014-014
CF251	4.453-014	4.446-014	4.439-014	4.432-014
CF252	1.866-015	1.103-015	6.523-016	3.857-016
SF250	1.534-011	1.734-011	1.920-011	2.092-011
SUMTOT	9.691-001	9.691-001	9.691-001	9.691-001

TABLE E.5.b. Actinides (Elemental), g/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE	9.714-007	1.07C-0C6	1.170-006	1.271-0C6
SF	1.534-011	1.734-011	1.920-C11	2.092-011
PB	4.786-011	6.482-011	8.270-C11	1.009-01C
BI	1.568-015	1.695-015	1.779-C15	1.839-015
RA	1.338-013	1.461-013	1.556-C13	1.640-013
AC	8.261-015	1.092-014	1.388-C14	1.714-014
TH	1.286-009	1.543-0C9	1.807-C09	2.081-0C9
PA	8.572-011	9.755-011	1.C94-C10	1.212-010
U	9.593-001	9.593-0C1	9.593-C01	9.593-0C1
NP	3.870-004	3.888-0C4	3.9C7-CC4	3.928-0C4
PU	8.750-003	8.677-0C3	8.610-C03	8.550-0C3
AM	6.C90-004	6.79C-0C4	7.421-004	7.991-004
CM	2.C66-005	1.923-005	1.791-C05	1.668-0C5
CF	7.190-013	7.09C-013	6.999-C13	6.916-013
SUMTCT	9.691-001	9.691-001	9.691-001	9.691-0C1
TOTAL	9.691-001	9.691-0C1	9.691-C01	9.691-0C1

TABLE E.5.c. Actinides (Isotopic), Ci/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL207	5.962-013	7.889-013	1.003-012	1.239-012
TL208	7.310-009	7.798-009	8.052-009	8.159-009
TL209	8.685-016	9.322-016	1.006-015	1.090-015
PB209	4.021-014	4.316-014	4.658-014	5.048-014
PB210	1.120-015	1.522-015	2.161-015	3.107-015
PB211	5.978-013	7.911-013	1.006-012	1.242-012
PB212	2.035-008	2.170-008	2.241-008	2.271-008
PB214	6.024-015	9.743-015	1.474-014	2.119-014
BI210	1.121-015	1.523-015	2.162-015	3.108-015
BI211	5.978-013	7.911-013	1.006-012	1.242-012
BI212	2.035-008	2.170-008	2.241-008	2.271-008
BI213	4.021-014	4.316-014	4.658-014	5.048-014
BI214	6.024-015	9.743-015	1.474-014	2.119-014
PO210	1.121-015	1.390-015	1.953-015	2.803-015
PO211	1.674-015	2.215-015	2.817-015	3.478-015
PO212	1.304-008	1.391-008	1.436-008	1.455-008
PO213	3.934-014	4.222-014	4.557-014	4.939-014
PO214	6.022-015	9.741-015	1.474-014	2.119-014
PO215	5.978-013	7.911-013	1.006-012	1.242-012
PO216	2.035-008	2.170-008	2.241-008	2.271-008
PO218	6.025-015	9.745-015	1.474-014	2.120-014
AT217	4.021-014	4.316-014	4.658-014	5.048-014
RN219	5.978-013	7.911-013	1.006-012	1.242-012
RN220	2.035-008	2.170-008	2.241-008	2.271-008
RN222	6.025-015	9.745-015	1.474-014	2.120-014
FR221	4.021-014	4.316-014	4.658-014	5.048-014
FR223	8.249-015	1.090-014	1.386-014	1.711-014
RA223	5.978-013	7.911-013	1.006-012	1.242-012
RA224	2.035-008	2.170-008	2.241-008	2.271-008
RA225	4.021-014	4.316-014	4.658-014	5.048-014
RA226	6.025-015	9.745-015	1.474-014	2.120-014
AC225	4.021-014	4.316-014	4.658-014	5.048-014
AC227	5.977-013	7.898-013	1.004-012	1.240-012
TH227	5.896-013	7.802-013	9.922-013	1.225-012
TH228	2.035-008	2.165-008	2.235-008	2.265-008
TH229	4.021-014	4.316-014	4.658-014	5.048-014
TH230	3.632-012	5.005-012	6.590-012	8.384-012
TH231	1.313-008	1.313-008	1.313-008	1.313-008
TH232	1.174-016	1.377-016	1.579-016	1.782-016
TH234	3.195-007	3.195-007	3.195-007	3.195-007
PA231	3.429-012	3.986-012	4.542-012	5.098-012
PA233	2.729-007	2.742-007	2.755-007	2.770-007
PA234M	3.195-007	3.195-007	3.195-007	3.195-007
PA234	4.154-010	4.154-010	4.154-010	4.154-010
U232	2.267-008	2.299-008	2.301-008	2.285-008
U233	1.432-011	1.684-011	1.937-011	2.191-011
U234	7.029-008	8.218-008	9.388-008	1.054-007
U235	1.313-008	1.313-008	1.313-008	1.313-008
U236	2.056-007	2.056-007	2.057-007	2.057-007
U237	1.975-006	1.794-006	1.629-006	1.480-006
U238	3.195-007	3.195-007	3.195-007	3.195-007
U240	4.699-013	4.699-013	4.699-013	4.699-013

TABLE E.5.c. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
NP235	9.170-012	2.554-012	7.111-013	1.980-013
NP236	4.771-012	4.771-012	4.771-012	4.771-012
NP237	2.729-007	2.742-007	2.755-007	2.770-007
NP238	3.404-008	3.374-008	3.343-008	3.313-008
NP239	1.929-005	1.928-005	1.928-005	1.928-005
NP240M	4.699-013	4.699-013	4.699-013	4.699-013
PU236	4.539-008	3.037-008	1.868-008	1.149-008
PU238	2.114-003	2.081-003	2.048-003	2.016-003
PU239	3.139-004	3.138-004	3.138-004	3.138-004
PU240	5.250-004	5.252-004	5.254-004	5.256-004
PU241	8.053-002	7.313-002	6.642-002	6.033-002
PU242	1.890-006	1.890-006	1.890-006	1.890-006
PU243	1.078-013	1.078-013	1.078-013	1.078-013
PU244	4.705-013	4.705-013	4.705-013	4.705-013
AM241	1.757-003	1.997-003	2.214-003	2.409-003
AM242M	6.809-006	6.747-006	6.686-006	6.625-006
AM242	6.775-006	6.713-006	6.652-006	6.592-006
AM243	1.929-005	1.928-005	1.928-005	1.928-005
CM242	5.611-006	5.562-006	5.511-006	5.461-006
CM243	1.542-005	1.469-005	1.399-005	1.333-005
CM244	1.555-003	1.440-003	1.334-003	1.236-003
CM245	1.757-007	1.757-007	1.756-007	1.756-007
CM246	3.879-008	3.878-008	3.877-008	3.876-008
CM247	1.078-013	1.078-013	1.078-013	1.078-013
CM248	2.490-013	2.490-013	2.490-013	2.490-013
BK249	3.280-013	6.740-014	1.385-014	2.847-015
CF249	2.474-012	2.465-012	2.455-012	2.446-012
CF250	7.536-012	6.778-012	6.097-012	5.484-012
CF251	7.065-014	7.054-014	7.043-014	7.032-014
CF252	1.004-012	5.935-013	3.509-013	2.075-013
SUMTOT	8.687-002	7.957-002	7.293-002	6.690-002
TOTAL	8.687-002	7.957-002	7.293-002	6.690-002

TABLE E.5.d. Actinides (Elemental), Ci/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL	7.311-009	7.799-009	8.053-009	8.160-009
PB	2.035-008	2.170-008	2.241-008	2.271-008
BI	2.035-008	2.170-008	2.241-008	2.271-008
PO	3.338-008	3.561-008	3.677-008	3.726-008
AT	4.021-014	4.316-014	4.658-014	5.048-014
RN	2.035-008	2.170-008	2.241-008	2.271-008
FR	4.846-014	5.405-014	6.044-014	6.759-014
RA	2.035-008	2.170-008	2.241-008	2.271-008
AC	6.380-013	8.330-013	1.051-012	1.290-012
TH	3.530-007	3.543-007	3.550-007	3.553-007
PA	5.929-007	5.941-007	5.955-007	5.970-007
U	2.607-006	2.438-006	2.285-006	2.147-006
NP	1.959-005	1.959-005	1.959-005	1.959-005
PU	8.348-002	7.606-002	6.931-002	6.318-002
AM	1.790-003	2.030-003	2.246-003	2.442-003
CM	1.576-003	1.461-003	1.354-003	1.255-003
BK	3.280-013	6.740-014	1.385-014	2.847-015
CF	1.108-011	9.907-012	8.973-012	8.207-012
SUMTOT	8.687-002	7.957-002	7.293-002	6.690-002
TOTAL	8.687-002	7.957-002	7.293-002	6.690-002

