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MCC
Materials Characterization Center

Characterization of Spent Fuel Approved Testing Material—ATM-103

April 1988

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

Pacific Northwest Laboratory
Operated for the U.S. Department of Energy
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CHARACTERIZATION OF SPENT FUEL APPROVED TESTING MATERIAL--ATM-103

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ABSTRACT

The characterization data obtained to date are described for Approved Testing Material (ATM)-103, which is spent fuel from Assembly D101 of pressurized-water reactor Calvert Cliffs, No. 1. This report is one in a series being written by the Materials Characterization Center (MCC) at Pacific Northwest Laboratory (PNL)[a] on spent fuel ATMs. The ATMs are receiving extensive examinations to provide a source of well-characterized spent fuel for testing in the U.S. nuclear waste repository program. ATM-103 consists of 176 full-length irradiated fuel rods with rod-average burnups of about 2600 GJ/kgM (30 MWd/kgM) and less than 1% fission gas release. Characterization data include 1) as-fabricated fuel design, irradiation history, and subsequent storage and handling; 2) isotopic gamma scans; 3) fission gas analyses; 4) ceramography of the fuel and metallography of the cladding; 5) special fuels studies involving analytical transmission electron microscopy (AEM); 6) calculated nuclide inventories and radioactivities in the fuel and cladding; and 7) radiochemical analyses of the fuel and cladding. Additional analyses of the fuel are being conducted and will be included in planned revisions of this report.

(a) Operated for the U.S. Department of Energy by Battelle Memorial Institute under Contract DE-AC06-76RLO 1830.

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The editorial assistance of D. K. Hilliard is sincerely appreciated.

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1.0 INTRODUCTION

The Materials Characterization Center (MCC) at Pacific Northwest Laboratory (PNL) has the responsibility to provide spent fuel Approved Testing Materials (ATMs) for use in the investigation of nuclear waste disposal forms by the U.S. Department of Energy (DOE) geologic repository project. This MCC reference report describes the characterization of ATM-103, the second in a series of spent fuel ATMs that are being characterized. The first of this series, ATM-101, was reported by Barner (1985). General descriptions of the five present spent fuel ATMs being characterized by the MCC are provided in Table 1.1. Additional ATMs, such as spent fuel with stainless steel cladding or burnable poisons, are being considered for future characterization.

ATM-103 is a moderate-burnup fuel, averaging about 2600 GJ/kgM (30 MWd/kgM), that was expected to have had only minor fission gas release from the UO_2 fuel during irradiation. It was fabricated by Combustion Engineering (C-E) and irradiated in the Calvert Cliffs Nuclear Reactor No. 1 (CC-1), which is a pressurized-water reactor (PWR) operated by Baltimore Gas and Electric in Maryland.

The 176 full-length fuel rods from Assembly D101 constitute ATM-103. This material is similar to ATM-101 in burnup and expected fission gas release, providing for useful comparisons of as-irradiated fuel characteristics. Subsequent characterization of ATM-104 (high burnup, low fission gas release) and ATM-106 (high burnup, high fission gas release) will also provide additional beneficial information to experimenters who use these materials to determine the release behavior of radionuclides contained in the fuel and exposed to potential repository environments. ATM-105 (moderate burnup, low fission gas release) will provide characterization data for boiling-water reactor (BWR) spent fuel and will eventually be compared with the characterization data obtained from the PWR spent fuel in ATM-101, -103, -104, and -106. All of these spent fuel ATMs were selected to represent the typical range of end-of-life (EOL) fuel conditions, including potential extremes in EOL spent fuel conditions, from U.S. commercial nuclear reactors. The moderate burnup and low fission gas release of ATM-103 are representative of typical spent fuel

TABLE 1.1. Summary of Spent Fuel ATMs Being Characterized by the MCC

ATM	Fuel Type	Reactor	Expected Burnup Level	Expected Fission Gas Release, %	No. of Rods
101	PWR	H. B. Robinson, No. 1	Moderate, 2600 GJ/kgM (~30 MWd/kgM)	<1	9 as 27 1.2-m (4-ft) segments
103	PWR	Calvert Cliffs, No. 1	Moderate, 2600 GJ/kgM (~30 MWd/kgM)	<1	176 full length
104	PWR	Calvert Cliffs, No. 1	High, 3715 GJ/kgM (~43 MWd/kgM)	<1	128 full length
105	BWR	Cooper	Moderate, 2400 GJ/kgM (~28MWd/kgM)	<1	98 full length
106	PWR	Calvert Cliffs, No. 1	High, 3700 GJ/kgM (~43 MWd/kgM)	~10	20 full length

currently being discharged from PWR reactors operating in the U.S. Portions of the characterized fuel rods have been made available to the repository projects for spent fuel testing. Substantial quantities of ATM-103 will also be available for further distribution to experimenters.

The characterizations of ATM-103 spent fuel are based on a general characterization plan described by Barner (1984) and the specific characterization plan described in Section 3.0. All of the characterizations have been conducted at the Hanford Reservation in Richland, Washington. The present report describes the completed characterization of Rod MLA098 from ATM-103. Additional characterization data for Rod MLA098 and characterization data from two additional fuel rods from ATM-103 will be included in subsequent revisions of this report.

2.0 CONCLUSIONS

As a result of the analyses completed to date, Rod MLA098 from ATM-103 has been determined to have moderate burnup and low fission gas release from the UO_2 fuel. Excellent agreement between the ^{137}Cs and ^{134}Cs isotopic gamma scan data for two ATM-103 fuel rods (MLA089 and MLA098) indicates that the two rods probably have similar characteristics. Gamma scanning and fission gas sampling will be performed on many additional ATM-103 rods. Detailed characterization of two other fuel rods from ATM-103 will be conducted to provide assurance that all of the 176 fuel rods in ATM-103 have moderate burnup and low fission gas release and may be considered representative of typical of this type of spent fuel that might be deposited in a repository. Additional information obtained during characterization of Rod MLA098 is summarized below.

- Analyses of the gas sampled from Rod MLA098 indicated that about 0.25% of the fission gas was released from the fuel. This low fission gas release compares well with the axial gamma scan along the fuel rod. The gamma scan did not indicate any significant ^{137}Cs movement. The regular decrease in ^{137}Cs at intervals equivalent to the length of a fuel pellet was also indicative of a lack of fission product movement. The beta/gamma autoradiographs of both transverse and longitudinal ceramographic samples also indicated that the fission products had not migrated to any noticeable extent. These results are consistent with the expected fission gas release for fuel operated at moderate powers to moderate burnup.
- Ceramography of fuel samples from the peak-power and low-power regions of Rod MLA098 indicated that the fuel did not experience any noticeable grain growth or fission gas bubble formation. The as-fabricated grains were about 17 to 20 μm.
- Limited examination of the cladding oxide layers indicated a uniform layer of about 8 μm on the exterior surface near the middle of the fuel rod and 3 to 4 μm near the bottom of the rod. The oxide on the exterior cladding surface appeared to be composed of two layers of approximately equal thickness; the layer next to the cladding adhered

and the other layer was separated from the inner layer. At the same axial location along the rod, the interior surface of the Zircaloy-4 cladding exhibited localized reaction areas where as much as 6 μm of the original surface was removed, leaving islands of reaction products on the interior surface of the peak-power sample. There was negligible oxidation/reaction of the cladding interior surface for the two samples examined from near the bottom of the rod.

- Analytical transmission electron microscopy (AEM) was conducted on fuel taken from the outer edge, mid-radius, and center of a sample from the peak-power region of Rod 103-MLA098. These examinations revealed fission product particles and bubbles that were too small to observe by ceramography. Near the edge of the fuel pellet, high densities of coprecipitated particles and gas bubbles were present along grain boundaries and within the UO_2 grains. Energy dispersive X-ray spectrometry (EDS) and electron diffraction analysis identified the predominanat solid phase as ε-ruthenium, also called five-metal particles or fission product metallic ingots, a solid-solution alloy consisting of molybdenum, ruthenium, technetium, palladium, and rhodium. Few gas bubbles were found near the mid-radius and center of the fuel pellet, but the 50 to 100-nm diameter ε-ruthenium particles contained within the UO_2 grains in these regions were associated with high concentrations of xenon and krypton. The AEM examinations of fuel from Rod MLA098 indicate that highly pressurized fission gas aggregates, containing predominantly xenon, form in association with ε-ruthenium particles located in the mid-radius to center region of the fuel pellet. Molybdenum, ruthenium, technetium, palladium, rhodium, xenon and krypton were the only fission products sufficiently concentrated to be detected by EDS. The existence of fission gases under high pressure in UO_2 fuel may be important to evaluations of fission gas release during fuel operating or storage conditions.
- Measured fuel burnup at three locations in Rod MLA098 allowed the development of a preliminary linear correlation between measured

burnup and ^{137}Cs activity. This correlation will be used to estimate the burnup in fuel from sibling ATM-103 fuel rods that will not be analyzed for burnup. Additional burnup and ^{137}Cs data will be obtained to determine the accuracy of this relationship.

- Radiochemical analyses of three fuel samples from different locations in Rod MLA098 yielded results for ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{237}Np, ^{241}Am, ^{243}Cm and ^{244}Cm, ^{90}Sr, ^{99}Tc, ^{135}Cs, and ^{137}Cs that agreed within about ±12% of the values predicted by ORIGEN2. However, the measured values for ^{79}Se and ^{126}Sn were only about 16% and 23%, respectively, of the values predicted by ORIGEN2. A similar difference between the measured and predicted values was observed for analyses of ATM-101 fuel, which suggests that ORIGEN2 overpredicts for these isotopes. The amount of ^{129}I measured in three fuel samples ranged from 10 to 17% higher than the predicted values, while the amount of ^{14}C measured in five fuel samples ranged from 12 to 24% higher than the predicted values. These differences will be investigated further when analytical results become available from other examinations, such as spark source mass spectrometry.

- Analyses of the cladding were conducted to determine the amount of ^{135}Cs and ^{137}Cs on the interior and exterior surfaces, the ^{129}I on the interior surface, and ^{14}C in the cladding. The ^{135}Cs and ^{137}Cs concentrations were relatively constant along the exterior surface of the cladding, and levels generally followed the power/burnup profile of the rod on the interior cladding surface. The ^{129}I level on the interior surface also followed the power profile of the fuel, decreasing in level at both ends of the fuel, rather than following the temperature profile in the cladding which increases from bottom to top. The measured ^{14}C in the cladding ranged from 10% to 150% of that predicted by ORIGEN2, possibly a result of measurement uncertainties or uncertainties for the nitrogen content assumed for the cladding at the start of irradiation.

3.0 CHARACTERIZATION PLAN FOR ATM-103

The logic for a generic characterization plan for MCC spent fuel ATMs was described and an example was presented by Barner (1984). The goals of the MCC's characterization of spent fuel ATMs are twofold: 1) document spent fuel characteristics for use in safety and performance assessments being conducted on spent fuel disposal under geologic repository conditions, and 2) evaluate how representative these spent fuel ATMs are of the larger population of spent fuel that will ultimately be disposed of in a geologic repository. Meeting those goals requires that the fuel, cladding, and assembly hardware be characterized.

The types of analyses currently planned for all spent fuel ATMs, the typical number of samples involved, and the general location of the samples are shown in Figure 3.1. The first column in Figure 3.1 is a key showing which section(s) of this report contains the results of the various analyses. (Some of the analyses have not been completed and will be included in subsequent revisions of this characterization report.)

Characterizations planned for the fuel rods will consist of standard or detailed examinations. The standard examinations include gamma scanning and analysis of the gas from the fuel rod. Detailed examinations consist of radiochemistry of the fuel and cladding, ceramography of the fuel and metallography of the cladding, and special studies in addition to standard gamma scanning and gas analyses.

3.1 STANDARD EXAMINATIONS

As can be seen in Figure 3.1, the first step in the MCC's characterization of spent fuel ATMs is to perform a full-length gamma scan on each of the intact fuel rods. A correlation between cesium activity and burnup will be developed for each spent fuel ATM which will make it possible to define the burnup of samples from any portion of a rod from a given ATM after the rod has been gamma scanned. The gamma scan data also provide valuable information on fission product movement in the rod (e.g., cesium migration) and on densification or shifts, if any, in the fuel column.

Report Sections	Type of Characterization	Description
Sec. 4.3 & Append. B	Gamma Scan[a]	Selected isotopes, e.g., Cs-137, Cs-134, etc.
Sec. 4.4 & Append C	Fission Gas[a]	H_2, Ar, Kr, Xe, N_2, O_2, CO_2 (C-14), etc.
Sec. 4.8	Burnup	Nd-148 method, isotopes of U and Pu
Sec. 4.8	Specific Radionuclides	Se-79, Sr-90, Tc-99, Sn-126, Cs-135, Cs-137, Np-237, Am-241 and Cm-244
	Spark Source Mass Spectroscopy (ORNL)	Radial distribution (six points on radius) of most fission products and actinides, plus bulk concentration of same radionuclides (adjacent sample)
Sec. 4.5 & Append. E	Fuel Ceramography	Amount and type of cracking, grain size and structure, porosity and noble metal fission product particles
Sec. 4.5 & Append. E	Cladding Metallography	Hydride orientation, inner and outer surface oxidation, crud on outer surface, if present
	Microprobe	Radial distribution of selected elements
Sec. 4.5 & Append. E	Autoradiography	Alpha and beta-gamma intensity maps
Sec. 4.8	I-129 Distribution	Bulk concentration in fuel and chemically stripped from inner cladding surface
Sec. 4.8	Cs-135 and Cs-137 on Cladding	Chemically stripped from inner and outer cladding surfaces
Sec. 4.8	C-14 Distribution	Bulk concentration in fuel and cladding
Sec. 4.6	Transmission Electron Microscopy	Fission product distribution within grains and at grain boundaries
	Activation Products in Assembly Hardware	C-14, Ni-59, Ni-63 and Nb-94
	Crud Analyses[b]	C-14 and selected radionuclides

[a] Conducted on all rods

[b] Conducted on one rod per ATM

[c] Transverse and longitudinal examinations

[d] Transverse section examinations only

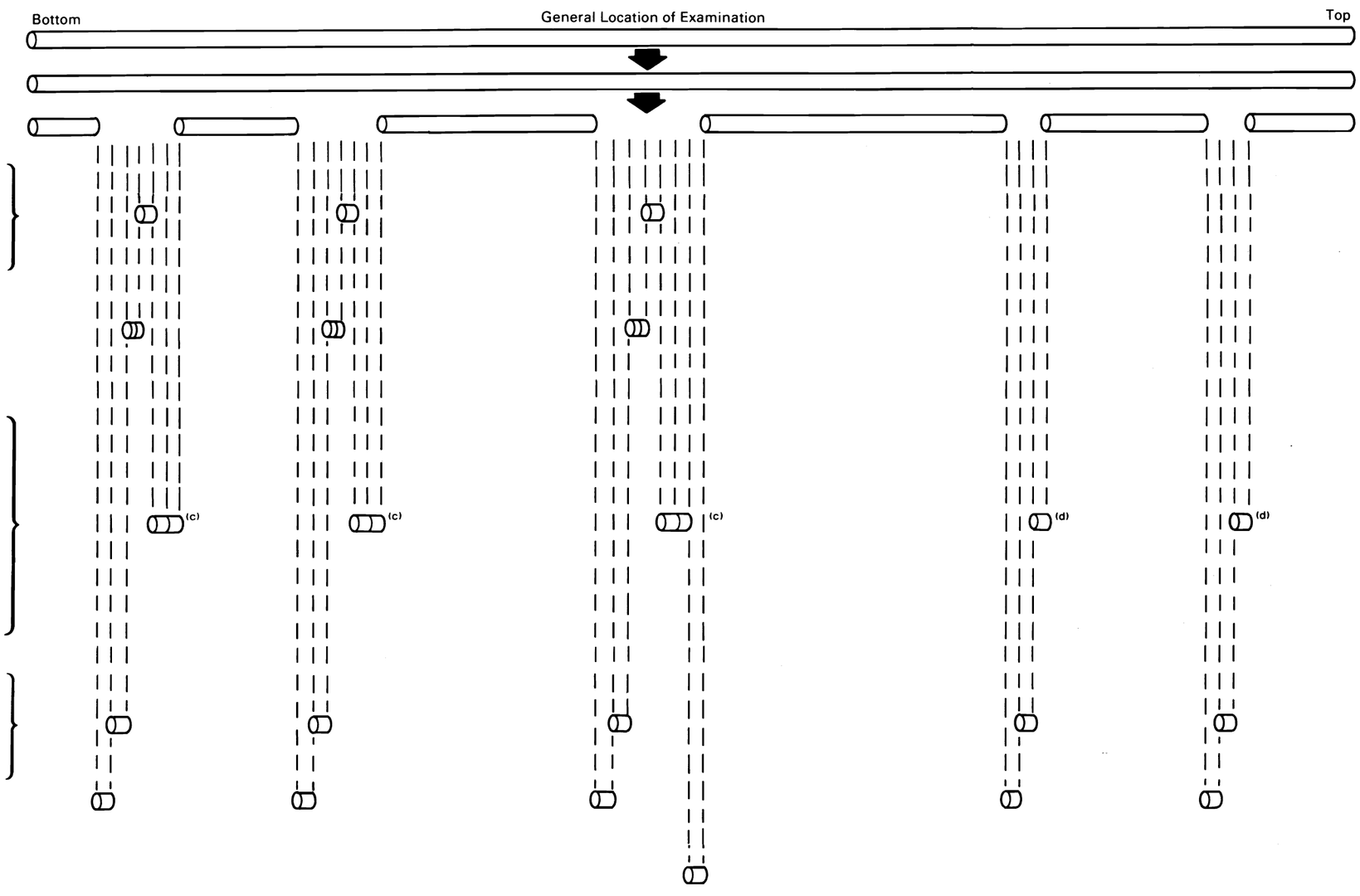


FIGURE 3.1. Characterization of Spent Fuel ATMs

After gamma scanning, each rod (except for the rod used as a gamma scan reference) is punctured and a gas sample is taken. Analysis of the gas provides an estimate of the fission gas released from the fuel during irradiation. The magnitude of the fission gas release is an indication of the extent of the microstructural changes that have occurred in the fuel. These microstructural changes are important to the dissolution of fuel in a repository. The magnitude of fission gas release is also indicative of the fraction of volatile-fission products, such as cesium and iodine, which have migrated to the grain boundaries and the pellet-cladding gap. Quantifying the inventory of fission products in the gap and at the grain boundaries is important because these fission products will be the first released in a repository after the waste package barriers are breached and will be independent of the dissolution rate of the matrix.

It is planned to gamma scan and fission gas sample a number of ATM-103 rods in order to 1) have a backlog ATM-103 material that can be made available immediately upon request, 2) document the homogeneity of or differences in the ATM-103 rods, and 3) provide a means of correlating measured data for fully characterized fuel rods with the gamma scan and fission gas release data that will be obtained from other ATM-103 fuel rods.

3.2 DETAILED EXAMINATIONS

As shown in Figure 3.1, samples are taken from several locations along the length of a rod receiving detailed characterization. Samples are taken for radiochemistry of the fuel and cladding, metallography of the cladding and ceramography of the fuel, and special examinations involving spark-source mass spectrometry (SSMS), electron microprobe analyses, and analytical transmission electron microscopy (AEM).

A principle purpose of sampling the fuel rod at different locations is to determine the bulk inventory of long-lived radionuclides in fuel with different burnups. The fission products, actinides, and activation products of interest in assessments of geologic disposal are analyzed. Samples are taken from the peak-power region of the rod that corresponds with the region of maximum gamma activity, and from two regions of lower power towards the bottom of the rod.

Generally, the radionuclide concentrations are obtained from radiometric measurements of dissolved, or in the case of ^{14}C, thermally decomposed samples. In addition to the radiometric measurements, thermal ionization and SSMS are being used to obtain the bulk concentration of selected isotopes to supplement the data obtained from radiochemical methods or as an overcheck on the determined values.

The measured bulk concentrations of the radionuclides of interest to geologic disposal are compared with the predictions made with the ORIGEN2 computer code based on the measured burnups for the samples and the power history for the fuel rod. Comparison of the measured and predicted values serves to validate the ORIGEN2 code for use in predicting the radionuclide inventory in samples from other locations or other rods from the spent fuel ATMs at any decay time of interest.

In addition to determining the bulk concentrations of radionuclides in the fuel and cladding, characterization is also directed towards obtaining information on the radionuclide distribution in the fuel. Information on the non-uniform distribution of radionuclides will assist in providing an understanding of the preferential release of certain radionuclides that is observed in leach testing of spent fuel. Special emphasis is being placed on determining the ^{14}C distribution in the fuel, cladding, crud, and assembly hardware because less is known about the actual concentrations of this radionuclide than most of the other radionuclides. Several mutually supportive techniques are being used to evaluate non-uniform distribution, including autoradiography, electron microprobe analyses, AEM, SSMS of small radial samples from fuel pellets, and radiochemical analyses of material chemically stripped from the inner-cladding surfaces.

Metallography and ceramography are performed on samples from the peak-power region of the fuel and other lower-power regions. Because cladding corrosion varies along the entire length of the rod, metallographic samples from the lower-power regions of the bottom and the top of the rod are examined. An understanding of cladding characteristics is needed because the cladding may serve as an important barrier during geologic disposal. Cladding corrosion on both the water-side and fuel-side is evaluated, along with hydriding and any

crud formation. Ceramography of the fuel is conducted to evaluate 1) the amount and location of fuel grain growth, 2) fission gas bubble formation and distribution, 3) the amount and distribution of fuel pellet cracking, 4) as-fabricated porosity and changes caused during irradiation, and 5) the formation of noble metal fission product agglomerates. Ceramography is important to interpreting differences in the behavior of fuel in leach tests and oxidation tests. Ceramography is also very important in establishing the characteristics of the individual spent fuel ATMs for comparison with the overall spent fuel population.

As shown in Figure 3.1, selected samples from the spent fuel ATM assembly hardware will also be analyzed for specific activation products. To interpret this information, it will also be necessary to analyze for the precursor isotopes. The inventory of activation products in hardware is an important part of the evaluation of repository performance.

3.3 CHARACTERIZATION OF ATM-103

This report contains detailed information on as-fabricated ATM-103 fuel rod characteristics and the irradiation history that were provided by the fuel vendor, but the report is devoted primarily to postirradiation characterization conducted according to the MCC characterization plan. Three ATM-103 rods will be subjected to the detailed destructive characterization shown in Figure 3.1. Some portions of the three fuel rods that are not analyzed will also be available for use in the repository testing program. These fuel rod sections will be stored in stainless steel tubes that have been purged with argon, welded shut on the bottom with a stainless steel plate, and capped on the top with a Swagelok® fitting. This report describes the results obtained from Rod MLA098 which is the first ATM-103 rod characterized. Limited characterization data is also presented for the Rod MLA089, which is used as a reference rod for gamma scanning.

® Swagelok fittings are manufactured by the Crawford Fitting Company, Solon, Ohio.

4.0 CHARACTERIZATION OF ATM-103

The following detailed characterization of ATM-103 spent fuel consists of a description of the fuel rods and assembly design, the irradiation history, postirradiation handling and transportation, and a variety of destructive and nondestructive examinations conducted on Rod MLA098 from ATM-103. Sections 4.1 and 4.2 include information on the as-fabricated fuel design, irradiation histories, and subsequent storage and handling of the 176 fuel rods in Assembly D101. The remaining sections deal with the examinations conducted to date on Rod MLA098; examinations include gamma scans of two ATM-103 fuel rods (Section 4.3), fission gas analyses (Section 4.4), ceramography and metallography of the fuel and cladding (Section 4.5), special fuel studies involving analytical transmission electron microscopy (AEM) (Section 4.6), calculated nuclide inventories and radioactivities in the fuel and cladding (Section 4.7), and radiochemical analyses of the fuel and cladding as well as a comparison with predicted values (Section 4.8).

4.1 ASSEMBLY AND FUEL ROD DESCRIPTIONS

ATM-103 consists of one fuel assembly (D101) that was fabricated by C-E and irradiated for three cycles in the CC-1 PWR, which is operated by Baltimore Gas and Electric and located outside Lusby, Maryland. The fuel assembly was discharged on October 18, 1980, and transported from the reactor cooling basin to PNL in September 1985. Information in this and the next section (4.1 and 4.2) was provided to the MCC by C-E.(a)

Assembly D101 is a standard C-E 14 x 14 fuel assembly. The 14 x 14 fuel assembly is constructed with five guide tubes that comprise the main structure of the assembly. The upper and lower end fittings, together with eight spacer grids and the five guide tubes, form a structural cage to support the fuel rods (Figure 4.1). All structural components except the lower Inconel grid and the stainless steel upper and lower end fittings are fabricated from Zircaloy-4.

(a) Fuel Characterization Report for DOE Spent Fuel for Repository Studies. January 1986, a report to Battelle, Pacific Northwest Laboratory from Combustion Engineering, Inc., PNL P.O. MS5313F, C-E Contract 12585.

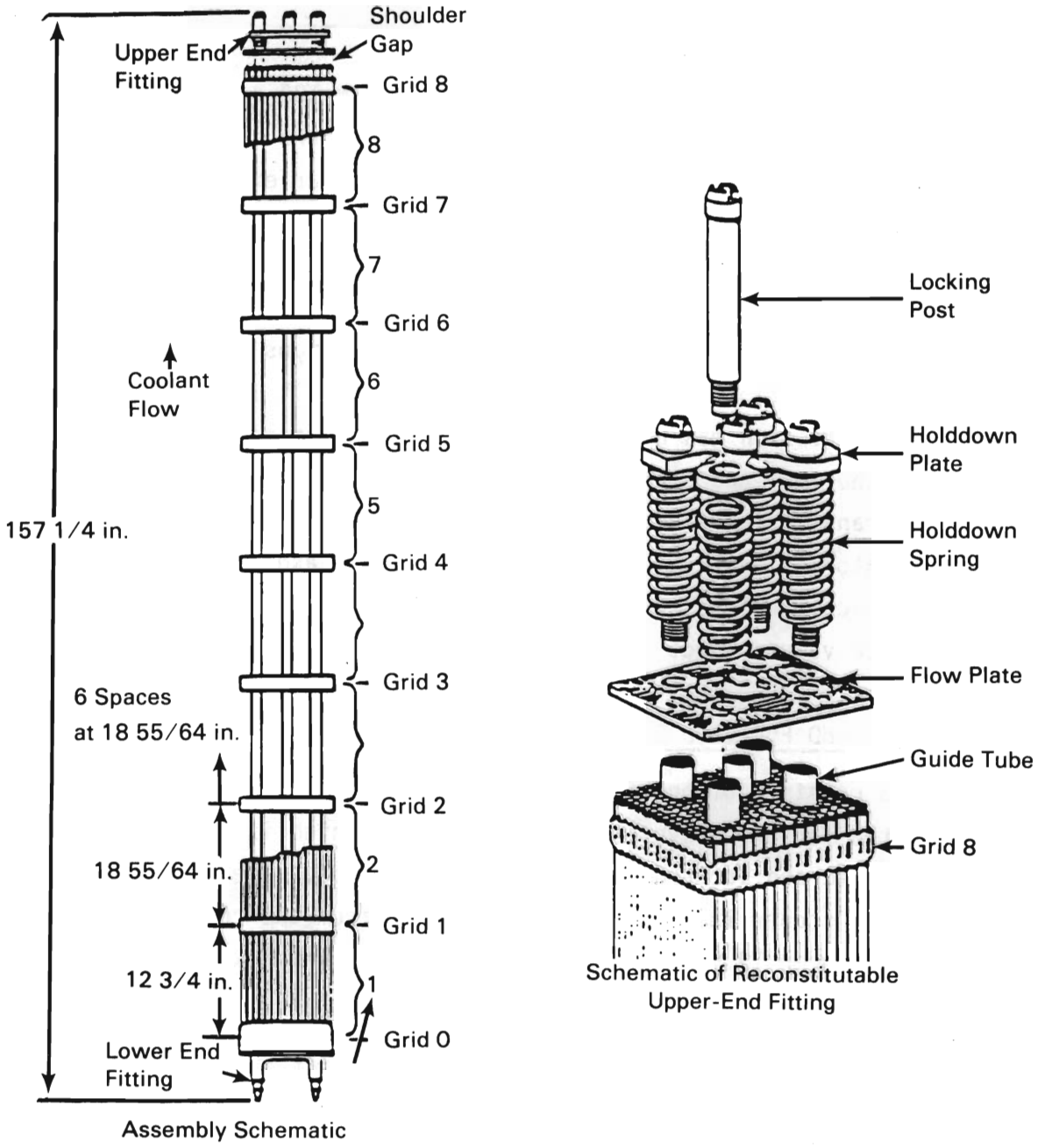


FIGURE 4.1. Fuel Assembly Schematic

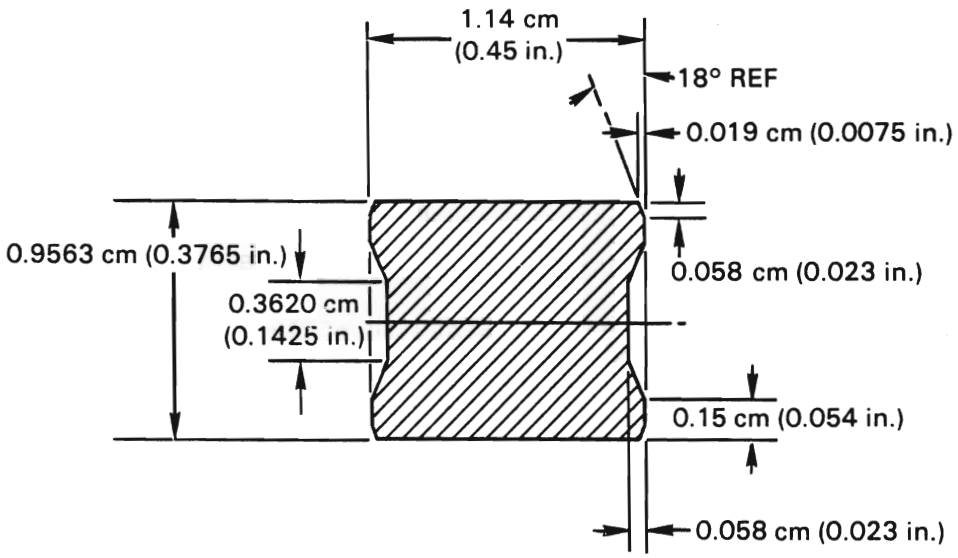
The fuel assembly contains 176 fuel rods. The fuel rods rest on the flow plate, which is part of the lower end fitting. Zircaloy-4 grid strips with integral springs align the rods with each other and provide axial, lateral, and rotational restraint against fuel rod motion during operation. Combustion Engineering's standard fuel assembly is reconstitutable. Any or all fuel rods can be easily removed and replaced using the proper remote handling tools.

The fuel rod and pellet dimensions are shown in Figure 4.2. All the fuel pellets were fabricated using a standard cold-pressing and sintering process. The fuel pellet certification data for Assembly D101 are shown in Table 4.1. All ATM-103 fuel rods are clad with Zircaloy-4 tubing fabricated by Sandvik Special Metals, Lot Nos 5FS72, 5FS73, and 5DM11. Fuel cladding certification data are listed in Table 4.2.

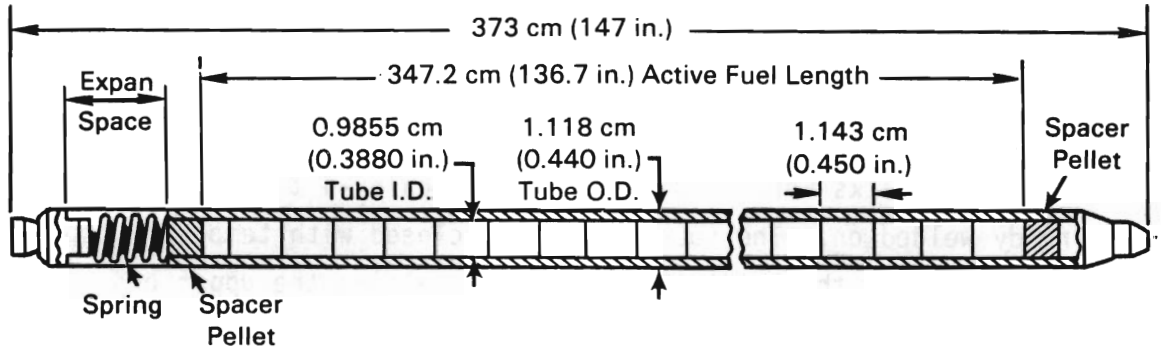
In fabricating the fuel rods, the pellet stacks were laid out on a V-trough. The stacks were weighed and the stack lengths measured. The pellet stacks were then dried in a vacuum furnace and cooled in a flowing helium atmosphere. An Al_2O_3 spacer pellet was added to each stack at the top and bottom, and the stacks were loaded into the Zircaloy-4 tubes with bottom end caps already welded on. The tubes were then closed with temporary caps to minimize exposure to the environment prior to welding the upper end caps. The plenum springs and permanent upper end caps were inserted, the rods were pressurized with helium to 3.1 MPa (450 psi), and the end caps were welded. The end-cap welds were made using a magnetic force welding machine, which provides for filling the rod to the required helium pressure. The locations of the fuel rods in Assembly D101 are shown in Figure 4.3. Rod MLA098, the rod characterized in this report, was located at position A8 near the middle of an exterior row in the assembly.

4.2 IRRADIATION AND HANDLING HISTORY

The position of Assembly D101 in the core during each cycle of irradiation is shown in Figure 4.4. Assembly D101 was irradiated during Cycles 2, 3, and 4 of operation of CC-1 between March 22, 1977, and October 18, 1980 (see Figure 4.5). The core thermal power rating of CC-1 was 2560 MWt from beginning-of-life (BOL) until midway through Cycle 2 (September 9, 1977) when a new



Fuel Pellet Schematic



Test Fuel Rod Schematic (Batch D)

FIGURE 4.2. ATM-103 Pellet and Fuel Rod Dimensions

TABLE 4.1. ATM-103 Fuel Pellet Certification Data

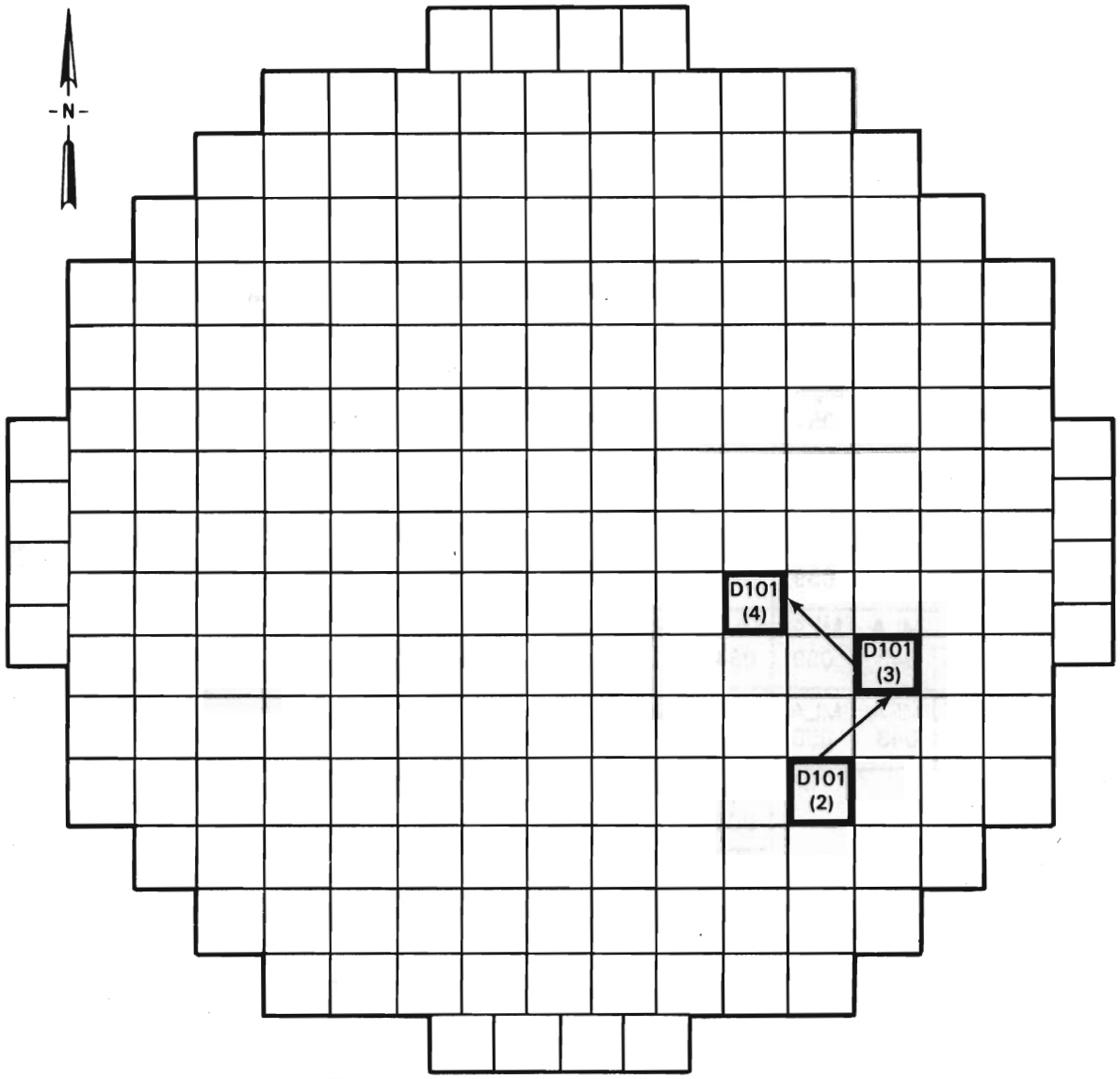
Chemical Attribute	Fuel Lot B-60-EB Analysis Results		
Total uranium wt%	88.149	88.149	88.152
Carbon, ppm	13	12	12
Nitrogen, ppm	28	28	17
Fluorine, ppm	<5	<5	<5
Chlorine & fluorine, ppm	<10	<10	<10
Iron, ppm	51	50	55
Silver, ppm	<1	<1	<1
Calcium, ppm			
Aluminum, ppm	<121	<120	<121
Silicon, ppm			
O:U ratio	2.000	2.000	2.000
Nickel, ppm	<25	<25	<25
Mass spec. analysis	2.72 % U-235		
Density	10.34-10.47 g/cm^3		
Grain size	$\geq$5 µm		

TABLE 4.2. Fuel Rod Cladding Certification Data

Fuel Assembly: D101	ROD LOT: MLA CLAD LOT: 5FS72			ROD LOT: MLA CLAD LOT: 5FS73			ROD LOT: MLA/MLB CLAD LOT: 5DM11		
Tensile Properties									
Room UTS, psi	100900	98600		98500	96800		98800	96000	
0.2% YS, psi	76200	73900		76400	75300		74500	74300	
Elong. 2 in., %	24	24		24	25		23	24	
750°F UTS, psi	54000	51200		51500	49800		53400	50600	
0.2% YS, psi	40700	37200		38900	37600		38500	36700	
Elong. 2 in., %	32	33		33	33		30	32	
Burst Test (closed end with mandrel at room temperature)									
Pressure., psi	17300	16800		17100	17100		17200	17100	
Circ. Elong., %	17	19.7		20.6	23.7		21	21	
Hydride Orientation									
OD	0.04	0.06		0.05	0.08		0.03	0.01	
Fn Mid	0.03	0.02		0.02	0.08		0.02	0.04	
ID	0.05	0.00		0.04	0.04		0.00	0.02	
Corrosion Test (3 day, 750°F steam)									
	Etched			Etched			Etched		
Sample wt/dm^2	12.7	14.4		12.9	13.1		14.6	12.7	
Color	Lustrous Black			Lustrous Black			Lustrous Black		
Std. wt/dm^2	14.7	12.8	11.9	14.7	12.8	11.9	12.5	12.8	15.0
Std. No.:	C217(T)	C218(C)	C223(B)	C217(T)	C218(C)	C223(B)	C312(T)	C348(C)	C371(B)
	Unetched			Unetched			Unetched		
Sample wt/dm^2	16.6	17.3		15.6	15.6		17.2	17.1	
Color	Slightly gray			Slightly gray			Slightly gray		
Chemical Analysis, ppm									
Hydrogen	14	15		15	14		9	14	
Nitrogen	33	24		31	24		31	37	
Oxygen	1230	1160		1240	1240		1358	1313	
Carbon	119	113		124	106		178	179	
Grain Size									
Long. ASTM	12.0	11.5		12.0	12.0		12.0	12.0	
Trans. ASTM	11.5	12.0		12.0	-12.0		12.0	12.0	
Recrystallization Data:	1100°F, 45 min.			1100°F, 45 min.			1100°F, 45 min.		
Surface Roughness									
OD, RMS, microinch	20	20		18	19		18	18	
ID, RMS, microinch	20	20		18	19		18	18	