TABLE E.5.e. Fission Products (Isotopic), g/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	3.058-008	2.733-008	2.443-008	2.183-008
LI 6	1.579-010	1.579-010	1.579-010	1.579-010
LI 7	9.176-012	9.176-012	9.176-012	9.176-012
BE 9	1.766-011	1.766-011	1.766-011	1.766-011
BE 10	1.179-010	1.179-010	1.179-010	1.179-010
C 14	2.381-011	2.380-011	2.380-011	2.379-011
ZN 66	3.077-014	3.077-014	3.077-014	3.077-014
ZN 67	1.265-015	1.265-015	1.265-015	1.265-015
GA 71	8.432-013	8.432-013	8.432-013	8.432-013
GE 72	2.137-008	2.137-008	2.137-008	2.137-008
GE 73	4.283-008	4.283-008	4.283-008	4.283-008
GE 74	9.091-008	9.091-008	9.091-008	9.091-008
AS 75	1.857-007	1.857-007	1.857-007	1.857-007
GE 76	4.492-007	4.492-007	4.492-007	4.492-007
SE 76	5.084-009	5.084-009	5.084-009	5.084-009
SE 77	9.148-007	9.148-007	9.148-007	9.148-007
SE 78	2.194-006	2.194-006	2.194-006	2.194-006
SE 79	5.289-006	5.289-006	5.288-006	5.288-006
BR 79	6.459-010	7.588-010	8.716-010	9.845-010
SE 80	1.193-005	1.193-005	1.193-005	1.193-005
KR 80	2.243-010	2.243-010	2.243-010	2.243-010
BR 81	1.928-005	1.928-005	1.928-005	1.928-005
KR 81	2.286-011	2.286-011	2.286-011	2.286-011
SE 82	2.965-005	2.965-005	2.965-005	2.965-005
KR 82	8.933-007	8.933-007	8.933-007	8.933-007
KR 83	3.585-005	3.585-005	3.585-005	3.585-005
KR 84	9.891-005	9.891-005	9.891-005	9.891-005
KR 85	1.087-005	9.553-006	8.394-006	7.376-006
RB 85	9.419-005	9.551-005	9.667-005	9.768-005
KR 86	1.635-004	1.635-004	1.635-004	1.635-004
SR 86	3.572-007	3.572-007	3.572-007	3.572-007
RB 87	2.095-004	2.095-004	2.095-004	2.095-004
SR 87	2.987-009	2.987-009	2.987-009	2.987-009
SR 88	3.002-004	3.002-004	3.002-004	3.002-004
Y 89	3.908-004	3.908-004	3.908-004	3.908-004
SR 90	3.612-004	3.444-004	3.284-004	3.131-004
Y 90	9.057-008	8.636-008	8.234-008	7.852-008
ZR 90	1.138-004	1.306-004	1.467-004	1.619-004
ZR 91	5.095-004	5.095-004	5.095-004	5.095-004
ZR 92	5.568-004	5.568-004	5.568-004	5.568-004
ZR 93	6.314-004	6.314-004	6.314-004	6.314-004
NB 93	9.254-010	1.209-009	1.520-009	1.856-009
NB 93M	2.350-009	2.639-009	2.900-009	3.135-009
ZR 94	6.549-004	6.549-004	6.549-004	6.549-004
NB 94	7.656-010	7.655-010	7.655-010	7.654-010
MO 95	6.740-004	6.740-004	6.740-004	6.740-004
ZR 96	7.141-004	7.141-004	7.141-004	7.141-004
MO 96	3.009-005	3.009-005	3.009-005	3.009-005
MO 97	7.130-004	7.130-004	7.130-004	7.130-004
MO 98	7.470-004	7.470-004	7.470-004	7.470-004
TC 98	5.761-009	5.761-009	5.761-009	5.761-009
TC 99	6.990-004	6.990-004	6.990-004	6.990-004

TABLE E.5.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
RU 99	2.569-008	3.024-008	3.479-008	3.933-008
MO100	8.460-004	8.460-004	8.460-004	8.460-004
RU100	8.704-005	8.704-005	8.704-005	8.704-005
RU101	7.075-004	7.075-004	7.075-004	7.075-004
RU102	7.155-004	7.155-004	7.155-004	7.155-004
RH102	8.509-011	5.523-011	3.424-011	2.123-011
RH103	4.422-004	4.422-004	4.422-004	4.422-004
RU104	5.280-004	5.280-004	5.280-004	5.280-004
PD104	2.093-004	2.093-004	2.093-004	2.093-004
PD105	3.755-004	3.755-004	3.755-004	3.755-004
RU106	1.751-007	4.427-008	1.119-008	2.829-009
RH106	1.646-013	4.161-014	1.052-014	2.659-015
PD106	3.666-004	3.668-004	3.668-004	3.668-004
PD107	2.255-004	2.255-004	2.255-004	2.255-004
AG107	2.644-010	3.126-010	3.607-010	4.088-010
PD108	1.562-004	1.562-004	1.562-004	1.562-004
AG108M	1.105-012	1.093-012	1.081-012	1.070-012
CD108	4.204-010	4.204-010	4.204-010	4.204-010
AG109	7.905-005	7.905-005	7.905-005	7.905-005
CD109	2.133-015	7.163-016	2.405-016	8.077-017
PD110	5.112-005	5.112-005	5.112-005	5.112-005
AG110M	3.723-011	4.908-012	6.470-013	8.529-014
CD110	3.568-005	3.568-005	3.568-005	3.568-005
CD111	2.832-005	2.832-005	2.832-005	2.832-005
CD112	1.681-005	1.681-005	1.681-005	1.681-005
CD113	1.523-007	1.523-007	1.523-007	1.523-007
CD113M	1.641-007	1.492-007	1.357-007	1.234-007
IN113	1.121-007	1.269-007	1.404-007	1.527-007
CD114	2.236-005	2.236-005	2.236-005	2.236-005
SN114	1.192-009	1.192-009	1.192-009	1.192-009
IN115	2.365-006	2.365-006	2.365-006	2.365-006
SN115	3.164-007	3.164-007	3.164-007	3.164-007
CD116	8.083-006	8.083-006	8.083-006	8.083-006
SN116	7.246-006	7.246-006	7.246-006	7.246-006
SN117	8.170-006	8.170-006	8.170-006	8.170-006
SN118	8.229-006	8.229-006	8.229-006	8.229-006
SN119	8.207-006	8.207-006	8.207-006	8.207-006
SN119M	1.713-012	2.169-013	2.746-014	3.478-015
SN120	8.359-006	8.359-006	8.359-006	8.359-006
SN121M	2.990-009	2.908-009	2.828-009	2.751-009
SB121	8.131-006	8.131-006	8.132-006	8.132-006
SN122	9.183-006	9.183-006	9.183-006	9.183-006
TE122	5.476-007	5.476-007	5.476-007	5.476-007
SN123	1.331-015	2.641-017	5.240-019	1.039-020
SB123	9.999-006	9.999-006	9.999-006	9.999-006
TE123	7.742-009	7.742-009	7.742-009	7.742-009
SN124	1.234-005	1.234-005	1.234-005	1.234-005
TE124	4.117-007	4.117-007	4.117-007	4.117-007
SB125	1.153-006	6.991-007	4.238-007	2.569-007
TE125	1.749-005	1.795-005	1.823-005	1.840-005
TE125M	1.613-008	9.781-009	5.929-009	3.595-009
SN126	2.674-005	2.674-005	2.674-005	2.674-005