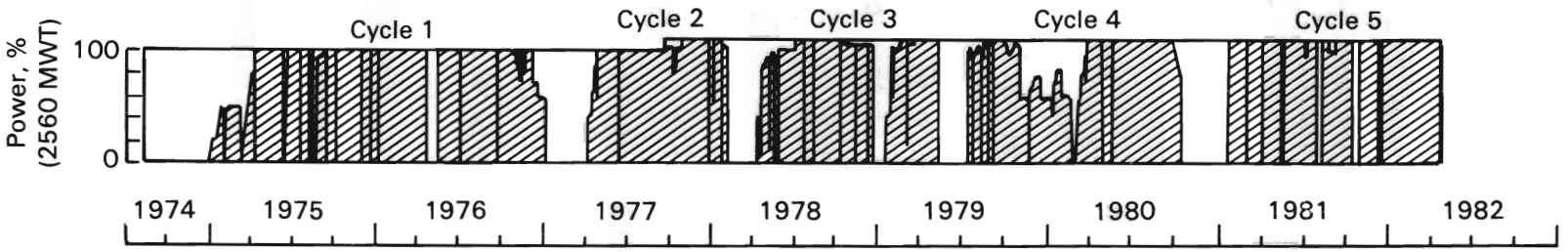
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
A	MLB 003	MLA 027	MLA 046	MLA 045	MLA 069	MLA 099	MLA 053	MLA 098	MLA 105	MLA 158	MLA 154	MLA 198	MLB 016	MLB 018
B	MLA 002	MLA 026	MLA 036	MLA 048	MLA 072	MLA 100	MLA 093	MLA 097	MLA 104	MLA 157	MLA 153	MLA 195	MLB 015	MLB 009
C	MLA 001	MLA 029			MLA 073	MLA 052	MLA 092	MLA 145	MLA 103	MLA 155			MLB 014	MLA 170
D	MLA 003	MLA 028			MLA 075	MLA 094	MLA 091	MLA 095	MLA 101	MLA 147			MLB 013	MLA 189
E	MLA 004	MLA 031	MLA 035	MLA 047	MLA 074	MLA 078	MLA 090	MLA 122	MLA 102	MLA 146	MLA 151	MLA 197	MLB 011	MLB 010
F	MLA 008	MLA 030	MLA 039	MLA 051	MLA 077	MLA 079	MLA 089	MLA 120	MLA 148	MLA 143	MLA 200	MLA 194	MLA 188	MLB 007
G	MLA 005	MLA 034	MLA 038	MLA 049	MLA 076	MLA 085			MLA 150	MLA 144	MLA 171	MLA 193	MLA 168	MLB 008
H	MLA 010	MLA 033	MLA 041	MLA 059	MLA 063	MLA 086			MLA 114	MLA 141	MLA 175	MLA 191	MLA 169	MLB 005
I	MLA 012	MLA 021	MLA 040	MLA 050	MLA 064	MLA 128	MLA 088	MLA 119	MLA 113	MLA 142	MLA 177	MLA 190	MLA 165	MLB 006
J	MLA 015	MLA 020	MLA 043	MLA 058	MLA 065	MLA 126	MLA 087	MLA 118	MLA 111	MLA 138	MLA 176	MLA 179	MLA 166	MLA 199
K	MLA 017	MLA 022			MLA 066	MLA 080	MLA 134	MLA 117	MLA 112	MLA 139			MLA 163	MLB 012
L	MLA 018	MLA 023			MLA 067	MLA 081	MLA 133	MLA 116	MLA 110	MLA 183			MLA 164	MLB 002
M	MLA 019	MLA 024	MLA 042	MLA 060	MLA 068	MLA 082	MLA 132	MLA 130	MLA 109	MLA 182	MLA 181	MLA 178	MLA 162	MLB 001
N	MLB 004	MLA 025	MLA 044	MLA 061	MLA 070	MLA 084	MLA 131	MLA 129	MLA 108	MLA 184	MLA 180	MLA 137	MLA 160	MLB 017

FIGURE 4.3. ATM-103 Rod Locations in Assembly D101 (characterized rods denoted in highlighted boxes)



*Bracketed Numbers Indicate the Cycle of Operation at the Indicated Location

FIGURE 4.4. Core Map Showing the Location of Assembly D101 (ATM-103) in Calvert Cliffs 1 for Cycles 2, 3, and 4



Dates	Cycle 1	Cycle 2	Cycle3	Cycle 4	Cycle 5
Beginning of Cycle	10-7-74	3-22-77	4-3-78	7-10-79	1-11-81
End of Cycle	12-31-76	1-22-78	4-20-79	10-18-80	4-17-82
Burnups and Powers					
Cycle Reactor Average Burnup at Shutdown, GJ/kgM (MWd/kgM)	1469 (17.0)	717 (8.3)	821 (9.5)	1011 (11.7)	1123 (13.0)
Cumulative D101 Assembly Average Burnup, GJ/kgM (MWd/kgM)	[a]	881 (10.2)	1763 (20.4)	2652 (30.7)	[a]
Cycle Reactor Average Linear Heat Generation Rate, KW/m (KW/ft)	19.99 (6.093)	19.97 (6.086) 21.06 (6.419[b])	20.37 (6.209)	20.37 (6.209)	20.58 (6.274)

[a] Not in reactor during this cycle.

[b] After increase to stretch power.

FIGURE 4.5. Calvert Cliffs 1 Reactor Operating History

license was issued to increase the power rating to 2700 MWt. Except for a period of about 5 months at reduced power during reactor Cycle 4, the reactor operated at essentially full power during Cycles 2, 3, and 4.

The CC-1 contains a total of 217 fuel assemblies. The linear heat generation rates (LHGRs) given in Figure 4.5 are averages for the entire core. The LHGRs for specific fuel rods vary significantly from average LHGRs. This is a typical effect of loading fresh fuel at the beginning of each cycle and moving the fuel assemblies to different core locations to optimally utilize the fissile fuel and maintain the required power distribution across the reactor core. As an example, the core average LHGR was relatively constant at about 20.3 kW/m (6.2 kW/ft) during Cycles 2, 3, and 4, while the average LHGR in Rod MLA098 ranged from a high of about 23 kW/m (7.1 kW/ft) at the beginning of Cycle 2 to a low of about 18 kW/m (5.5 kW/ft) at the end of Cycle 4. The power history specific to Rod MLA098 in Assembly D101 is shown in Figure 4.6. The power history for Rod MLA098 is approximated in tabular form in Appendix A and should be used for characterization studies because power history can have a marked effect on fission gas release and EOL fuel conditions.

Following discharge, Assembly D101 was stored wet in the fuel storage basin at CC-1 until September 1985 when it was loaded into a National Assurance Corporation NLI-1/2 cask and shipped dry to PNL. Since that time, it has been stored in air in B-cell of the 324 Building. There have been no unusual incidents associated with these fuel rods. Eight rods (see Table 4.3) were removed from the assembly in August 1986 and transferred to D-cell, 324 Building, where the intact fuel rods are stored in air at ambient cell temperature of ~25°C. These rods are being characterized by the MCC (see Sections 4.3 through 4.8) and are available for use in the repository testing program (see Section 5.0). No special considerations were attached to the selection of Rod MLA098 for the first detailed characterization. As described in Section 3.1, gamma scanning and fission gas sampling of a number of rods will be used to establish the rod-to-rod variability within ATM-103, although the variability is expected to be minimal.

Cycle No.	2	3	4
Start/End of Cycle	3-22-77/1-28-78	4-3-78/4-20-79	7-10-79/10-18-80
Cycle Duration	~10 months	~12.5 months	~15 months
Cycle Burnup GJ/kgM (MWd/kgM)	848 (9.82)	855 (9.90)	871 (10.08)
Cumulative Burnup GJ/kgM (MWd/kgM)	848 (9.82)	1704 (19.72)	2575 (29.80)

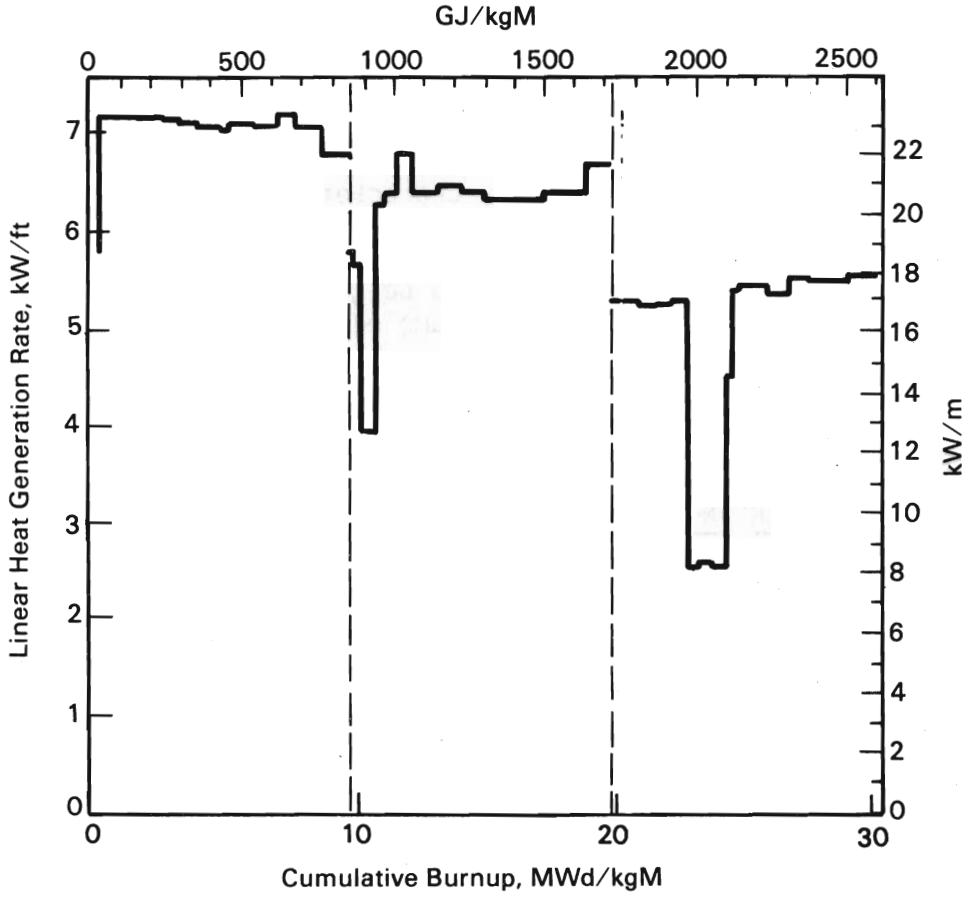


FIGURE 4.6. Power History for Rod MLA098 from Assembly D101

TABLE 4.3. Initial ATM-103 Fuel Rods to be Characterized and Used in Repository Project Testing Programs

Rod Number	Rod Location[a]	Comments
MLA053	A7	To be gamma scanned and fission gas sampled only
MLA089	F7	Gamma scan reference rod
MLA091	D7	Will receive in-depth characterization (to be described in subsequent revisions of this report)
MLA092	C7	
MLA095	D8	To be gamma scanned and fission gas sampled only
MLA097	B8	
MLA098	A8	Characterization of this rod is described in this report.
MLA145	C8	To be gamma scanned and fission gas sampled only

(a) Location refers to Figure 4.3.

4.3 GAMMA SCANNING RESULTS

Each fuel rod was gamma scanned axially using a germanium-lithium gamma-ray detector. Details on the gamma scanning equipment and procedure are provided in Appendix B. The same counting geometry, counting equipment, analyzing equipment, and data storage equipment were used for each measurement. It should be noted that this system is not the same system used to measure the gamma activity in the ATM-101 fuel rods (Barner 1985). As in the gamma scans for the ATM-101 fuel segments, the gamma scans for standard rods in ATM-103 are preceded and followed by gamma scans of short portions of a reference rod. The reference rod for ATM-103 is MLA089.

Initial spectral counting of the high-activity regions of the reference fuel rod showed significant gamma-ray peaks at 605 KeV (^{134}Cs), 662 KeV (^{137}Cs), and 796 KeV (^{134}Cs). There was no difficulty in obtaining adequate counting statistics. A ^{60}Co signal is also detected during gamma scanning

because a sample of this material is placed in the detection system as a reference point. The detailed results of the gamma scanning are provided in Appendix B for both Rods MLA089 and MLA098.

An example of the ^{137}Cs gamma activity along the fuel rod length is shown in Figure 4.7 for Rod MLA098. Even with the slit width of 2.54 mm (0.100 in.), the pellet/pellet interfaces are readily indicated in the gamma scans by the sharp dips in the gamma activity on a pitch equal to the pellet length of approximately 11.4 mm (0.45 in.). The ^{137}Cs gamma activity decreases about 5% at the location of each of the grid spacers. There were no indications of fuel relocation or densification in either of the two rods that were gamma scanned.

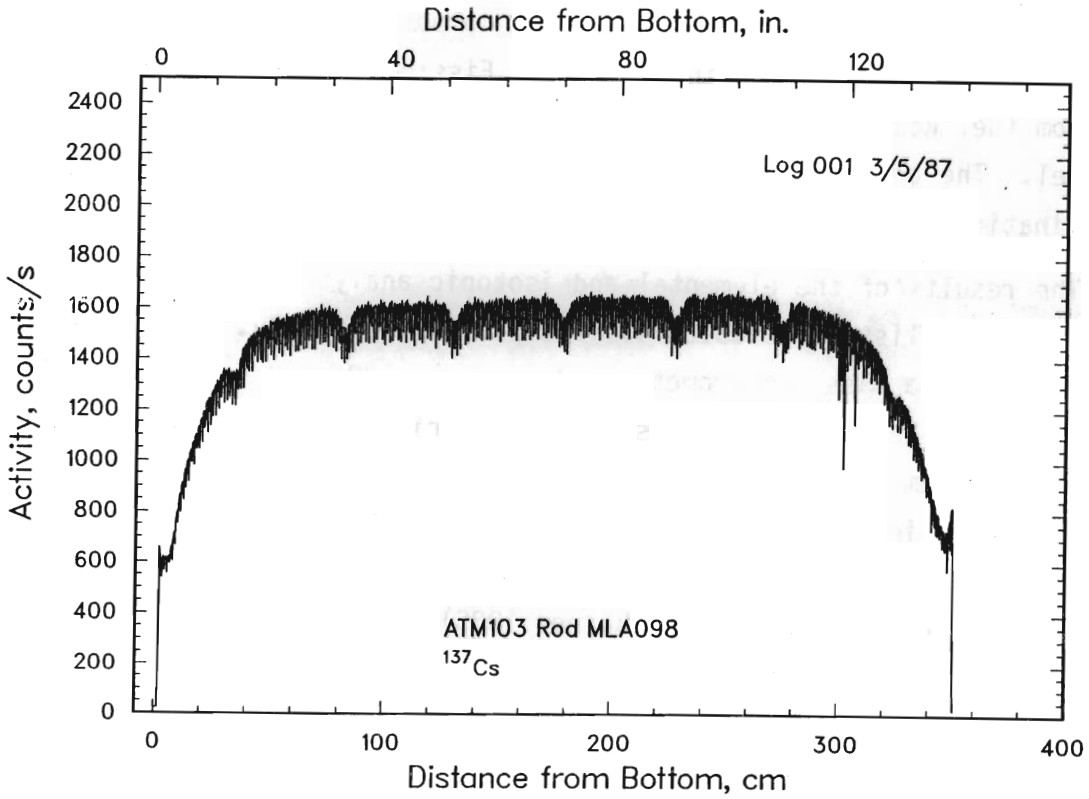


FIGURE 4.7. Spectral Gamma Scan for ^{137}Cs - Rod MLA098

The gamma scanning procedure requires the measurement of the as-irradiated fuel rod length from one end cap to the other. The as-measured fuel rod lengths are shown in Table 4.4 for the two ATM-103 rods that have been gamma scanned.

4.4 FISSION GAS ANALYSES

Fission gas release and the subsequent composition of the gas in the fuel rod void space can appreciably affect the fuel temperatures during reactor operation. This in turn can have an effect on the final characteristics of the spent fuel by increasing grain size, promoting additional fission gas release, and changing the distribution of fission products within the fuel. The extent of this effect depends on the initial gas composition, initial fuel characteristics, power history, and final burnup. Fission gas analyses were made on the gas from fuel Rod MLA098 to determine the release of fission gas from within the fuel. The procedures for gas sampling, void volume measurement, and determination of the gas volume are described in Appendix C.

The results of the elemental and isotopic analyses of the gas sample from Rod MLA098 are listed in Tables 4.5 and 4.6, respectively. These data were obtained using a mass spectrometer and procedure HTA-4-34.(a) The measurable gases included helium, the gas used to pressurize the fuel rod during fabrication, small amounts of xenon and krypton, and nitrogen. There were no indications of air in the fuel rods as there had been for ATM-101. Analyses of ATM-101 rods indicated that a small amount of air was probably not removed from the fuel rod during fabrication (Barner 1985). The Xe/Kr ratio of 9.2 for Rod MLA098 compares well with the average value of 9.0 for nine rods from ATM-101, which was also a low-releasing PWR fuel with moderate burnup of about 2600 GJ/kgM (30 MWd/kgM) (Barner 1985).

The ^{14}C content in the gas removed from Rod MLA098 was determined by using procedure HTA-4-31 to collect the gas containing carbon, converting it to CO_2, trapping the CO_2 in a caustic solution, and measuring it by beta-scintillation analysis. The ^{14}C content was less than the detection limit of .0015 nCi/cm^3

(a) Copies of procedures are available upon request from the MCC.

TABLE 4.4. Fuel Rod Lengths Measured During Gamma Scanning

Fuel Rod Number	As-Irradiated Fuel Rod Length, m (in.)
MLA089	3.752 ± 0.003 (147.7 ± 0.1)
MLA098	3.756 ± 0.003 (147.9 ± 0.1)

TABLE 4.5. Gas Composition for Rod MLA098, Vol%

He	Xe	Kr	Ar	H_2	CO_2	CO	N_2	O_2	Organics	Xe-Kr Ratio
99.4	0.55	0.06	<0.01	<0.01	<0.01	<0.03	0.03	<0.01	<0.01	9.17

TABLE 4.6. Isotopic Gas Analyses of Xenon and Krypton for Rod MLA098

	Xenon, %						Krypton, %			
Gas Compared	128	130	131	132	134	136	83	84	85	86
Xe or Kr	(a)	(a)	7.3	20.0	29.1	43.6	16.7	33.3	(a)	50.0
Total Rod Gas	<0.01	<0.01	0.04	0.11	0.16	0.24	0.01	0.02	<0.01	0.03

(a) Below detection limits. Assumed to be essentially zero for calculating relative percentages of Xe or Kr isotopes.

at STP. In analyses of ATM-101, where there was probably some nitrogen in the original fill gas, the ^{14}C content averaged 0.81 nCi/cm^3 in the nine rods (Barner 1985). Thus, although ATM-103 and ATM-101 had similar EOL burnups and expected fission gas releases, the single ATM-103 fuel rod analyzed to date had a ^{14}C content in the gas that was less than 0.2% of the ^{14}C in the gas taken from the ATM-101 fuel rods. This difference is primarily attributed to the activation of the nitrogen from the residual air believed to have been in the ATM-101 fuel rods.

Fission gas release in Rod MLA098 was estimated to be 0.25%. This value was obtained assuming: a) 31.0 cm^3 of fission gas was generated for each MWd of burnup at standard temperature (0°C) and pressure (0.1 MPa, 1 Atm.) (SSA 1982), b) data in Table 4.7, and c) the rod-average burnup of 2580 GJ/kgM (29.8 MWd/kgM) provided by C-E. The measured rod void volume was 46.8 cm^3 based on the sampling described in Appendix C. It is believed that this void volume may be high by about 11 cm^3 based on estimates of the as-fabricated void

TABLE 4.7. Fission Gas Release Results for ATM-103, Rod MLA098

Total Recovered Gas at STP, cm^3	Xe + Kr, %	Volume of Xe + Kr at STP, cm^3	Rod-Average Burnup, MWd/kgM	Fuel Weight, kgM	Estimated Fission Gas Produced, cm^3	Fission Gas Released, %
852	0.61	5.20	29.8	2.214	2045	0.25

volume, although such an error for this rod contributes very little to the uncertainty in the estimation of the fission gas release because the fuel rod void volume is only a small fraction of the total gas volume at STP. The measured fission gas release of 0.25% in Rod MLA098 of ATM-103 is comparable to the 0.19% release for nine fuel rods from ATM-101. Based on these results, the ATM-103 fuel has low fission gas release as expected.

4.5 CERAMOGRAPHIC/METALLOGRAPHIC EXAMINATIONS

Selected fuel samples were sectioned from fuel Rod MLA098 for ceramographic examination of the irradiated fuel, metallographic examination of the irradiated cladding at the same location, and alpha and beta-gamma autoradiography of each sample. These fuel samples were taken in coordination with several other samples taken for radiochemistry, analytical transmission electron microscopy, distribution to experimenters, and archiving. The sectioning was based on the results of the ^{137}Cs gamma scan and the desired number and types of examinations for this fuel.

4.5.1 Fuel Rod Sectioning and Sample Selection

After gamma scanning and fission gas sampling, a sectioning diagram was prepared for Rod MLA098, as will be done for all ATM spent fuel rods that are to be characterized. The sectioning diagram was distributed to the repository projects for review prior to sectioning.

The sections used for radiochemical, ceramographic, and metallographic analysis were 0.6 to 2.5 cm (0.25 to 1.0 in.) in length. Each sample was designated with an alpha-numeric symbol in the order of sectioning from the top of the fuel rod. Detailed descriptions of the fuel sections, their lengths,

and locations in the fuel rod are given in Appendix D. Additional details on the sectioning process are also given in Appendix D.

Five transverse and three longitudinal fuel sections were taken from Rod MLA098, as indicated in Figure 4.8, to provide detailed ceramographic characterization across the fuel radius and along the fuel rod at locations with a variety of cladding temperatures and fuel burnups. The fuel sections taken from the low-power regions of the fuel rod also provide information on as-fabricated fuel data such as grain sizes and porosity. The more-significant results of the analyses of the fuel and cladding from Rod MLA098 of ATM-103 are provided below. Photographic details of all samples are provided in Appendix E.

4.5.2 Ceramography of ATM-103 Fuel

The fuel sections obtained from Rod MLA098 were used to characterize porosity and microstructural variations as a function of radial position and axial location. The general cracking pattern, porosity in the fuel, wedging of small fuel particles between fuel fragments and in the gap, and as-irradiated gap width are of interest and can be observed in the as-polished transverse and longitudinal samples. The cracking pattern and gap width are of interest in calculating in-reactor temperatures. The number of fuel fragments/pieces and their sizes can also be used to estimate the surface area of the fuel. Fission gas bubble size and distribution, metallic ingots, and grain size variations are also of interest. The grain size variations are particularly observable after etching the fuel samples. The number of fission gas bubbles is best observed in the as-polished condition when they are present; however, etching is most useful in determining the location of the fission gas bubbles. The formation of fission gas bubbles and grain growth correlate with higher fuel temperatures and migration of fission products. The metallic ingots (also called five-metal particles) are typically seen only near the fuel center, if at all, in fuel with moderate to high operating temperatures. Details are given below for macrophotography and microphotography of as-polished and as-etched fuel.

Both the transverse and longitudinal fuel samples were prepared for examination by placing them in mounts followed by vacuum impregnation with polyester

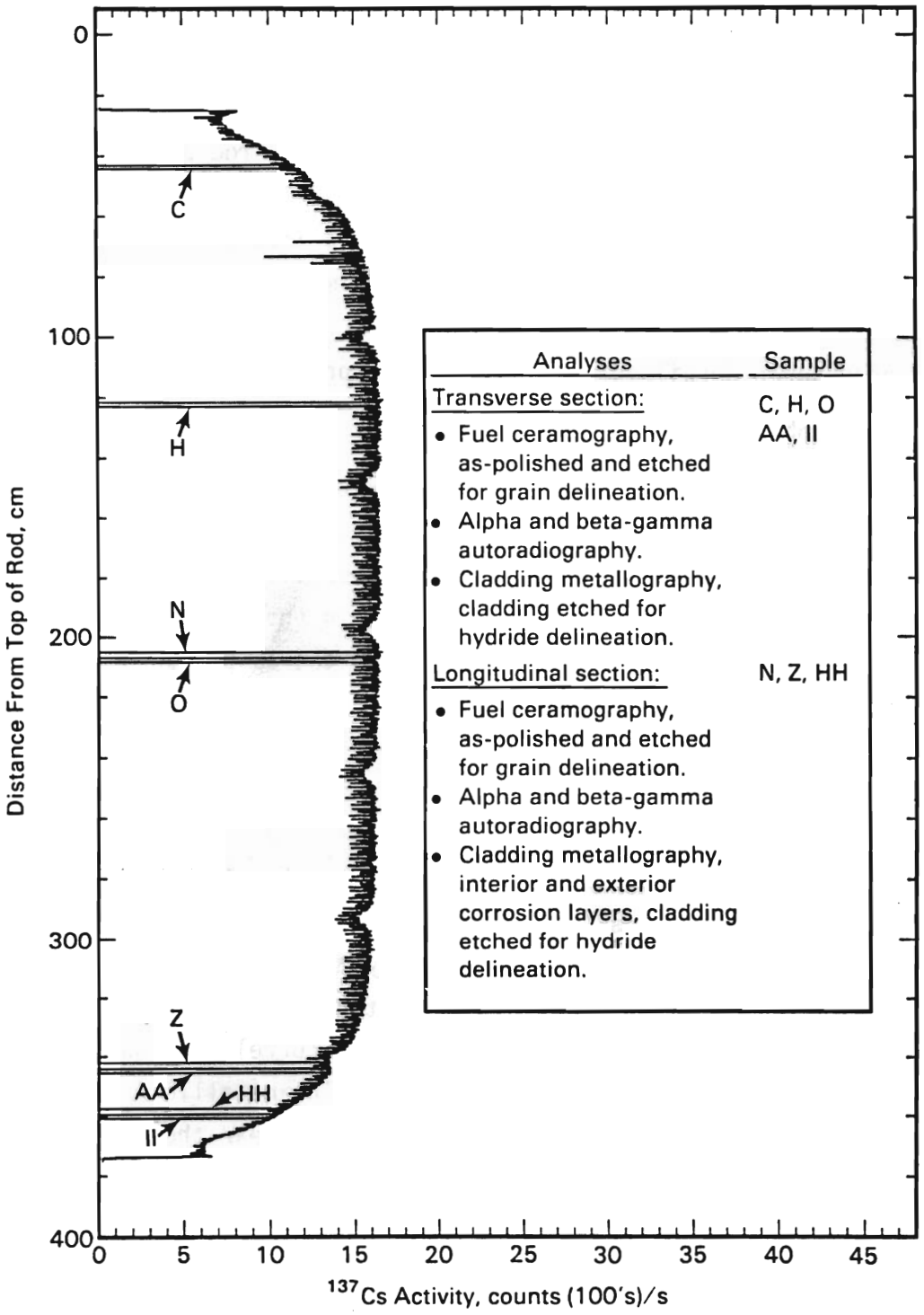


FIGURE 4.8. General Location of Metallographic/Ceramographic Samples from Rod MLA098

resin. The mounts included a reference notch so that high-magnification photographs of the as-polished and etched samples could be taken along approximately the same radial line. After grinding the mounted fuel sample with up to a 600 grit in a water-base lubricant, the samples were polished with a 1-μm diamond paste using kerosene. A final polish was then made in a 0.3-μm Al_2O_3 aqueous suspension.

As-Polished Fuel Condition

There are several features of interest when evaluating as-polished fuel samples: 1) crack patterns, 2) dish closure, and 3) variations in porosity in the fuel. These features are discussed below.

Crack Patterns. The as-polished transverse and longitudinal samples of fuel sectioned from the peak-power region of Rod MLA098 are shown in Figures 4.9 and 4.10, respectively. Sample 103-MLA098-0 (a transverse fuel sample) has four radially-oriented open cracks intersecting at the approximate center of the fuel and extending to the fuel pellet edge. Three additional fine-gapped radially-oriented cracks, which are approximately the length of the fuel radius, are also present. These open and fine-gapped cracks are similar to those observed on transverse specimens at the peak power region of ATM-101 fuel (Barner 1985). At the outer edge of the fuel, all cracks are approximately normal to the fuel surface.

The as-polished longitudinal sample, 103-MLA098-N, (also taken at the peak power region adjacent to the previously described transverse section) has an open crack along the full length of the pellets near the axis of the fuel. A few fine-gapped transverse cracks from the center axis crack to the outer edge of the fuel are also present. The remaining cracks are generally shorter than the fuel radius and are randomly oriented, intersecting other cracks at random angles. The cracking patterns in the photomacrographs are similar to those of ATM-101 PWR fuel exposed to a similar nominal burnup (Barner 1985).

Dish Closure. The macrophotography of the as-polished longitudinal sample can be used to determine whether there was any closure of the space formed by the dishes at the ends of the pellets; any closure would be indicative of high temperatures and low fuel strength during some operating period. Assuming an

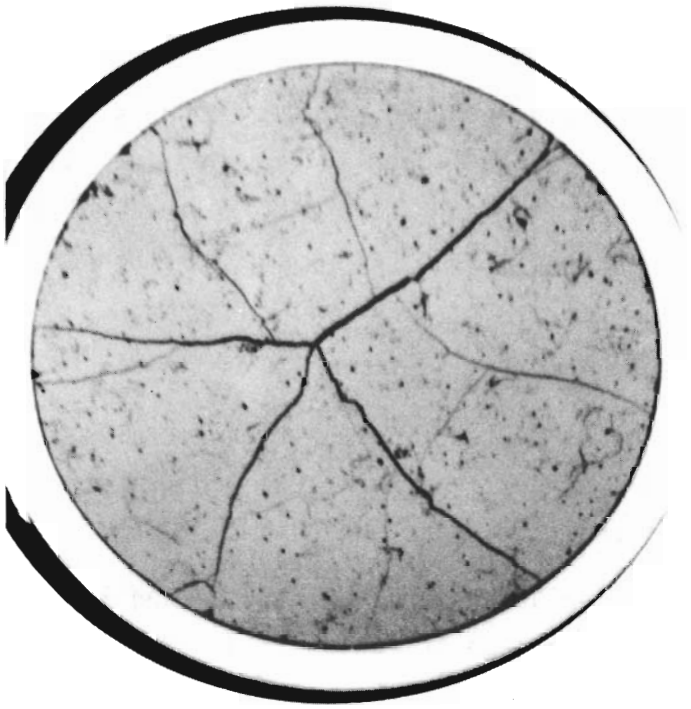


FIGURE 4.9. Photomacrograph of As-Polished Transverse Sample 103-MLA098-0 from the Peak-Power Region (~10x) (Neg. No. 8704675-24) (Note: Photo taken at an oblique angle to fuel surface)

as-fabricated pellet length of 1.14 cm (0.450 in.) for scaling purposes, the distance between fuel pellets in the widest portion of the adjacent dishes ranged from 1.17 to 1.24 mm (0.046 to 0.049 in.) as compared with the nominal 1.16-mm (0.046 in.) as-fabricated distance (see Figure 4.2). Thus, negligible closure of the as-fabricated pellet-pellet gap occurred, as expected for fuel with this burnup and power history.

Porosity Variation. The photomicrographs in Figures 4.11 and 4.12 were taken of transverse and longitudinal fuel samples, respectively, at four radial positions to estimate the radial variation of porosity in the peak-power region. Comparison of radial photomicrographs provides a means of detecting changes in fission gas bubble size and porosity concentration and distribution that may result from the increasing fuel temperatures from the edge to the center of the fuel pellet.

The few large pores observed in Figure 4.11 and 4.12 are probably a result of the addition of a pore former during fuel fabrication. Angular porosity,

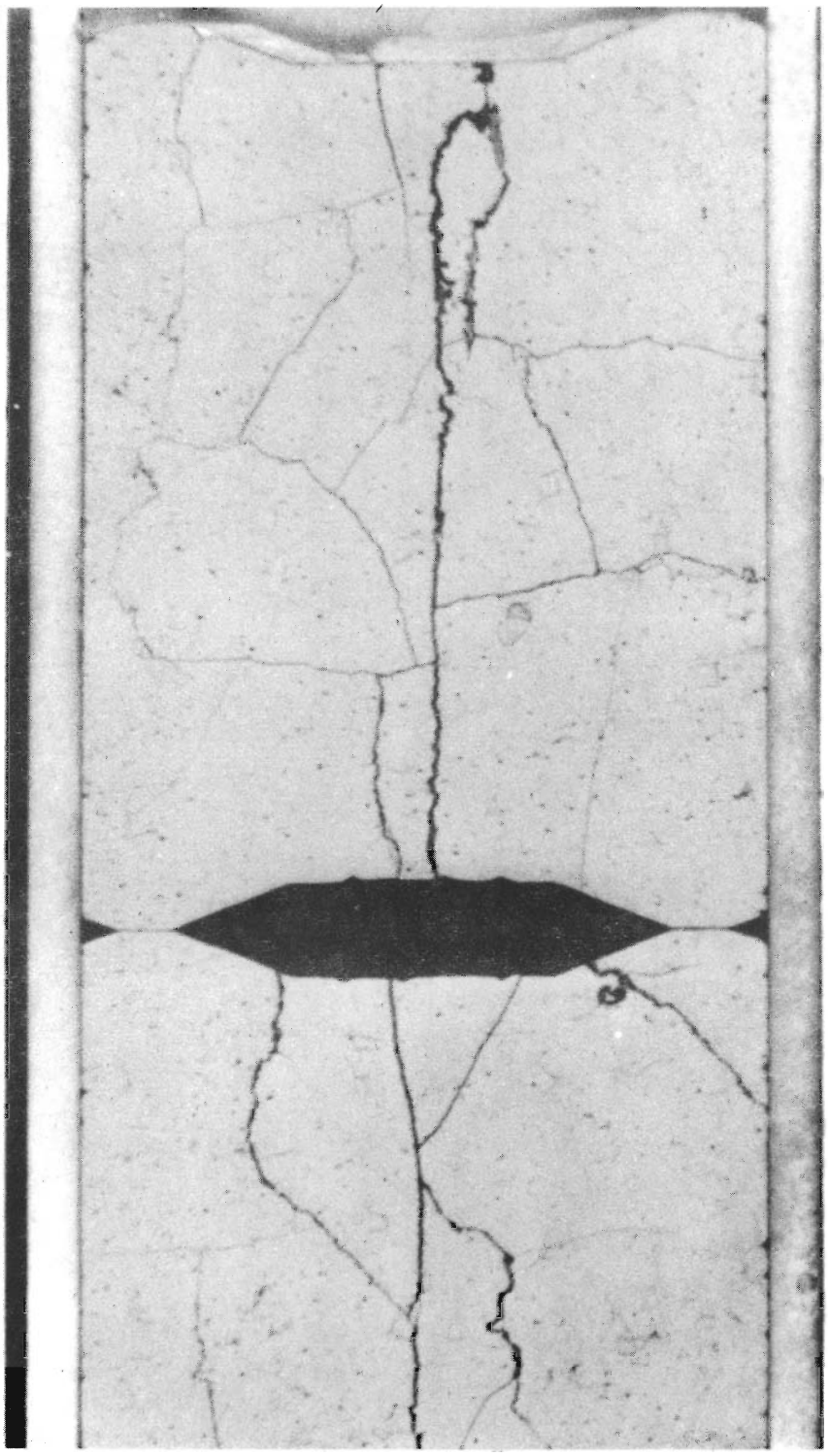
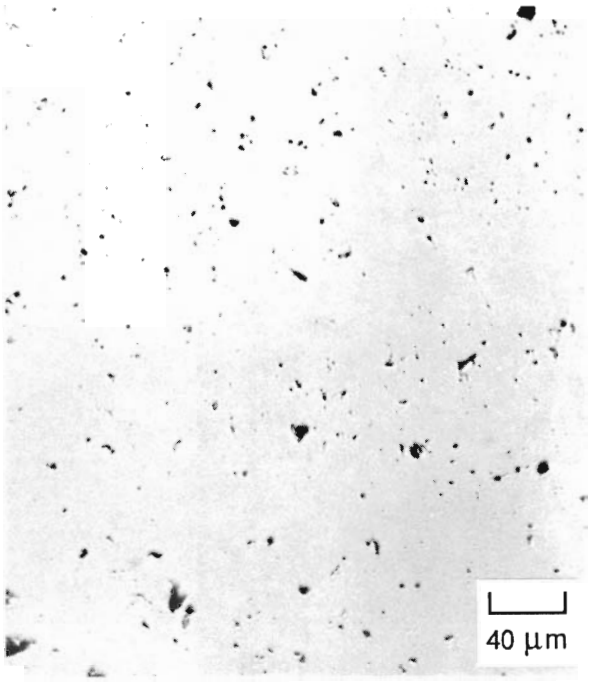
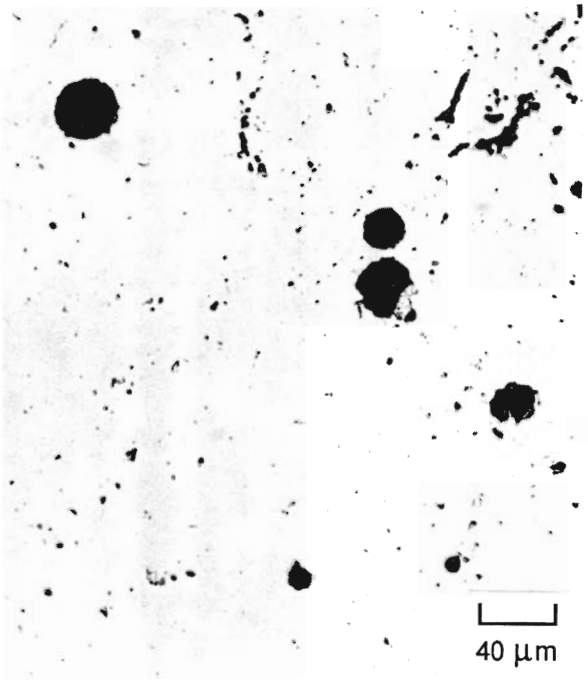


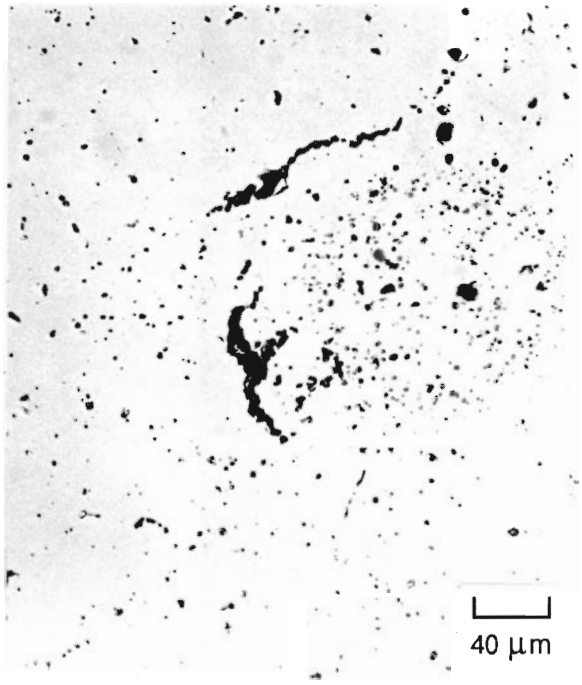
FIGURE 4.10. Photomacrograph of As-Polished Longitudinal Sample 103-MLA098-N from the Peak-Power Region (~10x) (Neg. No. 8704675-2)



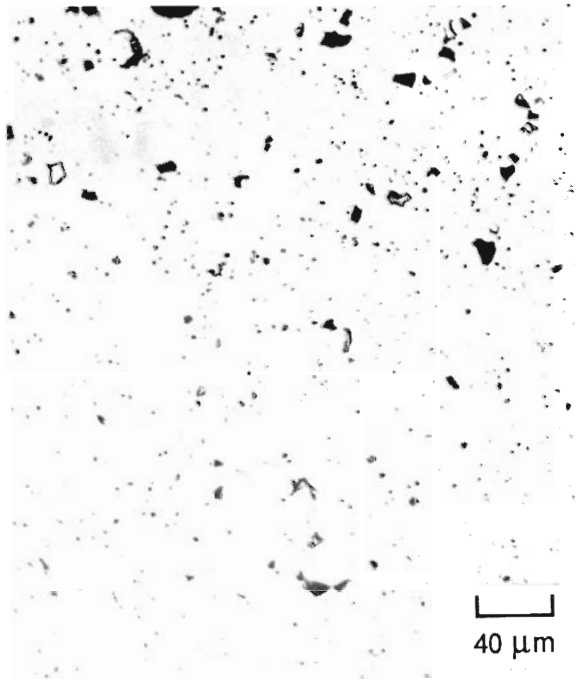
a) Center (Neg. No. P-2692)



b) 1/3 Radius (Neg. No. P-2691)

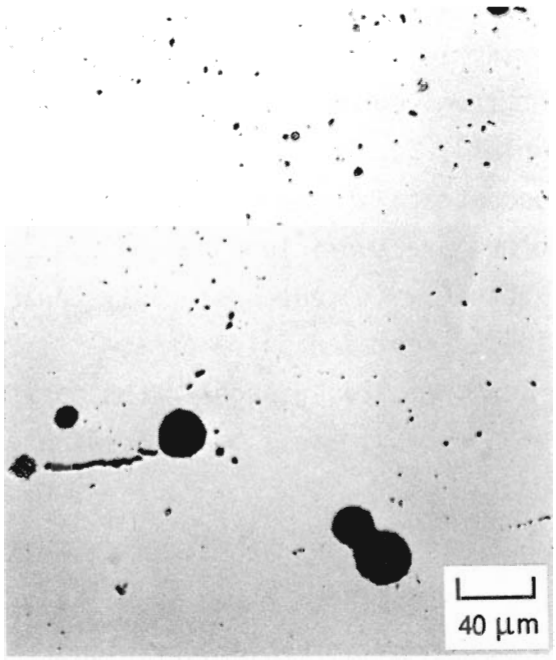


c) 2/3 Radius (Neg. No. P-2690)