TABLE E.5.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
SB126	1.271-012	1.271-012	1.271-012	1.271-012
SB126M	9.660-015	9.660-015	9.660-015	9.660-015
TE126	7.460-007	7.464-007	7.467-007	7.471-007
TE127M	1.247-016	1.198-018	1.151-020	1.161-022
I127	5.409-005	5.409-005	5.409-005	5.409-005
TE128	1.048-004	1.048-004	1.048-004	1.048-004
XE128	2.904-006	2.904-006	2.904-006	2.904-006
I129	1.693-004	1.693-004	1.693-004	1.693-004
XE129	1.617-008	1.619-008	1.620-008	1.622-008
TE130	3.306-004	3.306-004	3.306-004	3.306-004
XE130	1.158-005	1.158-005	1.158-005	1.158-005
XE131	3.960-004	3.960-004	3.960-004	3.960-004
XE132	9.927-004	9.927-004	9.927-004	9.927-004
BA132	1.714-009	1.714-009	1.714-009	1.714-009
CS133	1.022-003	1.022-003	1.022-003	1.022-003
XE134	1.329-003	1.329-003	1.329-003	1.329-003
CS134	3.740-006	1.910-006	9.749-007	4.977-007
BA134	1.381-004	1.399-004	1.409-004	1.413-004
CS135	2.813-004	2.813-004	2.813-004	2.813-004
BA135	2.187-007	2.188-007	2.190-007	2.192-007
XE136	2.125-003	2.125-003	2.125-003	2.125-003
BA136	1.696-005	1.696-005	1.696-005	1.696-005
CS137	8.633-004	8.243-004	7.871-004	7.515-004
BA137	2.572-004	2.962-004	3.334-004	3.690-004
BA137M	1.321-010	1.261-010	1.204-010	1.150-010
BA138	1.144-003	1.144-003	1.144-003	1.144-003
LA138	4.687-009	4.687-009	4.687-009	4.687-009
LA139	1.094-003	1.094-003	1.094-003	1.094-003
CE140	1.112-003	1.112-003	1.112-003	1.112-003
PR141	1.003-003	1.003-003	1.003-003	1.003-003
CE142	1.009-003	1.009-003	1.009-003	1.009-003
ND142	2.332-005	2.332-005	2.332-005	2.332-005
ND143	6.934-004	6.934-004	6.934-004	6.934-004
CE144	4.498-008	7.575-009	1.276-009	2.149-010
PR144	1.899-012	3.199-013	5.387-014	9.074-015
PR144M	9.494-015	1.599-015	2.693-016	4.536-017
ND144	1.179-003	1.179-003	1.179-003	1.179-003
ND145	6.007-004	6.007-004	6.007-004	6.007-004
ND146	6.165-004	6.165-004	6.165-004	6.165-004
PM146	1.894-009	1.472-009	1.144-009	8.893-010
SM146	6.210-009	6.366-009	6.487-009	6.582-009
PM147	9.397-006	5.540-006	3.266-006	1.925-006
SM147	1.742-004	1.781-004	1.803-004	1.817-004
ND148	3.362-004	3.362-004	3.362-004	3.362-004
SM148	1.531-004	1.531-004	1.531-004	1.531-004
SM149	2.474-006	2.474-006	2.474-006	2.474-006
ND150	1.653-004	1.653-004	1.653-004	1.653-004
SM150	2.288-004	2.288-004	2.288-004	2.288-004
EU150	1.481-013	1.425-013	1.371-013	1.319-013
SM151	1.079-005	1.062-005	1.046-005	1.030-005
EU151	8.716-007	1.037-006	1.199-006	1.359-006
SM152	1.197-004	1.197-004	1.197-004	1.197-004

TABLE E.5.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	1.752-008	1.582-008	1.429-008	1.290-008
GD152	1.318-008	1.365-008	1.408-008	1.447-008
EU153	1.008-004	1.008-004	1.008-004	1.008-004
GD153	3.434-013	4.239-014	5.231-015	6.456-016
SM154	3.661-005	3.661-005	3.661-005	3.661-005
EU154	1.634-005	1.391-005	1.184-005	1.008-005
GD154	2.263-005	2.506-005	2.713-005	2.890-005
EU155	3.282-006	2.482-006	1.877-006	1.419-006
GD155	1.007-005	1.087-005	1.148-005	1.194-005
GD156	6.189-005	6.189-005	6.189-005	6.189-005
GD157	9.990-008	9.990-008	9.990-008	9.990-008
GD158	1.860-005	1.860-005	1.860-005	1.860-005
TB159	2.673-006	2.673-006	2.673-006	2.673-006
GD160	1.305-006	1.305-006	1.305-006	1.305-006
DY160	2.891-007	2.891-007	2.891-007	2.891-007
DY161	4.291-007	4.291-007	4.291-007	4.291-007
DY162	3.823-007	3.823-007	3.823-007	3.823-007
DY163	3.035-007	3.035-007	3.035-007	3.035-007
DY164	4.458-008	4.458-008	4.458-008	4.458-008
HO165	1.509-007	1.509-007	1.509-007	1.509-007
HO166M	1.545-009	1.543-009	1.541-009	1.540-009
ER166	4.852-008	4.852-008	4.852-008	4.852-008
ER167	3.160-009	3.160-009	3.160-009	3.160-009
ER168	8.617-009	8.617-009	8.617-009	8.617-009
TM169	6.048-011	6.048-011	6.048-011	6.048-011
ER170	2.840-014	2.840-014	2.840-014	2.840-014
YB170	1.907-011	1.907-011	1.907-011	1.907-011
TM171	2.376-014	1.154-014	5.606-015	2.723-015
YB171	1.379-012	1.391-012	1.397-012	1.400-012
YB172	4.071-014	4.071-014	4.071-014	4.071-014
SUMTOT	3.086-002	3.086-002	3.086-002	3.086-002
TOTAL	3.086-002	3.086-002	3.086-002	3.086-002

TABLE E.5.f. Fission Products (Elemental), g/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	3.058-008	2.733-008	2.443-008	2.183-008
LI	1.671-010	1.671-010	1.671-010	1.671-010
BE	1.355-010	1.355-010	1.355-010	1.355-010
C	2.381-011	2.380-011	2.380-011	2.379-011
ZN	3.206-014	3.206-014	3.206-014	3.206-014
GA	8.432-013	8.432-013	8.432-013	8.432-013
GE	6.043-007	6.043-007	6.043-007	6.043-007
AS	1.857-007	1.857-007	1.857-007	1.857-007
SE	4.999-005	4.999-005	4.999-005	4.999-005
BR	1.928-005	1.928-005	1.928-005	1.928-005
KR	3.100-004	3.087-004	3.075-004	3.065-004
RB	3.037-004	3.050-004	3.061-004	3.072-004
SR	6.617-004	6.450-004	6.289-004	6.137-004
Y	3.909-004	3.909-004	3.909-004	3.909-004
ZR	3.181-003	3.197-003	3.213-003	3.229-003
NB	4.041-009	4.613-009	5.185-009	5.757-009
MO	3.010-003	3.010-003	3.010-003	3.010-003
TC	6.990-004	6.990-004	6.990-004	6.990-004
RU	2.038-003	2.038-003	2.038-003	2.038-003
RH	4.422-004	4.422-004	4.422-004	4.422-004
PD	1.384-003	1.384-003	1.384-003	1.384-003
AG	7.905-005	7.905-005	7.905-005	7.905-005
CD	1.116-004	1.116-004	1.115-004	1.115-004
IN	2.477-006	2.492-006	2.505-006	2.518-006
SN	8.880-005	8.880-005	8.879-005	8.879-005
SB	1.928-005	1.883-005	1.855-005	1.839-005
TE	4.547-004	4.552-004	4.554-004	4.556-004
I	2.234-004	2.234-004	2.234-004	2.234-004
XE	4.858-003	4.858-003	4.858-003	4.858-003
CS	2.171-003	2.130-003	2.092-003	2.056-003
BA	1.557-003	1.598-003	1.636-003	1.672-003
LA	1.094-003	1.094-003	1.094-003	1.094-003
CE	2.121-003	2.121-003	2.121-003	2.121-003
PR	1.003-003	1.003-003	1.003-003	1.003-003
ND	3.614-003	3.614-003	3.614-003	3.614-003
PM	9.399-006	5.541-006	3.267-006	1.926-006
SM	7.256-004	7.293-004	7.314-004	7.326-004
EU	1.213-004	1.183-004	1.157-004	1.137-004
GD	1.146-004	1.179-004	1.205-004	1.227-004
TB	2.673-006	2.673-006	2.673-006	2.673-006
DY	1.449-006	1.449-006	1.449-006	1.449-006
HO	1.524-007	1.524-007	1.524-007	1.524-007
ER	6.029-008	6.029-008	6.030-008	6.030-008
TM	6.050-011	6.049-011	6.048-011	6.048-011
YB	2.049-011	2.051-011	2.051-011	2.051-011
SUMTOT	3.086-002	3.086-002	3.086-002	3.086-002
TOTAL	3.086-002	3.086-002	3.086-002	3.086-002