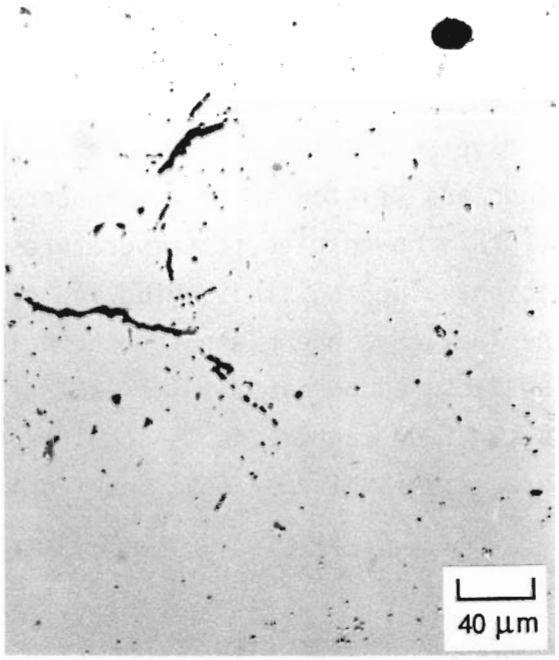


d) Edge (Neg. No. P-2689)

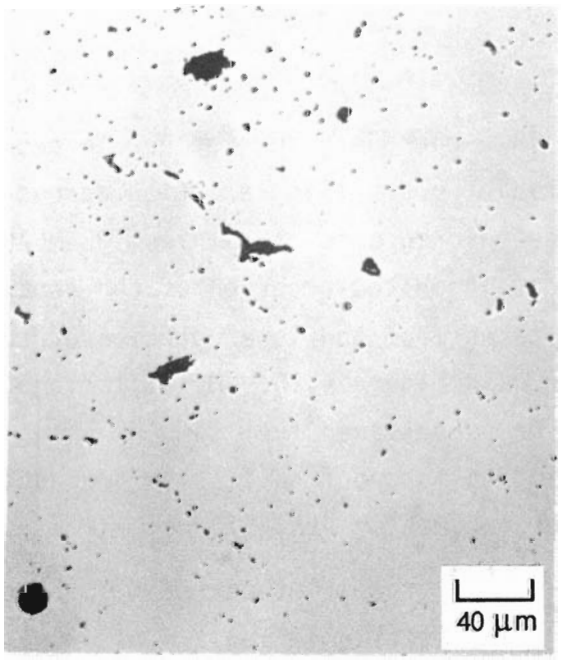
FIGURE 4.11. Photomicrographs of As-Polished Transverse Sample 103-MLA098-0 from the Peak-Power Region



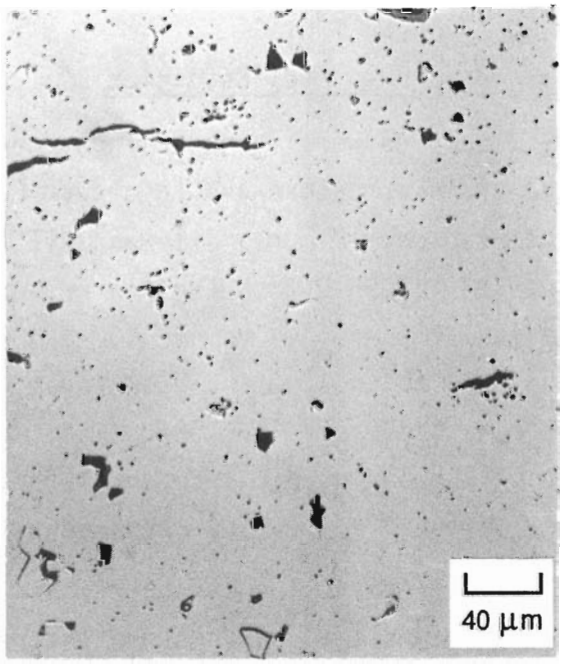
a) Center (Neg. No. P-2675)



b) 1/3 Radius (Neg. No. P-2674)



c) 2/3 Radius (Neg. No. P-2673)



d) Edge (Neg. No. P-2672)

FIGURE 4.12. Photomicrographs of As-Polished Longitudinal Sample 103-MLA098-N from the Peak-Power Region

located primarily near the pellet edge of the samples is apparent and may be partially due to fuel grain pullout during sample preparation. Small rounded pores (up to about 5 μm) increase in number from center to edge in both the transverse and longitudinal peak-power samples. Fisson gas bubbles formed by xenon and krypton gases are expected to concentrate at the hotter fuel center at grain boundaries if temperatures and burnup are sufficient for bubble formation. The radial distribution of pores actually increases slightly towards the fuel edge where the structure is considered representative of as-manufactured porosity. The lack of significant fission-gas-generated porosity at the fuel centerline is consistent with the approximately 0.25% fission gas release for this rod (see Section 4.4).

The photomicrograph of as-polished Sample 103-MLA098-II, taken from the lower end of the fuel rod where the burnup was about 63% of the peak level, reveals a significantly higher concentration of small rounded pores located throughout the fuel (Figures 4.13 and E.2.e). Because the porosity is greater throughout the pellet, this difference between peak-power and lower-power samples is probably due to random variations in the distribution of as-fabricated porosity.

As-Etched Fuel Condition

Samples were etched using argon ions in a cathode vacuum etcher to observe the grain structure and to determine any radial grain size variation across the fuel radius. Figures 4.14 and 4.15 are photomicrographs of Samples 103-MLA098-O and 103-MLA098-N from the peak-power region. A photomicrograph of the center region of as-etched Sample 103-MLA098-II, taken from the lower portion of the fuel rod at ~63% of the peak power, is shown in Figure 4.16. Metallic ingots were not observed in either the as-etched or as-polished fuel samples using optical techniques. Very small metallic ingots formed from fission products are observable using AEM as discussed later in Section 4.6.

Fuel grain size was determined using the intercept method (ASTM 1980) on the 250x photomicrographs and the results are presented in Table 4.8. Fuel grain size is essentially invariant across the radius of the peak-power sample indicating the peak temperature was not high enough at the fuel center to cause detectable grain growth. The fuel grain size of Sample 103-MLA098-II at

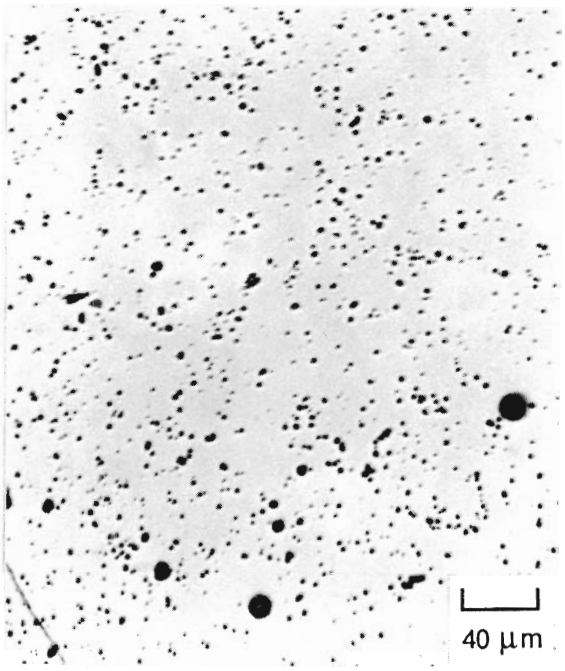


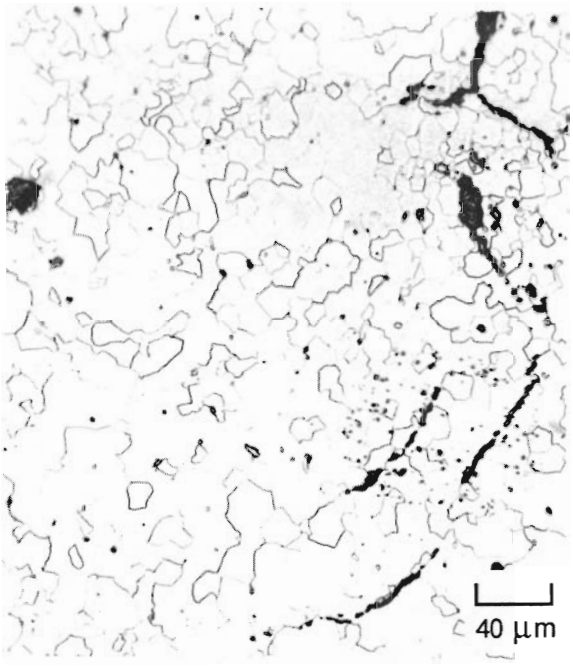
FIGURE 4.13. As-Polished Sample 103-MLA098-II (approximately 63% of peak power) Near Fuel Center (Neg. No. P-2763)

approximately 63% of the peak power is similar to the grain size of the peak-power samples, indicating that the as-manufactured true grain size was in the range from about 17 to 20 µm. The fuel design specified grains ≥5 µm.

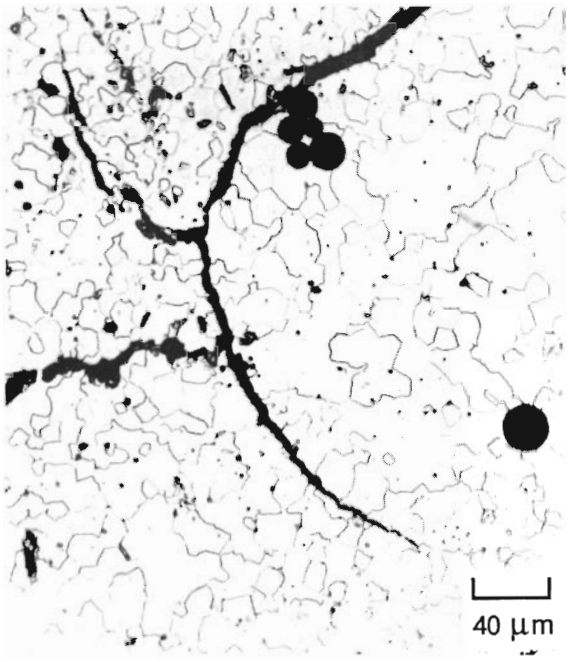
The as-etched fuel samples also show that the majority of the smaller porosity is located within the grains and not at the grain boundaries. This pattern is indicative of as-fabricated porosity rather than fission gas bubbles and supports with the conclusion that there was no apparent fission gas accumulation at the grain boundaries.

4.5.3 Metallography of ATM-103 Cladding

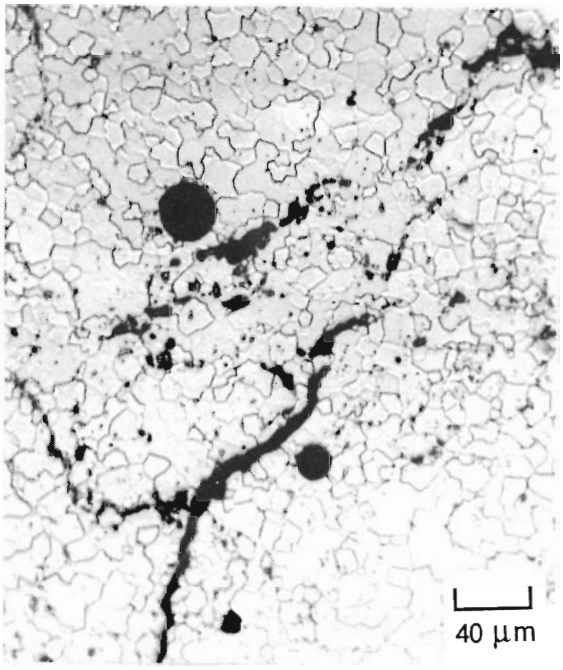
Oxide thickness on the interior and exterior surfaces of the cladding and hydride orientation within the cladding were determined during the cladding examinations conducted on the same mounted specimens as those used for the fuel examinations. Information on the exterior oxide/crud layers on the cladding is useful in determining the potential for airborne contamination during handling



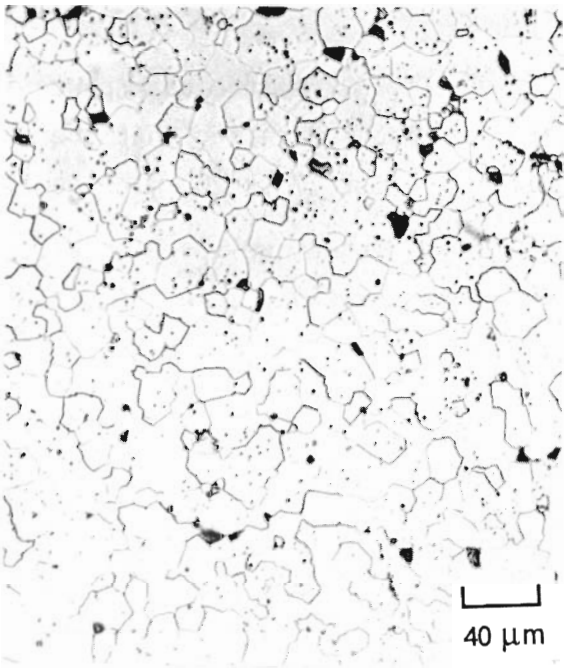
a) Center (Neg. No. P-2904)



b) 1/3 Radius (Neg. No. P-2903)

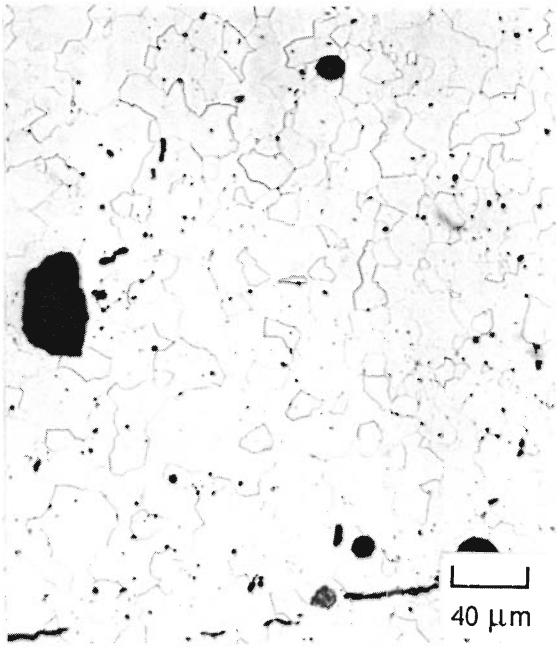


c) 2/3 Radius (Neg. No. P-2902)

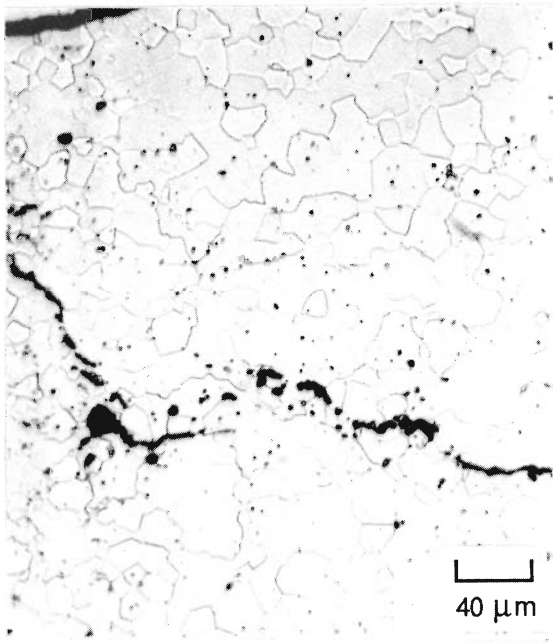


d) Edge (Neg. No. P-2901)

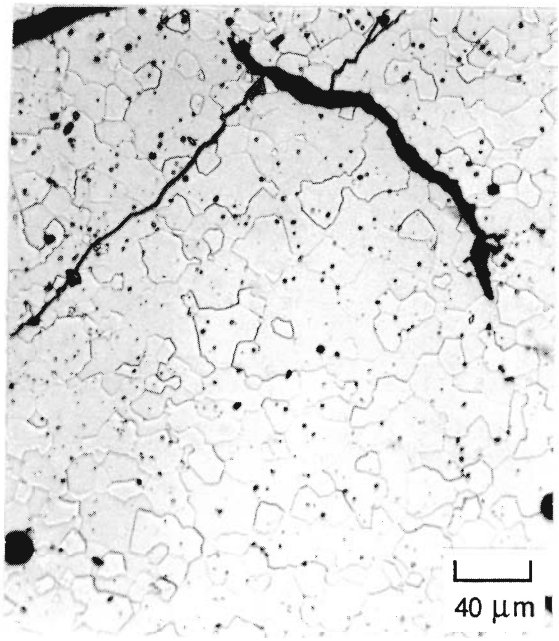
FIGURE 4.14. Photomicrographs of Argon Ion-Etched Transverse Sample 103-MLA098-0 from the Peak-Power Region



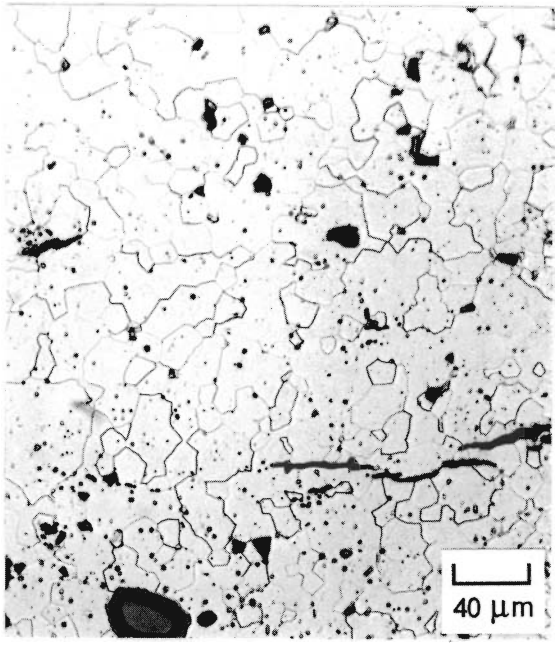
a) Center (Neg. No. P-2924)



b) 1/3 Radius (Neg. No. P-2923)



c) 2/3 Radius (Neg. No. P-2922)



d) Edge (Neg. No. P-2921)

FIGURE 4.15. Photomicrographs of Argon Ion-Etched Longitudinal Sample 103-MLA098-N from the Peak-Power Region

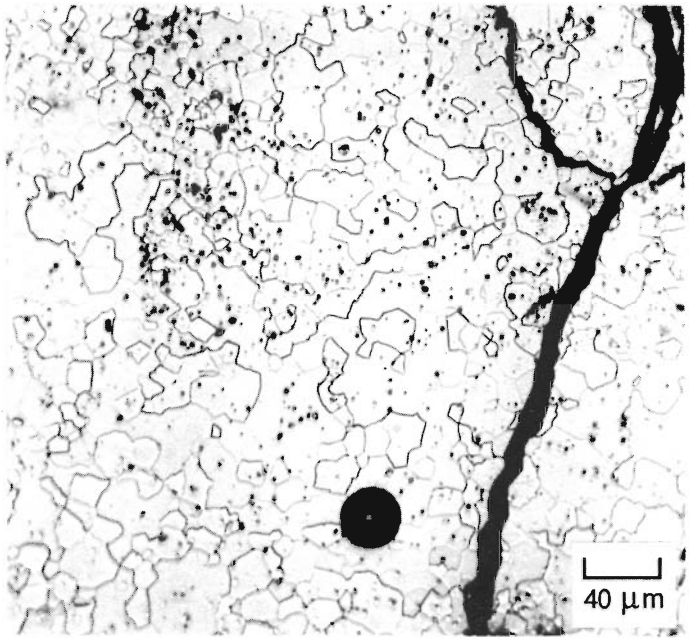


FIGURE 4.16. Photomicrograph of Argon Ion-Etched Transverse Sample 103-MLA098-II at Fuel Center (Neg. No. P-2932)

TABLE 4.8. Results of Fuel Grain Size Measurements[a]

	Grain Size, µm							
	Centerline		1/3 Radius		2/3 Radius		Edge	
Sample	Intercept	True	Intercept	True	Intercept	True	Intercept	True
103-MLA098-C	10.4	16.3	11.4	17.9	10.4	16.3	11.9	18.7
103-MLA098-H	13.6	21.3	12.0	18.8	12.1	19.0	10.6	16.6
103-MLA098-N	12.5	19.6	13.8	21.7	13.0	20.4	13.8	21.7
103-MLA098-O	10.4	16.3	10.7	16.8	9.2	14.4	11.6	18.2
103-MLA098-Z	12.4	19.5	10.7	16.8	11.4	17.9	10.9	17.1
103-MLA098-AA	12.5	19.6	13.0	20.4	11.8	18.5	11.7	18.4
103-MLA098-HH	10.6	16.6	13.0	20.4	10.7	16.8	12.0	18.8
103-MLA098-II	12.0	18.8	12.0	18.8	10.8	17.0	11.3	17.7
Average ± 1 σ	11.8±1.2	18.5±1.9	12.1±1.1	19.0±1.8	11.2±1.2	17.5±1.8	11.7±1.0	18.4±1.5

(a) The true grain size equals the intercept grain size multiplied by 1.57.

operations and potential interactions with the exterior environment during disposal. The interior oxide layer is of interest for correlating fission product deposits with structural observations in the fuel as possible clues to fission product distributions. Hydride orientations are important to the strength of the cladding because of the brittle nature of zirconium hydrides.

Cladding Oxide Examinations

Oxide thickness measurements were made of the oxide and/or crud layers on the interior and exterior surfaces of the cladding of as-polished samples from Rod MLA098. The results are listed in Table 4.9. A uniform oxide layer was not present over the entire length of the interior cladding surface of Sample 103-MLA098-N taken from the peak-power region; instead, localized "islands" of oxide were present as illustrated in Figure 4.17. The Zircaloy cladding is partially thinned at the same location as the deposit buildup on the interior cladding surface. The buildup is rough in comparison to the smoothness of the cladding interior wall where there is no reaction product. The oxide layers were essentially negligible on the cladding interior surfaces of the two longitudinal samples taken near the bottom of Rod MLA098. The interior surface of the cladding of Sample 103-MLA098-Z near the bottom of the rod is shown in Figure 4.18 for comparison with the localized interior oxide layers shown in Figure 4.17 for a sample from near the middle of the rod.

The exterior oxide/crud layer decreased, in general, from the top to the bottom of the fuel rod. For each sample examined, the exterior layer was relatively uniform in thickness. Samples examined from the top and mid-length of the fuel rod had a dual-layered outer oxide layer. The total exterior layer thickness of ~8 μm at the peak-power region (mid-length of the fuel rod) had two distinct layers with cracks parallel to the cladding surface. The outermost layer appears to readily separate from the inner oxide layer that is adherent to the cladding (Figure 4.19). The oxide on the cladding exterior surface near the bottom end of the rod formed a single solid layer (Figure 4.20).

TABLE 4.9. Oxide Layer Thicknesses on Cladding of ATM-103 Samples

Sample	Axial Location, cm (in.) From Top of Fuel Rod	Oxide Thickness[a], µm (mils)					
		Exterior Layer			Interior Layer		
		Typical	Approximate Range	Observations	Typical	Approximate Range	Observations
103-MLA098-H	122.2 (48.1)	11.6 (0.46)	±1.4 (0.06)	Uniform thickness, layered	None		Negligible oxide.
103-MLA098-N	205.8 (81.0)	8.3 (0.33)[b]	±2.6 (0.10)	Uniform thickness, layered	7.8 (0.31)[c]	±2.8 (0.11)	Localized solid oxide.
103-MLA098-Z	343.1 (135.1)	3.0 (0.12)	±1.0 (0.04)	Uniform thickness, solid	None		Negligible oxide.
103-MLA098-HH	358.5 (141.1)	4.3 (0.17)	±1.4 (0.06)	Uniform thickness, solid	None		Negligible oxide.

(a) Oxide thickness determined for layers shown in Figure 4.17-20 and Appendix E with a minimum of 30 measurements. Reported range is two standard deviations. Measurements in micrometers and mils (thousandths of an inch).
(b) Reported exterior oxide layer thickness for sample 103-MLA098-N is the summation of the two distinct layers.
(c) Typical where present.

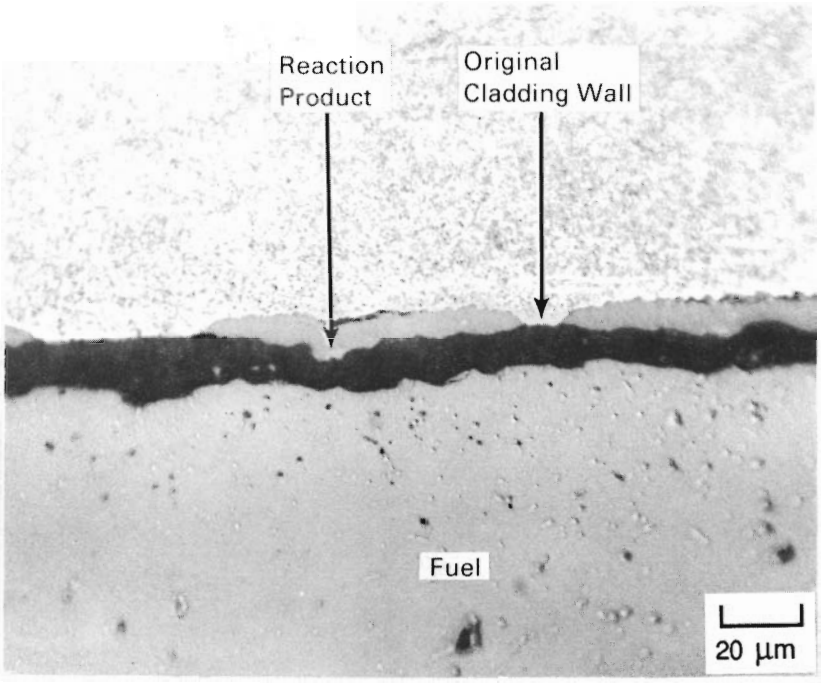


FIGURE 4.17. Interior Cladding Surface of As-Polished Sample 103-MLA098-N from Peak-Power Region (Neg. No. P-2677)

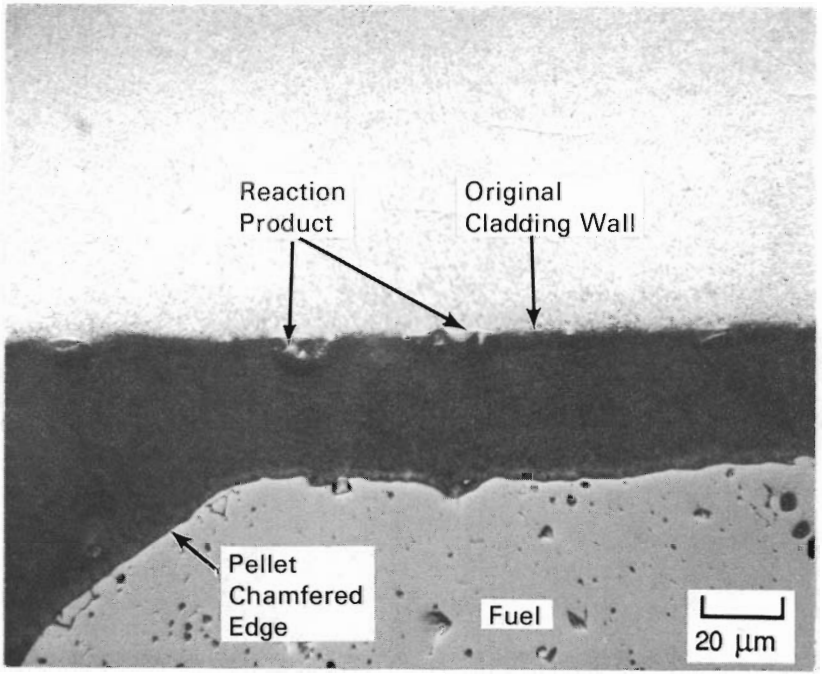


FIGURE 4.18. Interior Cladding Surface of As-Polished Sample 103-MLA098-Z from Lower End of Rod at ~82% of Peak Power (Neg. No. P-2988)

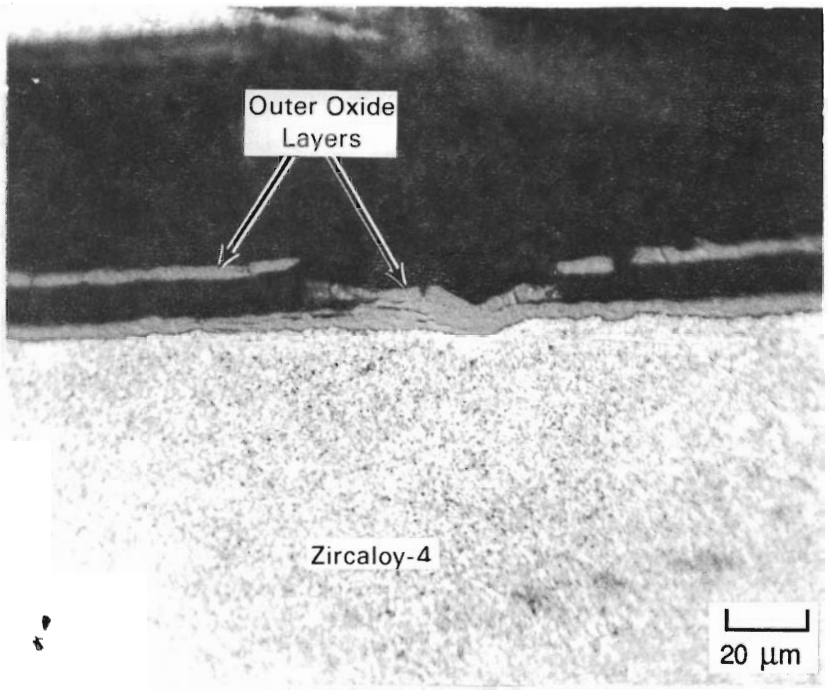


FIGURE 4.19. Exterior Cladding Surface of As-Polished Sample 103-MLA098-N from Peak-Power Region (Neg. No. P-2676)

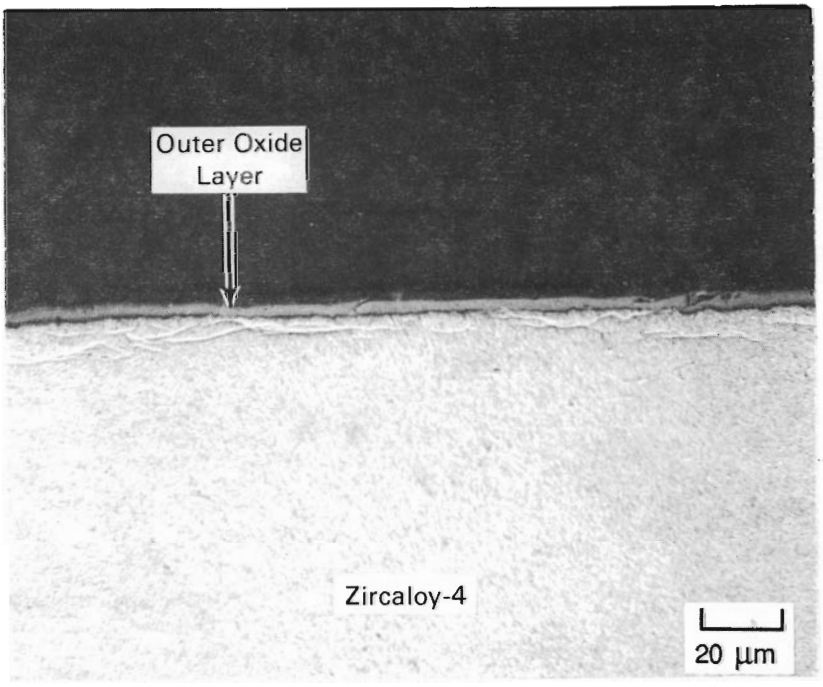


FIGURE 4.20. Exterior Cladding Surface of As-Polished Sample 103-MLA098-Z from Lower End of Rod at ~82% of Peak Power (Neg. No. P-2987)

Cladding Hydride Examinations

The Zircaloy-4 cladding is etched with 45% HNO_3, 45% glycerin, and 10% HF to reveal the cladding grain structure. This step is followed by etching with a 45% HNO_3, 45% H_2O_2, and 10% HF solution to reveal the hydrides. Hydrides in the cladding of all the metallographic samples are typically present primarily in the circumferential/longitudinal planes as shown in Figures 4.21 and 4.22. Additional examples of hydriding in the cladding are given in Appendix E.

4.5.4 Autoradiography of ATM-103 Fuel Samples

Alpha and beta-gamma autoradiographs of the ion-etched samples from Rod MLA098 were obtained to evaluate the distribution of alpha emitting isotopes and other fission products. Kodak LR115 (Type II) film and Kodak SO-343 film were used for the alpha and beta-gamma autoradiographs, respectively. The photographs were obtained by direct contact exposure on film.

The alpha and beta-gamma autoradiographs for longitudinal Sample 103-MLA098-N and transverse Sample 103-MLA098-O are shown in Figures 4.23 through 4.26. These two samples were taken from the peak-power region at the middle of the rod. The darker regions of the photographs indicate higher relative activity. The high activity in the alpha autoradiographs at the pellet outer edges indicates the preferential generation of alpha emitting isotopes such as plutonium, americium, and curium.

The beta-gamma autoradiographs (Figures 4.24 and 4.26) of the fuel sample from the peak-power region do not show any radial variations in activity. Slightly higher production of the fission products occurs near the fuel edge, as is the case for plutonium, but the higher production of fission products at the edge is not noticeable in the beta/gamma radiographs because of the range and geometric effects of gamma radiation in the fuel. The gamma radiation does shine down the cracks causing most fuel cracks to appear dark in the beta/gamma radiographs, but this does not necessarily indicate substantial fission product movement, particularly if the intensity is uniform along all the cracks. These results are similar to those for the high-power fuel from ATM-101 (Barner 1985). The lack of any radial variation across the fuel indicates that there

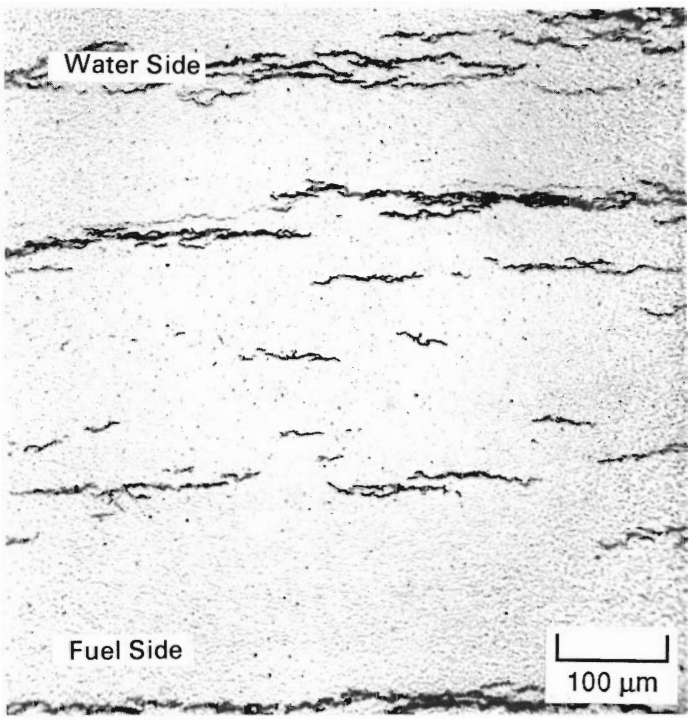


FIGURE 4.21. Etched Cladding of Longitudinal Sample 103-MLA098-N from the Peak-Power Region (Neg. No. P-3245)

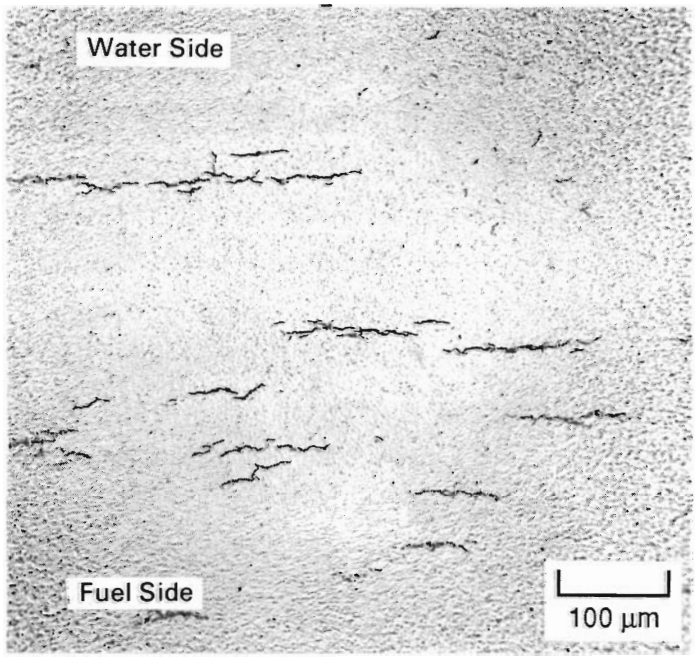


FIGURE 4.22. Etched Cladding of Transverse Sample 103-MLA098-O from the Peak-Power Region (Neg. No. P-3246)

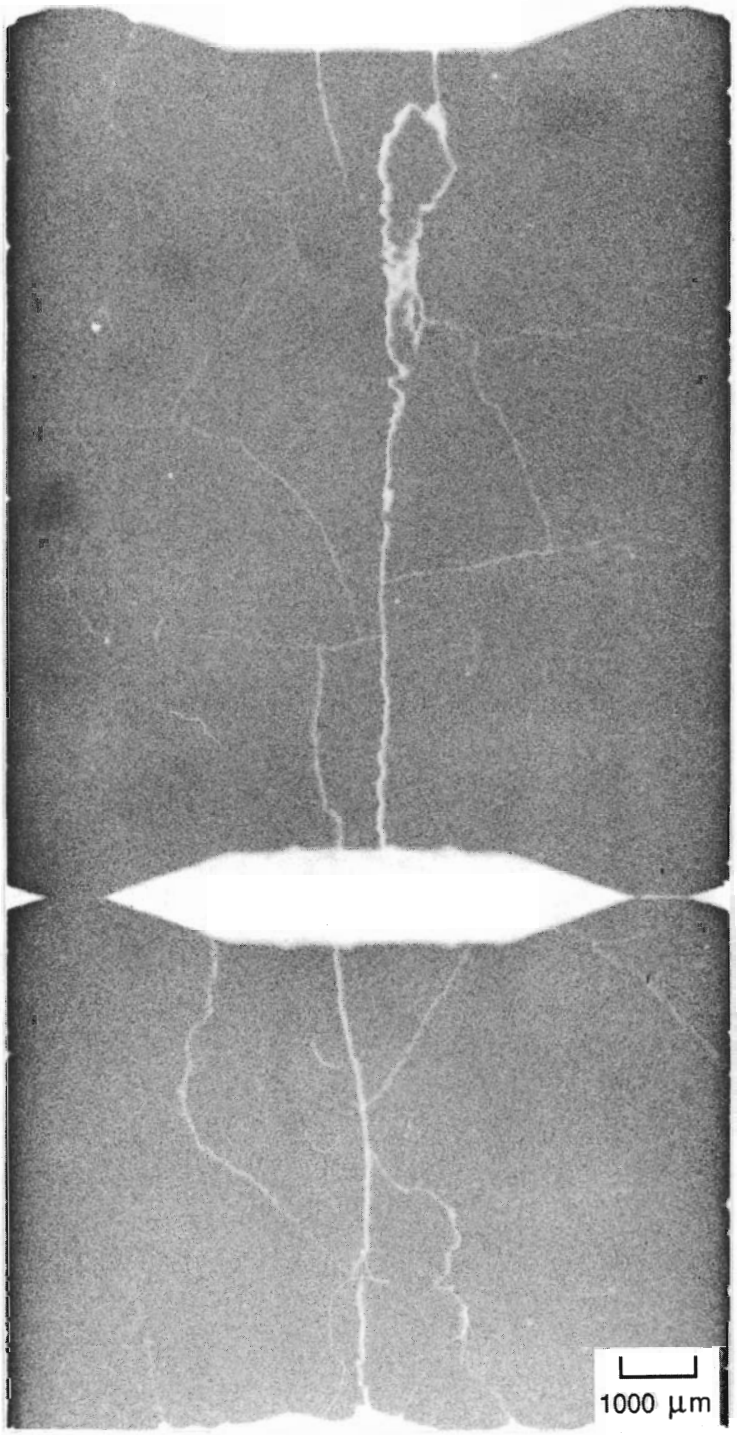


FIGURE 4.23. Alpha Autoradiograph of Longitudinal Sample 103-MLA098-N from Peak-Power Region (Neg. No. 5414)