TABLE E.5.g. Fission Products (Isotopic), Ci/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	2.952-004	2.638-004	2.358-004	2.108-004
BE 10	2.635-012	2.635-012	2.635-012	2.635-012
C 14	1.062-010	1.061-010	1.061-010	1.061-010
SE 79	3.686-007	3.686-007	3.686-007	3.685-007
KR 81	4.810-013	4.810-013	4.810-013	4.810-013
KR 85	4.267-003	3.749-003	3.295-003	2.895-003
RB 87	1.834-011	1.834-011	1.834-011	1.834-011
SR 90	4.928-002	4.699-002	4.481-002	4.273-002
Y 90	4.930-002	4.701-002	4.482-002	4.274-002
ZR 93	1.587-006	1.587-006	1.587-006	1.587-006
NB 93M	6.644-007	7.461-007	8.199-007	8.866-007
NB 94	1.435-010	1.435-010	1.435-010	1.435-010
TC 98	5.007-012	5.007-012	5.007-012	5.007-012
TC 99	1.185-005	1.185-005	1.185-005	1.185-005
RH102	1.077-007	6.678-008	4.140-008	2.567-008
RU106	5.863-004	1.482-004	3.746-005	9.468-006
RH106	5.863-004	1.482-004	3.746-005	9.468-006
PD107	1.161-007	1.161-007	1.161-007	1.161-007
AG108	2.565-012	2.537-012	2.509-012	2.482-012
AG108M	2.881-011	2.850-011	2.819-011	2.789-011
AG109M	5.510-012	1.850-012	6.213-013	2.086-013
CD109	5.510-012	1.850-012	6.213-013	2.086-013
AG110	2.353-009	3.102-010	4.090-011	5.391-012
AG110M	1.770-007	2.333-008	3.075-009	4.053-010
CD113M	3.560-005	3.237-005	2.944-005	2.677-005
SN119M	7.674-009	9.717-010	1.230-010	1.558-011
SN121M	1.768-007	1.720-007	1.673-007	1.627-007
SN123	1.095-011	2.172-013	4.309-015	8.546-017
TE123M	9.390-015	1.366-016	1.930-018	6.108-020
SB125	1.191-003	7.221-004	4.378-004	2.654-004
TE125M	2.906-004	1.762-004	1.068-004	6.477-005
SN126	7.590-007	7.590-007	7.590-007	7.590-007
SB126	1.063-007	1.063-007	1.063-007	1.063-007
SB126M	7.590-007	7.590-007	7.590-007	7.590-007
TE127	1.153-012	1.108-014	1.064-016	1.073-018
TE127M	1.177-012	1.131-014	1.086-016	1.096-018
I129	2.990-008	2.990-008	2.990-008	2.990-008
CS134	4.842-003	2.472-003	1.262-003	6.442-004
CS135	3.240-007	3.240-007	3.240-007	3.240-007
CS137	7.512-002	7.173-002	6.849-002	6.540-002
BA137M	7.107-002	6.786-002	6.479-002	6.187-002
CE142	2.422-011	2.422-011	2.422-011	2.422-011
CE144	1.435-004	2.418-005	4.072-006	6.858-007
PR144	1.435-004	2.418-005	4.072-006	6.858-007
PR144M	1.723-006	2.901-007	4.886-008	8.229-009
ND144	1.395-015	1.395-015	1.395-015	1.395-015
PM146	8.437-007	6.557-007	5.096-007	3.961-007
SM146	2.173-013	2.228-013	2.270-013	2.303-013
PM147	8.715-003	5.138-003	3.029-003	1.786-003
SM147	3.960-012	4.048-012	4.100-012	4.130-012
EU150	9.808-012	9.438-012	9.081-012	8.738-012
SM151	2.839-004	2.796-004	2.753-004	2.711-004

TABLE E.5.g. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	3.031-006	2.737-006	2.472-006	2.232-006
GD153	1.212-009	1.495-010	1.845-011	2.278-012
EU154	4.413-003	3.756-003	3.197-003	2.721-003
EU155	1.527-003	1.155-003	8.732-004	6.602-004
HO166M	2.774-009	2.771-009	2.767-009	2.764-009
TM171	2.588-011	1.257-011	6.107-012	2.966-012
SUMTOT	2.721-001	2.517-001	2.358-001	2.223-001
TOTAL	2.721-001	2.517-001	2.358-001	2.223-001

TABLE E.5.h. Fission Products (Elemental), Ci/gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	2.952-004	2.638-004	2.358-004	2.108-004
BE	2.635-012	2.635-012	2.635-012	2.635-012
C	1.062-010	1.061-010	1.061-010	1.061-010
SE	3.686-007	3.686-007	3.686-007	3.685-007
KR	4.267-003	3.749-003	3.295-003	2.895-003
RB	1.834-011	1.834-011	1.834-011	1.834-011
SR	4.928-002	4.699-002	4.481-002	4.273-002
Y	4.930-002	4.701-002	4.482-002	4.274-002
ZR	1.587-006	1.587-006	1.587-006	1.587-006
NB	6.645-007	7.462-007	8.201-007	8.867-007
TC	1.185-005	1.185-005	1.185-005	1.185-005
RU	5.863-004	1.482-004	3.746-005	9.468-006
RH	5.864-004	1.483-004	3.750-005	9.493-006
PD	1.161-007	1.161-007	1.161-007	1.161-007
AG	1.793-007	2.367-008	3.147-009	4.413-010
CD	3.560-005	3.237-005	2.944-005	2.677-005
SN	9.436-007	9.320-007	9.264-007	9.218-007
SB	1.192-003	7.230-004	4.386-004	2.663-004
TE	2.906-004	1.762-004	1.068-004	6.477-005
I	2.990-008	2.990-008	2.990-008	2.990-008
CS	7.996-002	7.420-002	6.875-002	6.604-002
BA	7.107-002	6.786-002	6.479-002	6.187-002
CE	1.435-004	2.418-005	4.072-006	6.858-007
PR	1.453-004	2.447-005	4.121-006	6.940-007
ND	1.395-015	1.395-015	1.395-015	1.395-015
PM	8.716-003	5.138-003	3.029-003	1.786-003
SM	2.839-004	2.796-004	2.753-004	2.711-004
EU	5.943-003	4.913-003	4.072-003	3.383-003
GD	1.212-009	1.495-010	1.845-011	2.278-012
HO	2.774-009	2.771-009	2.767-009	2.764-009
TM	2.588-011	1.257-011	6.107-012	2.966-012
SUMTOT	2.721-001	2.517-001	2.358-001	2.223-001
TOTAL	2.721-001	2.517-001	2.358-001	2.223-001

TABLE E.5.i. Neutron Source (Alpha-n), neutrons/sec-gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	2.011+000	1.98C+0CC	1.949+C00	1.918+000
PU239	2.286-001	2.286-0C1	2.286-001	2.286-0C1
PU24C	3.978-001	3.98C-001	3.981-C01	3.982-001
AM241	1.685+000	1.915+0CC	2.123+C00	2.311+000
AM243	1.645-002	1.645-002	1.645-C02	1.645-002
CM242	7.532-003	7.466-0C3	7.399-003	7.331-0C3
CM243	2.C54-002	1.956-0C2	1.863-002	1.775-0C2
CM244	1.774+000	1.644+0CC	1.523+C00	1.410+000

TABLE E.5.j. Neutron Source (Spontaneous fission), neutrons/sec-gU, at 30 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	3.279-001	3.228-0C1	3.178-C01	3.128-0C1
PU240	2.C97+C00	2.098+00C	2.C99+000	2.099+0C0
PU242	8.341-C01	8.341-0C1	8.341-C01	8.341-0C1
CM244	2.136+002	1.979+0C2	1.833+C02	1.698+0C2
CM246	1.123+000	1.123+00C	1.123+C00	1.122+000

TABLE E.6. Radionuclide Inventories at 35 MWd/kgM as a Function of Decay Time

Subtable	Species - Units	
E.6.a	Actinides (Isotopic), g/gU	E.85
E.6.b	Actinides (Elemental), g/gU	E.86
E.6.c	Actinides (Isotopic), Ci/gU	E.87
E.6.d	Actinides (Elemental), Ci/gU	E.89
E.6.e	Fission Products (Isotopic), g/gU	E.90
E.6.f	Fission Products (Elemental), g/gU	E.94
E.6.g	Fission Products (Isotopic), Ci/gU	E.95
E.6.h	Fission Products (Elemental), Ci/gU	E.97
E.6.i	Neutron Source (Alpha-n), neutrons/sec-g/U	E.98
E.6.j	Neutron Source (Spontaneous fission), neutrons/sec-gU	E.98

TABLE E.6.a. Actinides (Isotopic), g/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE 4	1.358-006	1.496-006	1.634-006	1.772-006
PB208	6.596-011	8.956-011	1.143-010	1.395-010
PB212	2.027-014	2.164-014	2.235-014	2.265-014
BI212	1.923-015	2.053-015	2.120-015	2.149-015
RA224	1.768-013	1.888-013	1.950-013	1.976-013
RA226	7.536-015	1.293-014	1.967-014	2.840-014
AC227	6.248-015	8.254-015	1.049-014	1.295-014
TH228	3.437-011	3.659-011	3.780-011	3.830-011
TH229	2.702-013	2.863-013	3.051-013	3.267-013
TH230	2.382-010	3.298-010	4.358-010	5.559-010
TH231	1.864-014	1.864-014	1.864-014	1.864-014
TH232	1.126-009	1.319-009	1.513-009	1.707-009
TH234	1.373-011	1.373-011	1.373-011	1.373-011
PA231	5.485-011	6.374-011	7.263-011	8.152-011
PA233	1.575-011	1.581-011	1.589-011	1.597-011
U232	1.468-009	1.489-009	1.490-009	1.480-009
U233	1.721-009	2.032-009	2.345-009	2.660-009
U234	1.513-005	1.773-005	2.029-005	2.281-005
U235	4.584-003	4.584-003	4.585-003	4.585-003
U236	3.327-003	3.328-003	3.328-003	3.329-003
U237	2.747-011	2.495-011	2.266-011	2.058-011
U238	9.454-001	9.454-001	9.454-001	9.454-001
NP235	8.553-015	2.382-015	6.633-016	1.847-016
NP236	4.549-010	4.549-010	4.549-010	4.549-010
NP237	4.637-004	4.656-004	4.678-004	4.702-004
NP238	1.374-013	1.361-013	1.349-013	1.337-013
NP239	1.337-010	1.337-010	1.336-010	1.336-010
PU236	1.298-010	7.983-011	4.909-011	3.019-011
PU238	1.688-004	1.661-004	1.635-004	1.610-004
PU239	5.118-003	5.118-003	5.118-003	5.118-003
PU240	2.555-003	2.557-003	2.559-003	2.561-003
PU241	8.872-004	8.058-004	7.318-004	6.646-004
PU242	6.690-004	6.690-004	6.690-004	6.690-004
PU244	5.380-008	5.380-008	5.380-008	5.380-008
AM241	5.772-004	6.566-004	7.284-004	7.931-004
AM242M	7.326-007	7.260-007	7.194-007	7.128-007
AM242	8.764-012	8.684-012	8.605-012	8.527-012
AM243	1.556-004	1.555-004	1.555-004	1.555-004
CM242	1.775-009	1.759-009	1.743-009	1.727-009
CM243	4.502-007	4.289-007	4.085-007	3.891-007
CM244	3.782-005	3.503-005	3.245-005	3.006-005
CM245	2.252-006	2.252-006	2.252-006	2.251-006
CM246	3.468-007	3.467-007	3.466-007	3.465-007
CM247	3.845-009	3.845-009	3.845-009	3.845-009
CM248	2.380-010	2.380-010	2.380-010	2.380-010
CF249	2.759-012	2.749-012	2.738-012	2.728-012
CF250	3.386-013	3.045-013	2.739-013	2.463-013
CF251	2.333-013	2.330-013	2.326-013	2.322-013
CF252	1.206-014	7.128-015	4.214-015	2.492-015
SF250	2.879-011	3.270-011	3.634-011	3.971-011
SUMTOT	9.640-001	9.640-001	9.640-001	9.640-001
TOTAL	9.640-001	9.640-001	9.640-001	9.640-001

TABLE E.6.b. Actinides (Elemental), g/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
HE	1.358-006	1.496-006	1.634-006	1.772-006
SF	2.879-011	3.270-011	3.634-011	3.971-011
PB	6.600-011	8.958-011	1.143-010	1.395-010
BI	2.190-015	2.368-015	2.486-015	2.569-015
RA	1.848-013	2.017-013	2.147-013	2.260-013
AC	6.249-015	8.255-015	1.049-014	1.295-014
TH	1.412-009	1.700-009	2.000-009	2.315-009
PA	7.059-011	7.955-011	8.852-011	9.749-011
U	9.534-001	9.534-001	9.534-001	9.534-001
NP	4.637-004	4.656-004	4.678-004	4.702-004
PU	9.398-003	9.316-003	9.241-003	9.173-003
AM	7.335-004	8.129-004	8.846-004	9.493-004
CM	4.088-005	3.807-005	3.546-005	3.305-005
CF	3.343-012	3.294-012	3.249-012	3.209-012
SUMTOT	9.640-001	9.640-001	9.640-001	9.640-001
TOTAL	9.640-001	9.640-001	9.640-001	9.640-001

TABLE E.6.c. Actinides (Isotopic), Ci/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL207	4.510-013	5.966-013	7.585-013	9.363-013
TL208	1.013-008	1.081-008	1.116-008	1.131-008
TL209	1.242-015	1.316-015	1.403-015	1.502-015
PB209	5.749-014	6.093-014	6.494-014	6.952-014
PB210	1.637-015	2.153-015	2.985-015	4.228-015
PB211	4.522-013	5.982-013	7.606-013	9.390-013
PB212	2.818-008	3.008-008	3.107-008	3.149-008
PB214	7.848-015	1.279-014	1.945-014	2.808-014
BI210	1.638-015	2.154-015	2.987-015	4.229-015
BI211	4.522-013	5.982-013	7.606-013	9.390-013
BI212	2.818-008	3.008-008	3.107-008	3.149-008
BI213	5.749-014	6.093-014	6.494-014	6.952-014
BI214	7.848-015	1.279-014	1.945-014	2.808-014
PO210	1.638-015	1.981-015	2.712-015	3.827-015
PO211	1.266-015	1.675-015	2.130-015	2.629-015
PO212	1.806-008	1.927-008	1.991-008	2.017-008
PO213	5.625-014	5.961-014	6.353-014	6.801-014
PO214	7.847-015	1.278-014	1.944-014	2.808-014
PO215	4.522-013	5.982-013	7.606-013	9.390-013
PO216	2.818-008	3.008-008	3.107-008	3.149-008
PO218	7.850-015	1.279-014	1.945-014	2.809-014
AT217	5.749-014	6.093-014	6.494-014	6.952-014
RN219	4.522-013	5.982-013	7.606-013	9.390-013
RN220	2.818-008	3.008-008	3.107-008	3.149-008
RN222	7.850-015	1.279-014	1.945-014	2.809-014
FR221	5.749-014	6.093-014	6.494-014	6.952-014
FR223	6.240-015	8.242-015	1.048-014	1.293-014
RA223	4.522-013	5.982-013	7.606-013	9.390-013
RA224	2.818-008	3.008-008	3.107-008	3.149-008
RA225	5.749-014	6.093-014	6.494-014	6.952-014
RA226	7.850-015	1.279-014	1.945-014	2.809-014
AC225	5.749-014	6.093-014	6.494-014	6.952-014
AC227	4.521-013	5.972-013	7.593-013	9.373-013
TH227	4.460-013	5.900-013	7.501-013	9.260-013
TH228	2.818-008	3.001-008	3.099-008	3.141-008
TH229	5.749-014	6.093-014	6.494-014	6.952-014
TH230	4.810-012	6.660-012	8.800-012	1.123-011
TH231	9.913-009	9.913-009	9.914-009	9.915-009
TH232	1.235-016	1.447-016	1.660-016	1.872-016
TH234	3.180-007	3.180-007	3.180-007	3.180-007
PA231	2.592-012	3.012-012	3.432-012	3.852-012
PA233	3.270-007	3.284-007	3.299-007	3.316-007
PA234M	3.180-007	3.180-007	3.180-007	3.180-007
PA234	4.134-010	4.134-010	4.134-010	4.134-010
U232	3.143-008	3.187-008	3.191-008	3.169-008
U233	1.666-011	1.968-011	2.271-011	2.576-011
U234	9.459-008	1.109-007	1.269-007	1.426-007
U235	9.913-009	9.913-009	9.914-009	9.915-009
U236	2.153-007	2.154-007	2.154-007	2.154-007
U237	2.243-006	2.037-006	1.850-006	1.680-006
U238	3.180-007	3.180-007	3.180-007	3.180-007
U240	9.533-013	9.533-013	9.533-013	9.533-013

TABLE E.6.c. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
NP235	1.200-011	3.343-012	9.309-013	2.592-013
NP236	5.995-012	5.995-012	5.995-012	5.995-012
NP237	3.270-007	3.284-007	3.299-007	3.316-007
NP238	3.562-008	3.529-008	3.497-008	3.465-008
NP239	3.102-005	3.102-005	3.101-005	3.101-005
NP240M	9.533-013	9.533-013	9.533-013	9.533-013
PU236	6.901-008	4.244-008	2.610-008	1.605-008
PU238	2.891-003	2.845-003	2.801-003	2.757-003
PU239	3.183-004	3.183-004	3.183-004	3.182-004
PU240	5.824-004	5.829-004	5.834-004	5.838-004
PU241	9.144-002	8.305-002	7.542-002	6.850-002
PU242	2.555-006	2.555-006	2.555-006	2.555-006
PU243	3.569-013	3.569-013	3.569-013	3.569-013
PU244	9.545-013	9.545-013	9.545-013	9.545-013
AM241	1.982-003	2.255-003	2.501-003	2.723-003
AM242M	7.123-006	7.058-006	6.994-006	6.931-006
AM242	7.087-006	7.023-006	6.959-006	6.896-006
AM243	3.102-005	3.102-005	3.101-005	3.101-005
CM242	5.872-006	5.819-006	5.766-006	5.713-006
CM243	2.325-005	2.215-005	2.110-005	2.009-005
CM244	3.061-003	2.836-003	2.627-003	2.433-003
CM245	3.869-007	3.868-007	3.868-007	3.867-007
CM246	1.066-007	1.066-007	1.065-007	1.065-007
CM247	3.569-013	3.569-013	3.569-013	3.569-013
CM248	1.012-012	1.012-012	1.012-012	1.012-012
BK249	1.509-012	3.102-013	6.375-014	1.310-014
CF249	1.131-011	1.127-011	1.122-011	1.118-011
CF250	3.703-011	3.330-011	2.995-011	2.694-011
CF251	3.702-013	3.696-013	3.690-013	3.685-013
CF252	6.486-012	3.835-012	2.267-012	1.341-012
SUMTOT	1.004-001	9.199-002	8.436-002	7.742-002
TOTAL	1.004-001	9.199-002	8.436-002	7.742-002