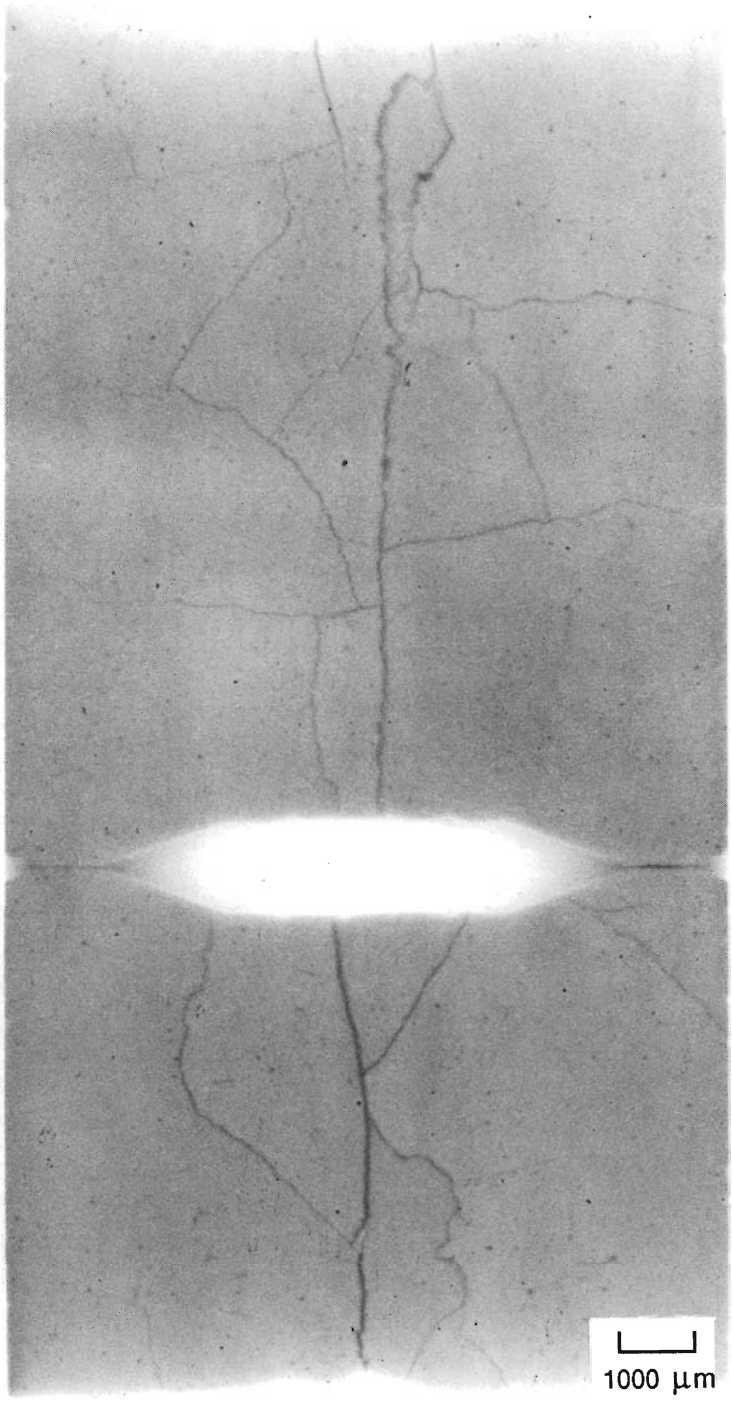


FIGURE 4.24. Beta-Gamma Autoradiograph of Longitudinal Sample 103-MLA098-N from Peak-Power Region (Neg. No. 5423)

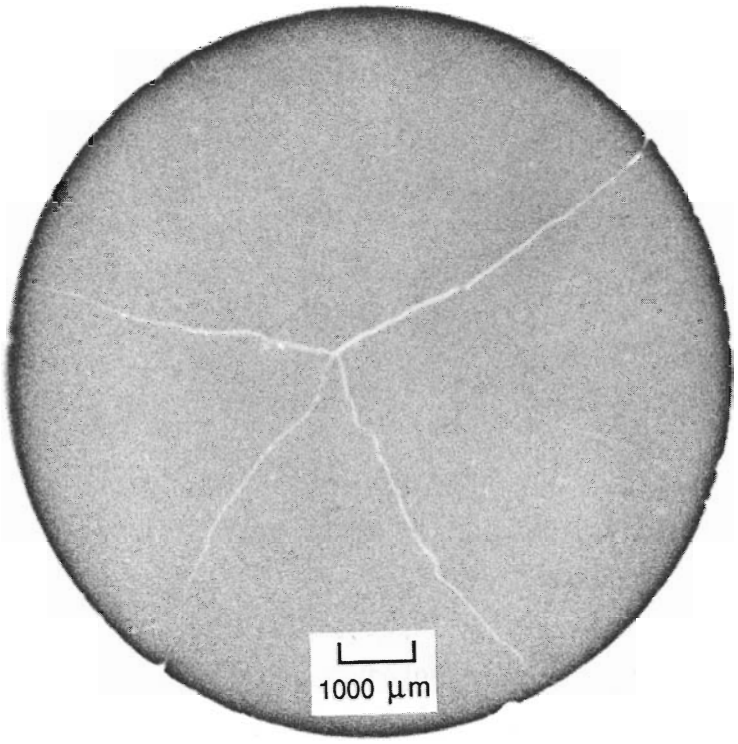


FIGURE 4.25. Alpha Autoradiograph of Transverse Sample 103-MLA098-0 from the Peak-Power Region (Neg. No. 5424)

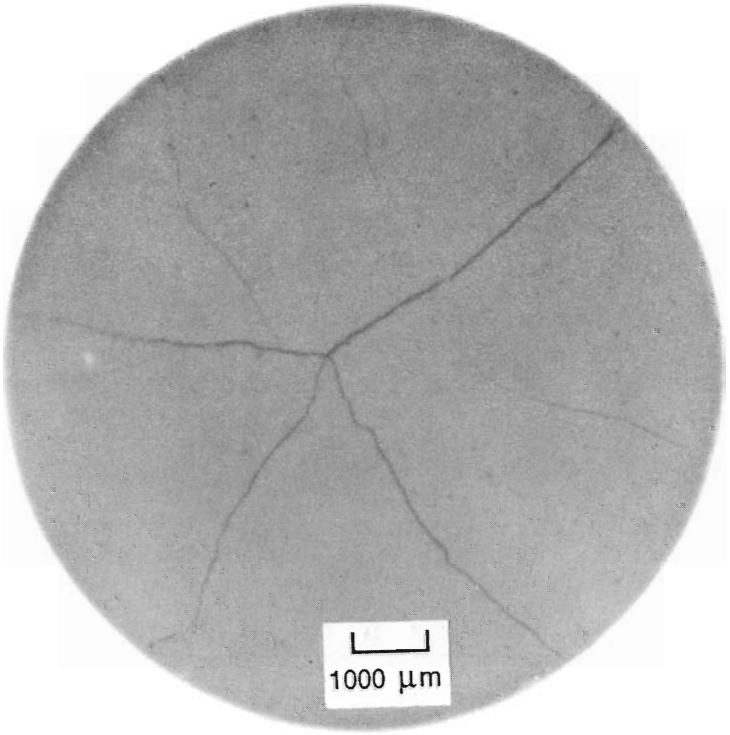


FIGURE 4.26. Beta-Gamma Autoradiograph of Transverse Sample 103-MLA098-0 from the Peak-Power Region (Neg. No. 5425)

has been no significant migration of fission products to the fuel edge or cracks; such migration would occur in fuel operated at high temperatures. The beta/gamma autoradiographs also include the region of the pellet-cladding gap, although it is difficult to see in some cases. The lack of indication of fission product movement correlates with the lack of grain growth in the fuel, no indication of fission product movement in the gamma scans, and low fission gas release.

4.6 SPECIAL FUEL STUDIES

Special studies are being conducted on the spent fuel ATMs to enhance characterization of microstructural features that could affect the rate of release of radionuclides from spent fuel in a geologic repository. One technique being used to carry out such characterization is analytical transmission electron microscopy (AEM). Fission product aggregates (gas bubbles and solid particles) were too small to be observed in significant amounts by optical microscopy of the moderate burnup, low-releasing ATM-103 and ATM-101 spent fuels (see Section 4.5.2 and Barner 1985). However, AEM indicates that very small gas bubbles and solid particles are present in the fuel in high numbers at grain boundaries and within the UO_2 grains. AEM allows the observation of fuel microstructures at resolutions approaching the atomic level and provides compositional analyses and phase identification of particles as small as about 20 nm in diameter. Such analyses may afford a means of understanding differences between various fuel samples that might otherwise seem similar based on radiochemical or ceramographic evidence alone.

Information is provided below on the preparation techniques, equipment, and analytical techniques used to perform these analyses; analytical results for AEM of three samples (small fuel particles) taken from locations along the fuel radius of Sample 103-MLA098-R; and discussion of the implications of these results.

4.6.1 Experimental Details of Special Studies by AEM

Sample 103-MLA098-R was taken from the peak-power region of Rod MLA098 (see Appendix D) to provide small fuel samples that could be characterized by AEM. These fuel samples, approximately 200 μm in diameter, were selected from

three radial locations (the outer edge, mid-radius, and fuel pellet center) on the as-cut fuel surface of Sample 103-MLA098-R, and prepared for examination. Preparation of the three fuel samples for AEM involved potting a single sample into a 3-mm diameter molybdenum or copper washer with epoxy resin, grinding the embedded sample to about 15 μm thickness, and ion micromilling to produce "electron-transparent" regions (50 to 150 nm thick) for AEM. Details of the preparation method are given by McCarthy and Thomas (1985). No water was used in preparing the samples; however, acetone, ethanol, and Freon TF solvents were used for necessary sample cleaning. Finished samples contained only about 10 μg of fuel held in epoxy; consequently, they could be handled and analyzed without special shielding.

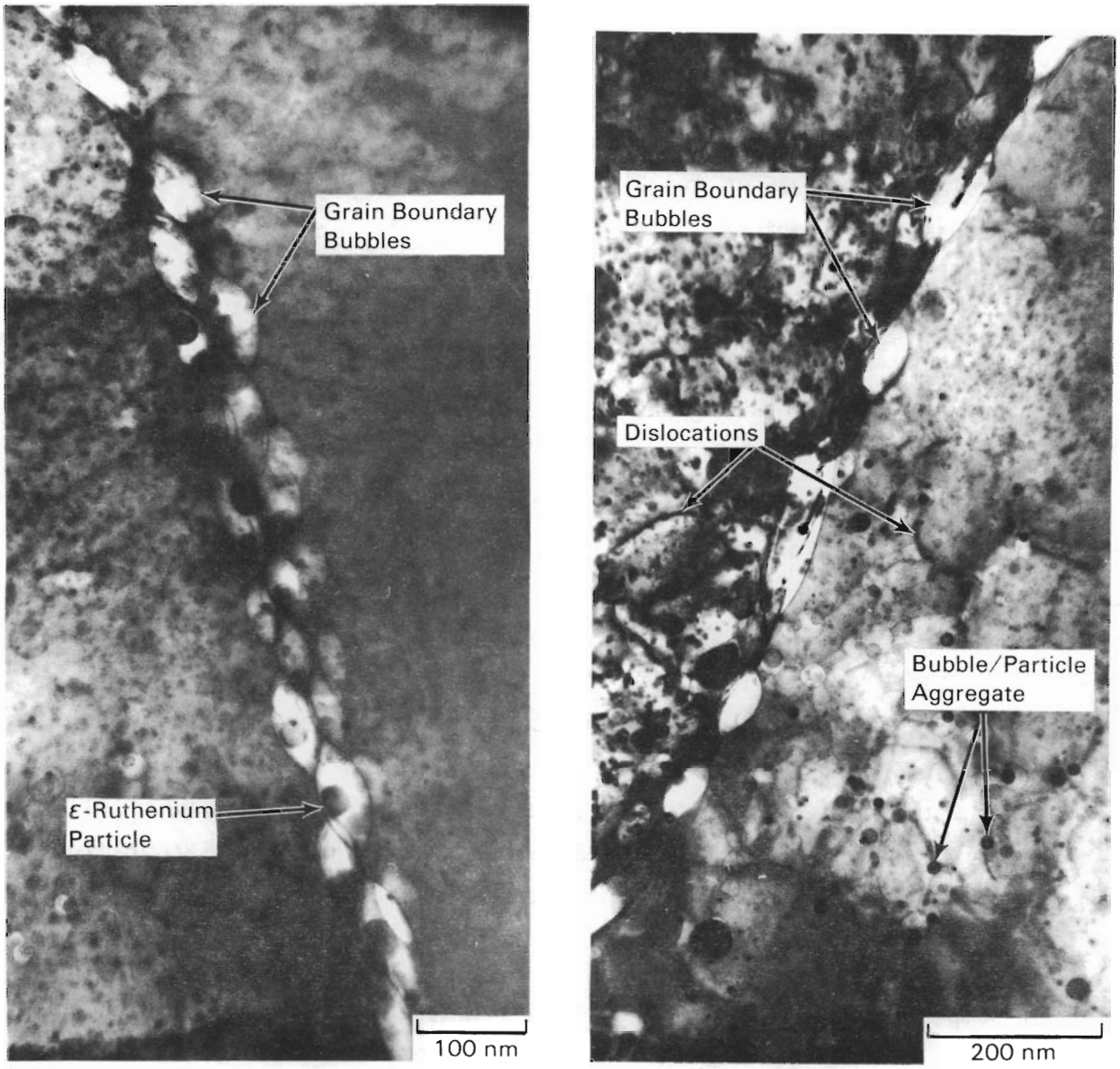
Microstructural, compositional, and crystallographic analyses were performed in a 200 kV transmission/scanning transmission electron microscope (TEM/STEM) equipped with a Si(Li) detector for energy-dispersive X-ray spectrometry (EDS). Analysis methods included brightfield TEM microstructural imaging, selected-area and microbeam electron diffraction for phase identification, and EDS for qualitative and semi-quantitative elemental analyses of sample micro-areas as small as 20 nm in diameter. The X-ray (EDS) detector used in this work was sensitive to all elements heavier than neon (Z = 10), and gave minimum detection limits of 0.3 to 0.5 wt%, although the accuracies of compositions determined with the detector are not defined.

4.6.2 Results of AEM Special Studies

Fuel samples from the outer edge, mid-radius, and center of the fuel in Sample 103-MLA098-R contained different types, sizes, and distributions of fission product aggregates. Descriptions of the microstructures and analyses of fission products are given below.

AEM of Material From Near Fuel Edge

In the fuel sample taken from near the outer fuel edge, high densities of coprecipitated particles and gas bubbles are present along grain boundaries and throughout the UO_2 grains. Grain boundaries at this location are decorated with 80- to 100-nm diameter lenticular bubbles and associated smaller solid particles, as shown in Figures 4.27a and 4.27b. The grain boundary bubbles and



a. Thicker TEM Sample Region (Neg. LT 1407)

b. Thinner TEM Sample Region (Neg. LT 1401)

FIGURE 4.27. Lenticular Bubbles on Grain Boundaries in Fuel Sample Taken from Near Outer Edge of Sample 103-MLA098-R

particles in a relatively thick (~150 nm) region of the fuel sample are shown in Figure 4.27a. Dislocations, bubbles, and particles in a thinner grain boundary region of the same edge sample are shown in Figure 4.27b. Regions next to grain boundaries contain high densities of dislocations and particle/bubble aggregates. Enlarged bubbles and particles are also present along dislocations. The bubbles and particles appear to coprecipitate, and particles often appear to have formed within the bubbles.

Bubble/particle aggregates near the center of a UO_2 grain in the edge fuel sample are shown in Figure 4.28; the particles are next to, or in, the bubbles. The intragranular particles are typically 10 nm in diameter. Any fission gases in the bubbles were below the detection limit of EDS analysis. EDS analysis showed only molybdenum, ruthenium, technetium, palladium, and rhodium in the particles.

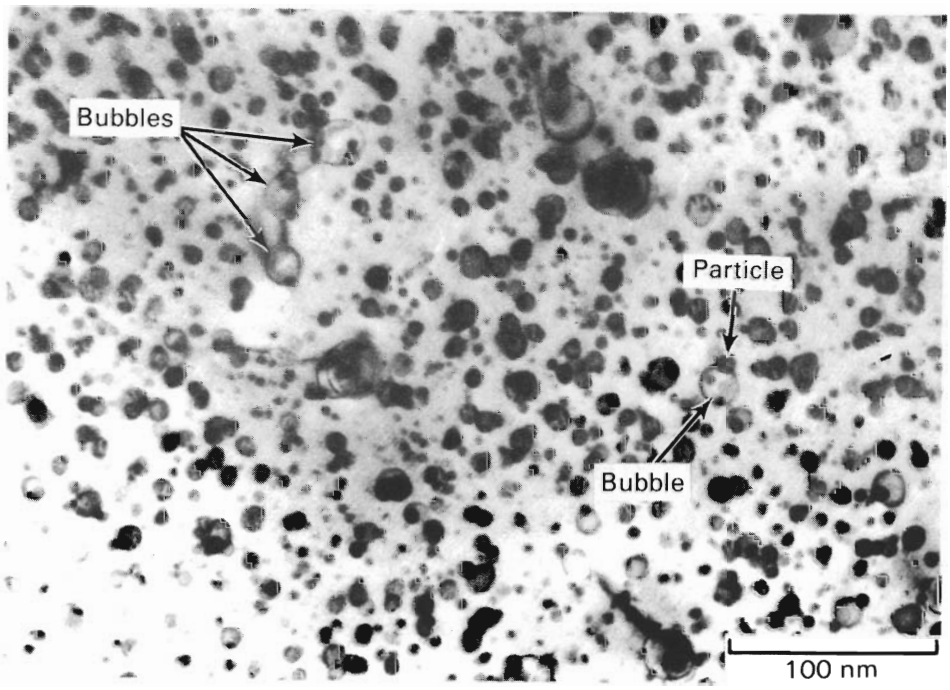


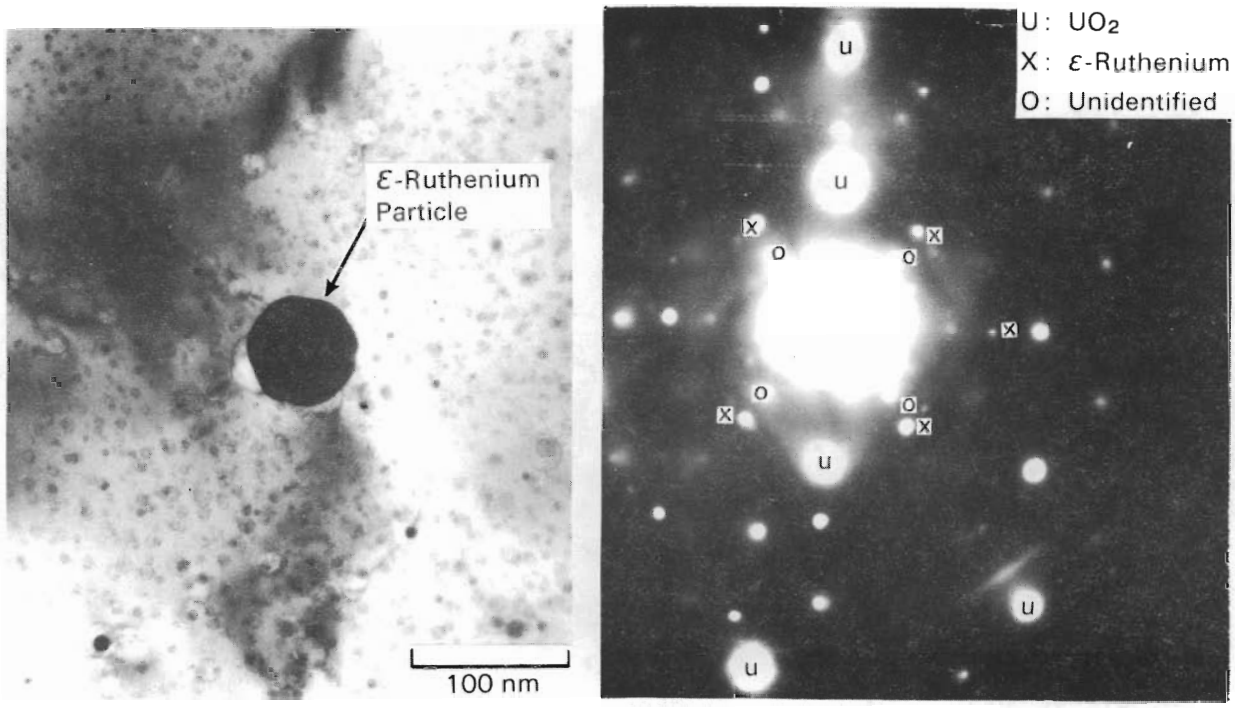
FIGURE 4.28. Distribution of Bubbles/Particles at Intragranular Location in Fuel Particle Taken from Outer Edge of Sample 103-MLA098-R. (Neg. LT 1190)

All fission product particles that were identified at grain boundaries or within the UO_2 grains of the edge fuel sample were ε-ruthenium, a hexagonal close-packed solid solution alloy containing molybdenum, ruthenium, technetium, palladium, and rhodium (five-metal particle). Results of the analyses of a 70-nm diameter particle observed in the fuel sample taken from the edge of Sample 103-MLA098-R are shown in Figure 4.29. A micrograph of the 70-nm five-metal particle is shown in Figure 4.29a. The EDS spectrum for this particle (Figure 4.29b) contains characteristic X-ray peaks from the five constituent metals of the ε-ruthenium phase as well as uranium peaks from the UO_2 matrix that encloses the particle. There is also a small copper contribution from the sample mounting washer. The particle composition was determined to be 39.9 wt% molybdenum, 42.3 wt% ruthenium, 11.8 wt% technetium, 5.6 wt% rhodium, and 0.4 wt% palladium, using a standardless semiquantitative analysis program.