TABLE E.6.d. Actinides (Elemental), Ci/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
TL	1.C13-008	1.081-008	1.116-008	1.131-008
PB	2.E18-008	3.0C8-008	3.107-008	3.149-0C8
BI	2.E18-C08	3.0C8-0CE	3.107-008	3.149-0C8
PO	4.624-008	4.935-0CE	5.C97-008	5.166-008
AT	5.749-014	6.093-014	6.494-014	6.952-014
RN	2.E18-008	3.0C8-0CE	3.107-C08	3.149-0C8
FR	6.373-014	6.917-014	7.541-014	8.245-014
RA	2.E18-008	3.0C8-0CE	3.107-C08	3.149-008
AC	5.C97-013	6.582-013	8.243-C13	1.007-012
TH	3.561-007	3.579-0C7	3.589-CC7	3.593-0C7
PA	6.454-007	6.468-0C7	6.483-C07	6.500-0C7
U	2.912-006	2.723-0C6	2.552-006	2.398-006
NP	3.139-005	3.138-0C5	3.138-005	3.137-005
PU	9.523-002	8.679-0C2	7.913-C02	7.216-0C2
AM	2.C27-003	2.3CC-0C3	2.546-C03	2.768-0C3
CM	3.C91-003	2.864-003	2.654-C03	2.459-0C3
BK	1.509-012	3.1C2-013	6.375-014	1.31C-014
CF	5.519-011	4.877-011	4.381-C11	3.983-011
SUMTOT	1.C04-001	9.199-0C2	8.436-002	7.742-002
TOTAL	1.C04-001	9.199-0C2	8.436-002	7.742-0C2

TABLE E.6.e. Fission Products (Isotopic), g/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	3.626-008	3.241-008	2.897-008	2.589-008
LI 6	1.587-010	1.587-010	1.587-010	1.587-010
LI 7	1.069-011	1.069-011	1.069-011	1.069-011
BE 9	2.056-011	2.056-011	2.056-011	2.056-011
BE 10	1.373-010	1.373-010	1.373-010	1.373-010
C 14	2.773-011	2.772-011	2.771-011	2.771-011
ZN 66	3.416-014	3.416-014	3.416-014	3.416-014
ZN 67	1.396-015	1.396-015	1.396-015	1.396-015
GA 71	1.001-012	1.001-012	1.001-012	1.001-012
GE 72	2.549-008	2.549-008	2.549-008	2.549-008
GE 73	5.004-008	5.004-008	5.004-008	5.004-008
GE 74	1.066-007	1.066-007	1.066-007	1.066-007
AS 75	2.147-007	2.147-007	2.147-007	2.147-007
GE 76	5.163-007	5.163-007	5.163-007	5.163-007
SE 76	6.949-009	6.949-009	6.949-009	6.949-009
SE 77	1.038-006	1.038-006	1.038-006	1.038-006
SE 78	2.552-006	2.552-006	2.552-006	2.552-006
SE 79	6.091-006	6.091-006	6.091-006	6.091-006
BR 79	7.442-010	8.742-010	1.004-009	1.134-009
SE 80	1.371-005	1.371-005	1.371-005	1.371-005
KR 80	2.724-010	2.724-010	2.724-010	2.724-010
BR 81	2.191-005	2.191-005	2.191-005	2.191-005
KR 81	3.092-011	3.092-011	3.092-011	3.092-011
SE 82	3.378-005	3.378-005	3.378-005	3.378-005
KR 82	1.188-006	1.188-006	1.188-006	1.188-006
KR 83	3.860-005	3.860-005	3.860-005	3.860-005
KR 84	1.143-004	1.143-004	1.143-004	1.143-004
KR 85	1.228-005	1.079-005	9.484-006	8.334-006
RB 85	1.062-004	1.077-004	1.090-004	1.102-004
KR 86	1.840-004	1.840-004	1.840-004	1.840-004
SR 86	4.832-007	4.832-007	4.832-007	4.832-007
RB 87	2.354-004	2.354-004	2.354-004	2.354-004
SR 87	4.277-009	4.277-009	4.277-009	4.277-009
SR 88	3.372-004	3.372-004	3.372-004	3.372-004
Y 89	4.380-004	4.380-004	4.380-004	4.380-004
SR 90	4.050-004	3.862-004	3.682-004	3.511-004
Y 90	1.016-007	9.684-008	9.233-008	8.804-008
ZR 90	1.280-004	1.468-004	1.648-004	1.819-004
ZR 91	5.740-004	5.740-004	5.740-004	5.740-004
ZR 92	6.314-004	6.314-004	6.314-004	6.314-004
ZR 93	7.181-004	7.181-004	7.181-004	7.181-004
NB 93	1.056-009	1.378-009	1.732-009	2.114-009
NB 93M	2.674-009	3.003-009	3.300-009	3.568-009
ZR 94	7.519-004	7.519-004	7.519-004	7.519-004
NB 94	9.359-010	9.358-010	9.357-010	9.357-010
MO 95	7.682-004	7.682-004	7.682-004	7.682-004
ZR 96	8.233-004	8.233-004	8.233-004	8.233-004
MO 96	4.150-005	4.150-005	4.150-005	4.150-005
MO 97	8.257-004	8.257-004	8.257-004	8.257-004
MO 98	8.697-004	8.697-004	8.697-004	8.697-004
TC 98	7.961-009	7.961-009	7.961-009	7.961-009
TC 99	7.970-004	7.970-004	7.970-004	7.970-004

TABLE E.6.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
RU 99	2.529-008	3.448-008	3.967-008	4.486-008
MO100	9.868-004	9.868-004	9.868-004	9.868-004
RU100	1.201-004	1.201-004	1.201-004	1.201-004
RU101	8.238-004	8.238-004	8.238-004	8.238-004
RU102	8.512-004	8.512-004	8.512-004	8.512-004
RH102	1.216-010	7.536-011	4.673-011	2.897-011
RH103	4.944-004	4.944-004	4.944-004	4.944-004
RU104	6.426-004	6.426-004	6.426-004	6.426-004
PD104	2.854-004	2.854-004	2.854-004	2.854-004
PD105	4.525-004	4.525-004	4.525-004	4.525-004
RU106	2.198-007	5.555-008	1.404-008	3.549-009
RH106	2.066-013	5.221-014	1.320-014	3.336-015
PD106	4.695-004	4.697-004	4.697-004	4.698-004
PD107	2.841-004	2.841-004	2.841-004	2.841-004
AG107	3.328-010	3.934-010	4.540-010	5.146-010
PD108	1.974-004	1.974-004	1.974-004	1.974-004
AG108M	1.403-012	1.388-012	1.373-012	1.358-012
CD108	6.221-010	6.221-010	6.221-010	6.221-010
AG109	9.588-005	9.588-005	9.588-005	9.588-005
CD109	3.642-015	1.223-015	4.107-016	1.379-016
PD110	6.474-005	6.474-005	6.474-005	6.474-005
AG110M	5.432-011	7.161-012	9.439-013	1.244-013
CD110	5.263-005	5.263-005	5.263-005	5.263-005
CD111	3.573-005	3.573-005	3.573-005	3.573-005
CD112	2.103-005	2.103-005	2.103-005	2.103-005
CD113	1.571-007	1.571-007	1.571-007	1.571-007
CD113M	2.103-007	1.913-007	1.739-007	1.582-007
IN113	1.430-007	1.620-007	1.793-007	1.951-007
CD114	2.727-005	2.727-005	2.727-005	2.727-005
SN114	1.753-009	1.753-009	1.753-009	1.753-009
IN115	2.437-006	2.437-006	2.437-006	2.437-006
SN115	3.780-007	3.780-007	3.780-007	3.780-007
CD116	9.663-006	9.663-006	9.663-006	9.663-006
SN116	9.156-006	9.156-006	9.156-006	9.156-006
SN117	9.754-006	9.754-006	9.754-006	9.754-006
SN118	9.823-006	9.823-006	9.823-006	9.823-006
SN119	9.801-006	9.801-006	9.801-006	9.801-006
SN119M	2.128-012	2.695-013	3.412-014	4.321-015
SN120	9.976-006	9.976-006	9.976-006	9.976-006
SN121M	3.628-009	3.529-009	3.432-009	3.339-009
SB121	9.569-006	9.569-006	9.570-006	9.570-006
SN122	1.094-005	1.094-005	1.094-005	1.094-005
TE122	7.700-007	7.700-007	7.700-007	7.700-007
SN123	1.591-015	3.157-017	6.263-019	1.242-020
SB123	1.181-005	1.181-005	1.181-005	1.181-005
TE123	1.196-008	1.196-008	1.196-008	1.196-008
SN124	1.465-005	1.465-005	1.465-005	1.465-005
TE124	5.842-007	5.842-007	5.842-007	5.842-007
SB125	1.383-006	8.383-007	5.082-007	3.081-007
TE125	2.095-005	2.150-005	2.183-005	2.204-005
TE125M	1.934-008	1.173-008	7.110-009	4.310-009
SN126	3.198-005	3.198-005	3.197-005	3.197-005

TABLE E.6.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
SB126	1.519-012	1.519-012	1.519-012	1.519-012
SB126M	1.155-014	1.155-014	1.155-014	1.155-014
TE126	9.383-007	9.388-007	9.392-007	9.397-007
TE127M	1.503-016	1.444-018	1.388-020	1.401-022
I127	6.435-005	6.435-005	6.435-005	6.435-005
TE128	1.245-004	1.245-004	1.245-004	1.245-004
XE128	4.154-006	4.154-006	4.154-006	4.154-006
I129	1.987-004	1.987-004	1.987-004	1.987-004
XE129	2.735-008	2.736-008	2.738-008	2.740-008
TE130	3.906-004	3.906-004	3.906-004	3.906-004
XE130	1.631-005	1.631-005	1.631-005	1.631-005
XE131	4.358-004	4.358-004	4.358-004	4.358-004
XE132	1.196-003	1.196-003	1.196-003	1.196-003
BA132	2.359-009	2.359-009	2.359-009	2.359-009
CS133	1.158-003	1.158-003	1.158-003	1.158-003
XE134	1.548-003	1.548-003	1.548-003	1.548-003
CS134	4.989-006	2.547-006	1.300-006	6.638-007
BA134	1.844-004	1.868-004	1.881-004	1.887-004
CS135	2.991-004	2.991-004	2.991-004	2.991-004
BA135	3.530-007	3.532-007	3.533-007	3.535-007
XE136	2.525-003	2.525-003	2.525-003	2.525-003
BA136	2.121-005	2.121-005	2.121-005	2.121-005
CS137	1.008-003	9.622-004	9.188-004	8.773-004
BA137	3.003-004	3.458-004	3.892-004	4.307-004
BA137M	1.542-010	1.472-010	1.406-010	1.342-010
BA138	1.326-003	1.326-003	1.326-003	1.326-003
LA138	4.840-009	4.840-009	4.840-009	4.840-009
LA139	1.265-003	1.265-003	1.265-003	1.265-003
CE140	1.297-003	1.297-003	1.297-003	1.297-003
PR141	1.157-003	1.157-003	1.157-003	1.157-003
CE142	1.167-003	1.167-003	1.167-003	1.167-003
ND142	3.234-005	3.234-005	3.234-005	3.234-005
ND143	7.488-004	7.488-004	7.488-004	7.488-004
CE144	5.154-008	8.680-009	1.462-009	2.462-010
PR144	2.176-012	3.665-013	6.173-014	1.040-014
PR144M	1.088-014	1.832-015	3.086-016	5.197-017
ND144	1.410-003	1.410-003	1.410-003	1.410-003
ND145	6.781-004	6.781-004	6.781-004	6.781-004
ND146	7.306-004	7.306-004	7.306-004	7.306-004
PM146	2.410-009	1.873-009	1.456-009	1.132-009
SM146	7.889-009	8.088-009	8.242-009	8.362-009
PM147	9.581-006	5.649-006	3.330-006	1.963-006
SM147	1.772-004	1.811-004	1.835-004	1.848-004
ND148	3.924-004	3.924-004	3.924-004	3.924-004
SM148	1.860-004	1.860-004	1.860-004	1.860-004
SM149	2.709-006	2.709-006	2.709-006	2.709-006
ND150	1.960-004	1.960-004	1.960-004	1.960-004
SM150	2.687-004	2.687-004	2.687-004	2.687-004
EU150	1.588-013	1.528-013	1.470-013	1.415-013
SM151	1.157-005	1.140-005	1.122-005	1.105-005
EU151	9.335-007	1.110-006	1.285-006	1.456-006
SM152	1.336-004	1.336-004	1.336-004	1.336-004

TABLE E.6.e. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	1.587-008	1.433-008	1.294-008	1.169-008
GD152	1.186-008	1.229-008	1.268-008	1.303-008
EU153	1.209-004	1.209-004	1.209-004	1.209-004
GD153	3.645-013	4.746-014	5.857-015	7.228-016
SM154	4.514-005	4.514-005	4.514-005	4.514-005
EU154	2.135-005	1.817-005	1.547-005	1.317-005
GD154	2.960-005	3.278-005	3.548-005	3.779-005
EU155	4.268-006	3.227-006	2.440-006	1.845-006
GD155	1.308-005	1.412-005	1.491-005	1.550-005
GD156	9.044-005	9.044-005	9.044-005	9.044-005
GD157	1.302-007	1.302-007	1.302-007	1.302-007
GD158	2.551-005	2.551-005	2.551-005	2.551-005
TB159	3.405-006	3.405-006	3.405-006	3.405-006
GD160	1.655-006	1.655-006	1.655-006	1.655-006
DY160	4.141-007	4.141-007	4.141-007	4.141-007
DY161	5.330-007	5.330-007	5.330-007	5.330-007
DY162	4.826-007	4.826-007	4.826-007	4.826-007
DY163	4.118-007	4.118-007	4.118-007	4.118-007
DY164	5.922-008	5.922-008	5.922-008	5.922-008
HO165	2.190-007	2.190-007	2.190-007	2.190-007
HO166M	2.607-009	2.604-009	2.601-009	2.598-009
ER166	7.386-008	7.386-008	7.387-008	7.387-008
ER167	4.039-009	4.039-009	4.039-009	4.039-009
ER168	1.230-008	1.230-008	1.230-008	1.230-008
TM169	9.645-011	9.645-011	9.645-011	9.645-011
ER170	5.333-014	5.333-014	5.333-014	5.333-014
YB170	3.568-011	3.568-011	3.568-011	3.568-011
TM171	5.368-014	2.607-014	1.267-014	6.153-015
YB171	3.089-012	3.117-012	3.130-012	3.137-012
YB172	1.089-013	1.089-013	1.089-013	1.089-013
SUMTOT	3.598-002	3.598-002	3.598-002	3.598-002
TOTAL	3.598-002	3.598-002	3.598-002	3.598-002

TABLE E.6.f. Fission Products (Elemental), g/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	3.626-008	3.241-008	2.897-008	2.589-008
LI	1.694-010	1.694-010	1.694-010	1.694-010
BE	1.579-010	1.579-010	1.579-010	1.579-010
C	2.773-011	2.772-011	2.771-011	2.771-011
ZN	3.559-014	3.559-014	3.559-014	3.559-014
GA	1.001-012	1.001-012	1.001-012	1.001-012
GE	6.985-007	6.985-007	6.985-007	6.985-007
AS	2.147-007	2.147-007	2.147-007	2.147-007
SE	5.718-005	5.718-005	5.718-005	5.718-005
BR	2.191-005	2.191-005	2.191-005	2.191-005
KR	3.503-004	3.488-004	3.475-004	3.464-004
RB	3.416-004	3.431-004	3.444-004	3.456-004
SR	7.426-004	7.238-004	7.058-004	6.887-004
Y	4.381-004	4.381-004	4.381-004	4.381-004
ZR	3.627-003	3.646-003	3.664-003	3.681-003
NB	4.666-009	5.317-009	5.967-009	6.618-009
MO	3.492-003	3.492-003	3.492-003	3.492-003
TC	7.970-004	7.970-004	7.970-004	7.970-004
RU	2.438-003	2.438-003	2.438-003	2.438-003
RH	4.944-004	4.944-004	4.944-004	4.944-004
PD	1.754-003	1.754-003	1.754-003	1.754-003
AG	9.588-005	9.588-005	9.588-005	9.588-005
CD	1.467-004	1.467-004	1.467-004	1.466-004
IN	2.580-006	2.599-006	2.616-006	2.632-006
SN	1.065-004	1.065-004	1.065-004	1.065-004
SB	2.276-005	2.222-005	2.189-005	2.169-005
TE	5.383-004	5.389-004	5.392-004	5.394-004
I	2.631-004	2.631-004	2.631-004	2.631-004
XE	5.725-003	5.725-003	5.725-003	5.725-003
CS	2.470-003	2.422-003	2.377-003	2.335-003
BA	1.832-003	1.880-003	1.925-003	1.967-003
LA	1.265-003	1.265-003	1.265-003	1.265-003
CE	2.465-003	2.465-003	2.465-003	2.465-003
PR	1.157-003	1.157-003	1.157-003	1.157-003
ND	4.188-003	4.188-003	4.188-003	4.188-003
PM	9.584-006	5.650-006	3.331-006	1.964-006
SM	8.249-004	8.286-004	8.308-004	8.319-004
EU	1.475-004	1.434-004	1.401-004	1.374-004
GD	1.604-004	1.646-004	1.681-004	1.710-004
TB	3.405-006	3.405-006	3.405-006	3.405-006
DY	1.901-006	1.901-006	1.901-006	1.901-006
HO	2.216-007	2.216-007	2.216-007	2.216-007
ER	9.020-008	9.021-008	9.021-008	9.021-008
TM	9.651-011	9.648-011	9.647-011	9.646-011
YB	3.888-011	3.891-011	3.892-011	3.893-011
SUMTOT	3.598-002	3.598-002	3.598-002	3.598-002
TOTAL	3.598-002	3.598-002	3.598-002	3.598-002

TABLE E.6.g. Fission Products (Isotopic), Ci/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H 3	3.501-004	3.129-004	2.797-004	2.500-004
BE 10	3.069-012	3.069-012	3.069-012	3.069-012
C 14	1.236-010	1.236-010	1.236-010	1.235-010
SE 79	4.245-007	4.245-007	4.245-007	4.245-007
KR 81	6.505-013	6.505-013	6.505-013	6.505-013
KR 85	4.821-003	4.237-003	3.723-003	3.271-003
RB 87	2.061-011	2.061-011	2.061-011	2.061-011
SR 90	5.526-002	5.269-002	5.024-002	4.791-002
Y 90	5.528-002	5.271-002	5.026-002	4.792-002
ZR 93	1.805-006	1.805-006	1.805-006	1.805-006
NB 93M	7.562-007	8.491-007	9.330-007	1.009-006
NB 94	1.754-010	1.754-010	1.754-010	1.754-010
TC 98	6.920-012	6.920-012	6.920-012	6.920-012
TC 99	1.352-005	1.352-005	1.352-005	1.352-005
RH102	1.470-007	9.112-008	5.650-008	3.503-008
RU106	7.356-004	1.859-004	4.700-005	1.188-005
RH106	7.356-004	1.859-004	4.700-005	1.188-005
PD107	1.462-007	1.462-007	1.462-007	1.462-007
AG108	3.256-012	3.220-012	3.185-012	3.151-012
AG108M	3.658-011	3.618-011	3.579-011	3.540-011
AG109M	9.407-012	3.159-012	1.061-012	3.562-013
CD109	9.407-012	3.159-012	1.061-012	3.562-013
AG110	3.434-009	4.526-010	5.966-011	7.865-012
AG110M	2.582-007	3.403-008	4.486-009	5.913-010
CD113M	4.563-005	4.149-005	3.773-005	3.431-005
SN119M	9.534-009	1.207-009	1.529-010	1.936-011
SN121M	2.146-007	2.087-007	2.030-007	1.975-007
SN123	1.308-011	2.596-013	5.150-015	1.021-016
TE123M	1.597-014	2.323-016	3.400-018	1.076-019
SB125	1.428-003	8.659-004	5.249-004	3.182-004
TE125M	3.485-004	2.113-004	1.281-004	7.767-005
SN126	9.075-007	9.075-007	9.075-007	9.075-007
SB126	1.271-007	1.271-007	1.271-007	1.271-007
SB126M	9.075-007	9.075-007	9.075-007	9.075-007
TE127	1.389-012	1.335-014	1.283-016	1.294-018
TE127M	1.418-012	1.363-014	1.309-016	1.322-018
I129	3.509-008	3.509-008	3.509-008	3.509-008
CS134	6.458-003	3.297-003	1.683-003	8.593-004
CS135	3.445-007	3.445-007	3.445-007	3.445-007
CS137	8.770-002	8.374-002	7.995-002	7.634-002
BA137M	8.296-002	7.921-002	7.564-002	7.222-002
CE142	2.802-011	2.802-011	2.802-011	2.802-011
CE144	1.645-004	2.770-005	4.666-006	7.858-007
PR144	1.645-004	2.770-005	4.666-006	7.858-007
PR144M	1.974-006	3.324-007	5.599-008	9.430-009
ND144	1.668-015	1.668-015	1.668-015	1.668-015
PM146	1.073-006	8.343-007	6.484-007	5.040-007
SM146	2.761-013	2.830-013	2.884-013	2.926-013
PM147	8.886-003	5.238-003	3.088-003	1.821-003
SM147	4.029-012	4.118-012	4.171-012	4.202-012
EU150	1.052-011	1.012-011	9.739-012	9.371-012
SM151	3.046-004	2.999-004	2.953-004	2.908-004

TABLE E.6.g. (Contd)

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
EU152	2.745-006	2.479-006	2.239-006	2.022-006
GD153	1.357-009	1.674-010	2.066-011	2.550-012
EU154	5.766-003	4.968-003	4.177-003	3.555-003
EU155	1.586-003	1.501-003	1.135-003	8.584-004
HO166M	4.681-009	4.676-009	4.671-009	4.665-009
TM171	5.847-011	2.840-011	1.380-011	6.702-012
SUMTOT	3.134-001	2.897-001	2.713-001	2.558-001
TOTAL	3.134-001	2.897-001	2.713-001	2.558-001

TABLE E.6.h. Fission Products (Elemental), Ci/gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
H	3.501-004	3.129-004	2.797-004	2.500-004
BE	3.069-012	3.069-012	3.069-012	3.069-012
C	1.236-010	1.236-010	1.236-010	1.235-010
SE	4.245-007	4.245-007	4.245-007	4.245-007
KR	4.821-003	4.237-003	3.723-003	3.271-003
RB	2.061-011	2.061-011	2.061-011	2.061-011
SR	5.526-002	5.269-002	5.024-002	4.791-002
Y	5.528-002	5.271-002	5.026-002	4.792-002
ZR	1.805-006	1.805-006	1.805-006	1.805-006
NB	7.564-007	8.493-007	9.332-007	1.009-006
TC	1.352-005	1.352-005	1.352-005	1.352-005
RU	7.356-004	1.859-004	4.700-005	1.188-005
RH	7.358-004	1.860-004	4.706-005	1.191-005
PD	1.462-007	1.462-007	1.462-007	1.462-007
AG	2.616-007	3.453-008	4.586-009	6.381-010
CD	4.563-005	4.149-005	3.773-005	3.431-005
SN	1.132-006	1.117-006	1.111-006	1.105-006
SB	1.429-003	8.670-004	5.260-004	3.193-004
TE	3.485-004	2.113-004	1.281-004	7.767-005
I	3.509-008	3.509-008	3.509-008	3.509-008
CS	9.415-002	8.703-002	8.164-002	7.720-002
BA	8.296-002	7.921-002	7.564-002	7.222-002
CE	1.645-004	2.770-005	4.666-006	7.858-007
PR	1.665-004	2.803-005	4.722-006	7.952-007
ND	1.668-015	1.668-015	1.668-015	1.668-015
PM	8.887-003	5.239-003	3.089-003	1.821-003
SM	3.046-004	2.999-004	2.953-004	2.908-004
EU	7.754-003	6.412-003	5.315-003	4.416-003
GD	1.357-009	1.674-010	2.066-011	2.550-012
HO	4.681-009	4.676-009	4.671-009	4.665-009
TM	5.847-011	2.840-011	1.380-011	6.702-012
SUMTOT	3.134-001	2.897-001	2.713-001	2.558-001
TOTAL	3.134-001	2.897-001	2.713-001	2.558-001

TABLE E.6.i. Neutron Source (Alpha-n), neutrons/sec-gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	2.750+000	2.707+000	2.665+000	2.623+000
PU239	2.318-001	2.318-001	2.318-001	2.318-001
PU240	4.413-001	4.417-001	4.420-001	4.423-001
AM241	1.901+000	2.162+000	2.399+000	2.612+000
AM243	2.647-002	2.646-002	2.646-002	2.645-002
CM243	3.096-002	2.949-002	2.809-002	2.675-002
CM244	3.493+000	3.236+000	2.997+000	2.776+000

TABLE E.6.j. Neutron Source (Spontaneous fission), neutrons/sec-gU, at 35 MWd/kgM

	10 YEARS	12 YEARS	14 YEARS	16 YEARS
PU238	4.485-001	4.415-001	4.346-001	4.278-001
PU240	2.326+000	2.328+000	2.330+000	2.332+000
PU242	1.128+000	1.128+000	1.128+000	1.128+000
CM244	4.206+002	3.896+002	3.609+002	3.343+002
CM246	3.087+000	3.086+000	3.085+000	3.084+000

APPENDIX F

RADIOISOTOPES DETERMINED DURING BURNUP ANALYSES

TABLE F.1. Radioisotopes Determined During Burnup Analyses

Isotope	N-9C-D	N-9C-J	N-9B-D	N-9B-N	N-9B-S
Uranium					
U, g/g oxide	0.8497	0.8430			
^{234}U, wt.%	0.013	0.014			
^{235}U, wt.%	0.572	0.733			
^{236}U, wt.%	0.353	0.335			
^{238}U, wt.%	99.063	98.919			
Plutonium					
Pu, g/g oxide	0.00767	0.00773			
^{238}Pu, wt.%	1.700	1.475			
^{239}Pu, wt.%	54.760	58.869			
^{240}Pu, wt.%	27.625	25.500			
^{241}Pu, wt.%	9.019	8.818			
^{242}Pu, wt.%	6.897	5.339			
Neodymium					
Nd, $\frac{\text{atoms} \times 10^{15}}{\text{g oxide}}$	1.184	1.109			
$^{143}Nd/^{148}Nd$	2.055	2.208			
$^{144}Nd/^{148}Nd$	3.619	3.497			
$^{145}Nd/^{148}Nd$	1.811	1.841			
$^{146}Nd/^{148}Nd$	1.843	1.829			
$^{150}Nd/^{148}Nd$	0.487	0.485			

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