The selected-area electron diffraction pattern of the five-metal particle was obtained by tilting the sample to a low-index zone axis of the particle. The diffraction pattern for this particle is shown in Figure 4.29c and contains spots from at least three phases: 1) the α-UO_2 matrix, 2) the ε-ruthenium phase in a $[10\bar{1}1]$ orientation, and 3) an unidentified hcp phase, also in a $[10\bar{1}1]$ orientation but with a crystal lattice size different than the ε-ruthenium phase. The hcp lattice parameters of the ε-ruthenium phase determined by diffraction pattern measurements were a = 0.273 nm and c/a = 1.61, is agreement with previous x-ray diffraction work on spent fuel (Kleykamp and Pejsa 1984). Lattice parameters of the unidentified phase are a = 3.82 and c/a = 1.60. The random orientation of particles in the UO_2 matrix and the small particle sizes made it impractical to perform diffraction analyses on many particles. However, particle compositions determined by EDS indicate that the particles in the fuel sample taken from the edge of Sample 103-MLA098-R are predominantly ε-ruthenium.

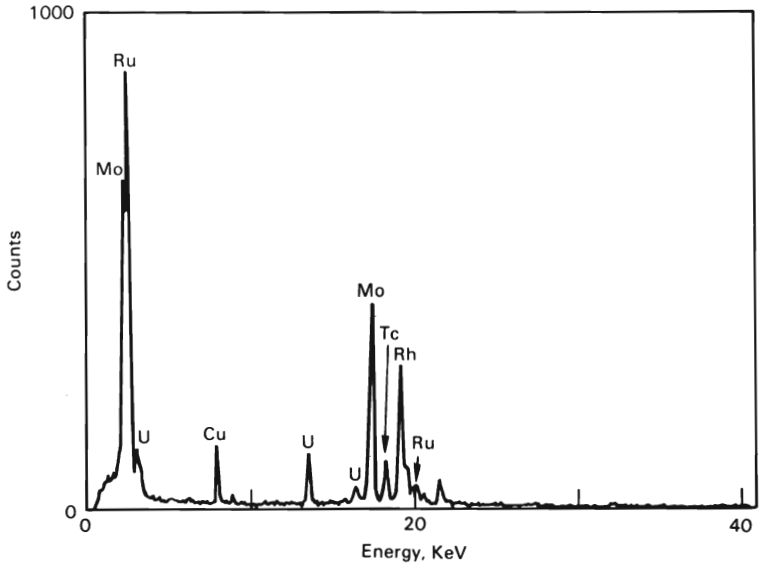
AEM of Material From Fuel Mid-Radius

The mid-radius fuel differs substantially from the fuel from near the edge of Sample 103-MLA098-R. The grain boundaries lack the array of bubbles seen at the outer edge of the fuel and are sometimes cracked apart as shown in Figure 4.30. Large, 100-nm-diameter particles along the grain boundaries were



a. Micrograph of ε-Ruthenium Particle (Neg. LT 1182)

c. Electron Diffraction Pattern of ε-Ruthenium Particle (Neg. LT 1186)



b. EDS Spectra of ε-Ruthenium Particle

FIGURE 4.29. ε-Ruthenium Particle Examined in Fuel Sample from Near the Outer Edge of Sample 103-MLA098-R.

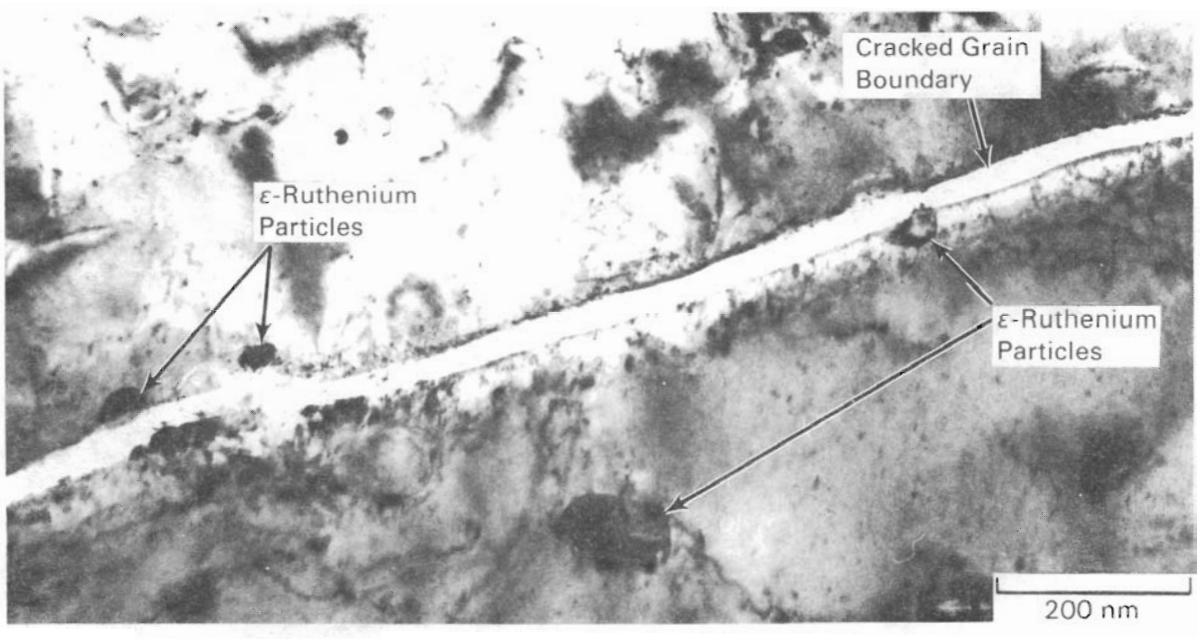


FIGURE 4.30. Example of Cracked Grain Boundary and ε-Ruthenium Particles in Fuel Taken from Mid-Radius of Sample 103-MLA098-R (Neg. LT 1032)

identified by EDS analysis as the ε-ruthenium phase. Intragranular particle and dislocation densities are much lower than those in the outer edge sample, and few gas bubbles are present.

As shown in Figure 4.31, there are two distinct particle sizes within the UO_2 grains of the mid-radius fuel sample: 1) large 80- to 100-nm-diameter particles, and 2) small 10-nm particles. The larger 80- to 100-nm-diameter particles were identified as ε-ruthenium by EDS and electron diffraction analyses. Where these particles intersect the sample surfaces, large, often triangular-appearing pits appear next to the particles (Figure 4.31). Matrix regions around the larger particles are highly strained; the particles are surrounded by dense dislocation tangles. The regions near the smaller particles within the grains appeared unstrained and are often associated with bubbles of similar diameter. The presence of molybdenum and ruthenium near detection limits in the analysis of the small particles suggests that they are also ε-ruthenium.

EDS analysis of the 80- to 100-nm-diameter particles in the mid-radius sample also revealed high concentrations of xenon associated with many of the

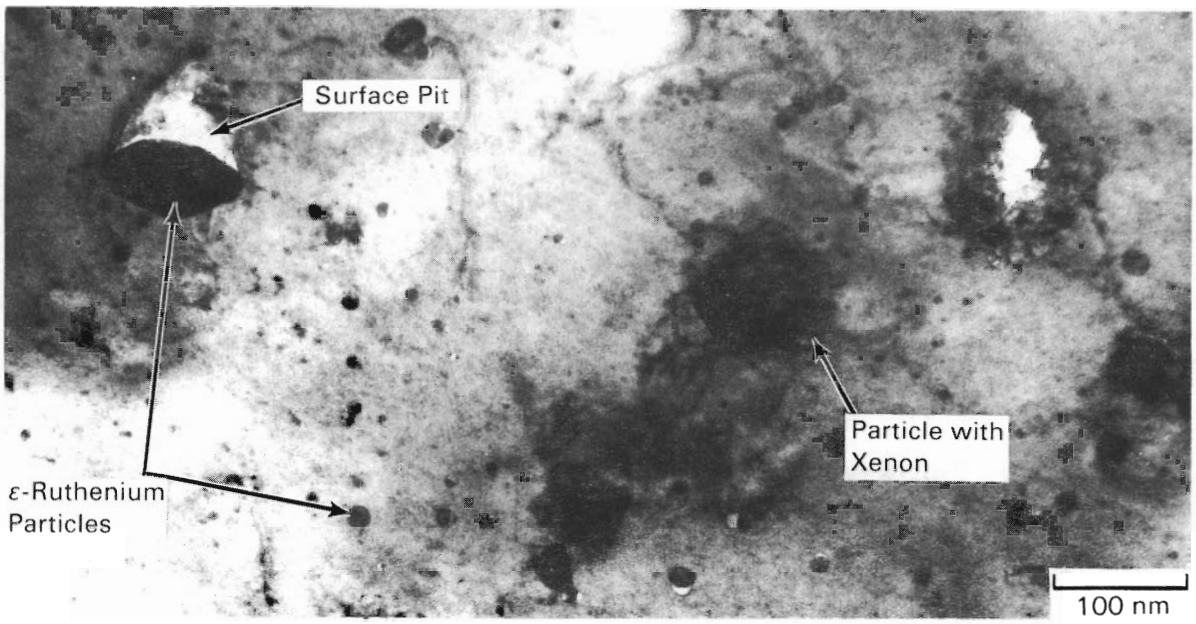
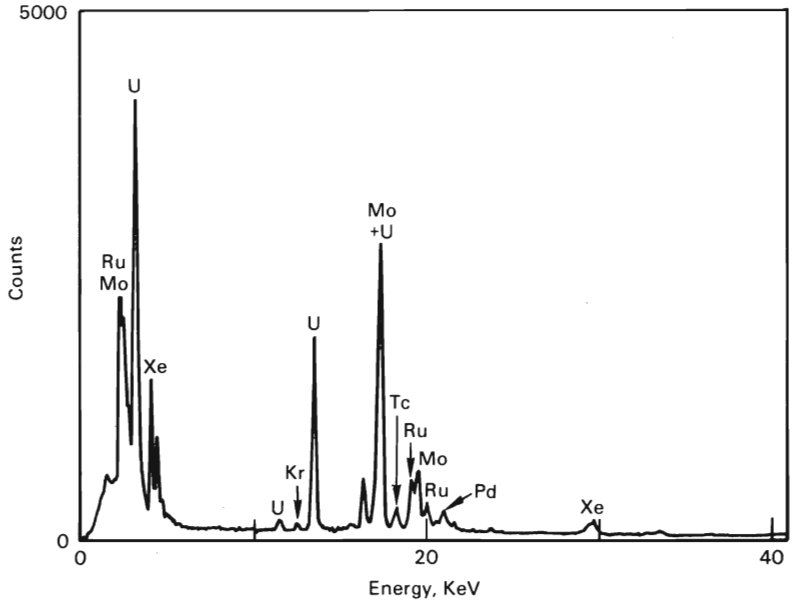
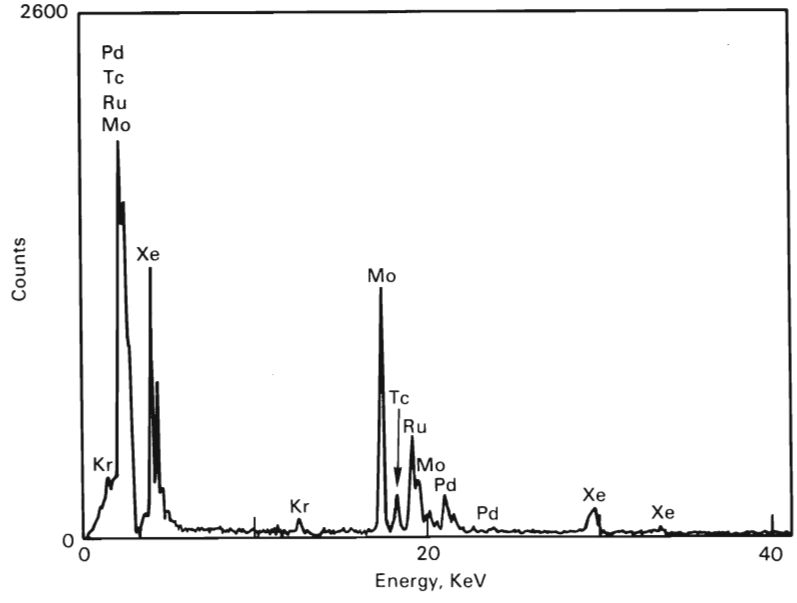


FIGURE 4.31. Example of Particle Sizes Within the Grains of Fuel Taken from Mid-Radius of Sample 103-MLA098-R (Neg. LT 1058)

particles. Spectra from a xenon-containing particle before and after removal of UO_2 matrix contributions are shown in Figure 4.32a and 4.32b, respectively. A spectrum from an adjacent particle-free UO_2 region was used to remove the uranium and spurious molybdenum contributions (from the mounting material) from the spectra in Figure 4.32a. All of the characteristic xenon-L and xenon-K X-ray emission peaks from xenon are visible in these spectra. Smaller peaks also indicate krypton associated with the particles. A typical result of semiquantitative EDS analysis from a xenon-containing particle gave 44.0 wt% molybdenum, 19.2 wt% ruthenium, 6.9 wt% technetium, 9.9 wt% palladium, 4.7 wt% rhodium, 14.0 wt% xenon, and 1.3 wt% krypton. Further EDS and stereoscopic image analyses showed that the xenon is locally concentrated at one side of the ε-ruthenium particles and that xenon is present only at particles that are entirely enclosed within UO_2 (see Figure 4.31). Particles that were cut open during sample preparation contain the five metal components of the ε-ruthenium phase but lack detectable xenon or krypton.



a. EDS Spectrum of Xenon-containing Particle Plus Surrounding UO_2 Matrix



b. EDS Spectrum of Xenon-containing Particle With UO_2 Matrix Contribution Removed

FIGURE 4.32. EDS Spectrum of Xenon-Containing Region from Fuel Sample at the Mid-Radius of Sample 103-MLA098-R

The only fission product elements detected by EDS analysis in the mid-radius sample were xenon, minor krypton, and the five-metal alloy phase elements. Analyses of grain boundary, particle, and matrix regions showed no concentrations of other fission products above the detection limits of EDS (about 0.3 wt%).

AEM of Material From Fuel Center

The fuel examined from the center of Sample 103-MLA098-R also contains high densities of xenon-containing particles but few apparent gas bubbles. Grain boundaries appear bubble-free, as shown in Figure 4.33, but are decorated with 100- to 1000-nm particles that were identified as ε-ruthenium. The possibility that bubbles larger than 1 μm exist in the center of the fuel cannot be excluded based on AEM examination alone. The large xenon-containing particles, some nearly 200 nm in diameter, are surrounded by dislocation tangles near the center of a UO_2 grain in Figure 4.34.

In one EDS analysis of a particle using a 20-nm diameter electron probe, essentially only xenon and krypton were indicated in the analysis region after the uranium contribution from the surrounding UO_2 matrix was subtracted. This

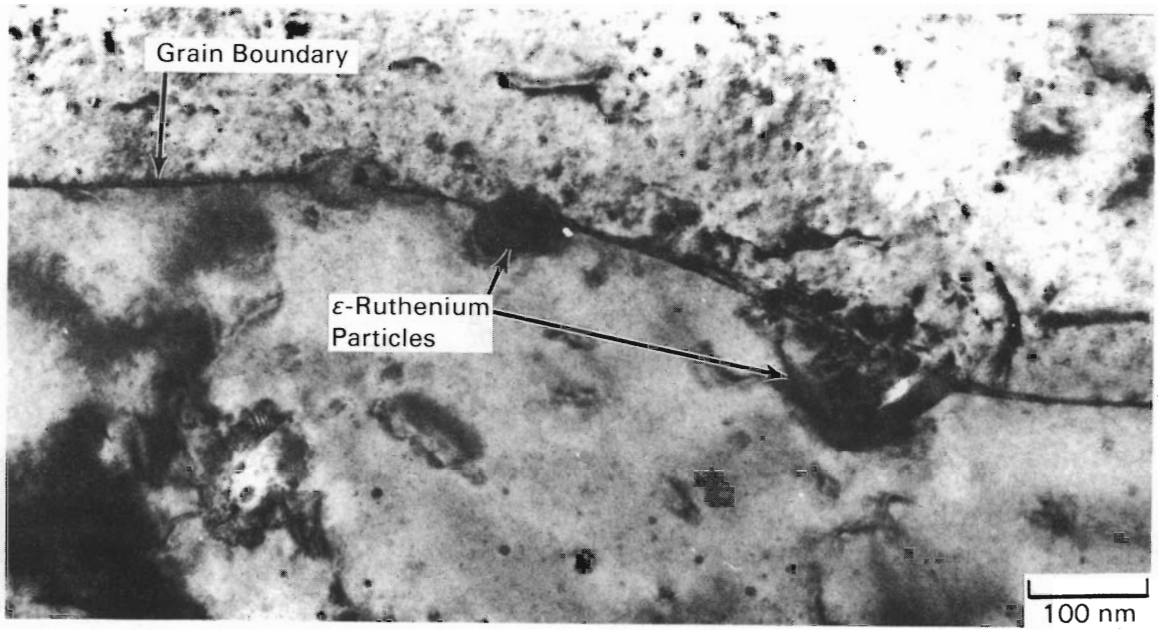


FIGURE 4.33. Bubble-Free Grain Boundary at Fuel Center of Sample 103-MLA098-R (Neg. LT 1335)

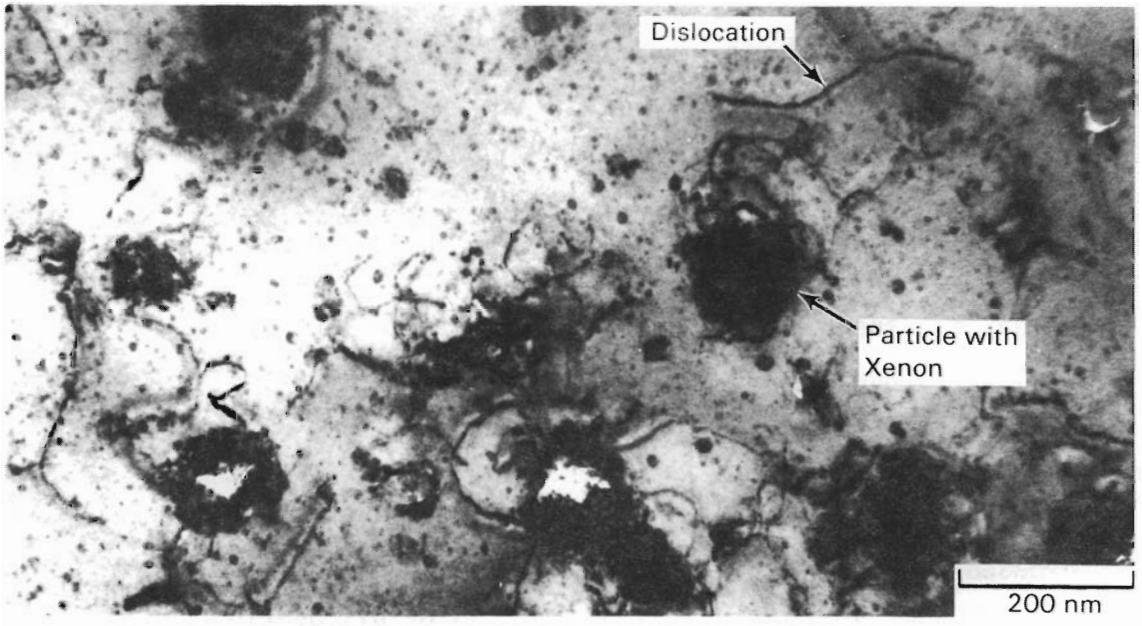


FIGURE 4.34. Large Xenon-containing Particle Surrounded by Dislocation Tangles (Neg. LT 1308)

observation further indicates that the xenon/krypton phase is distinct from the ε-ruthenium particles. Efforts to detect diffraction from the xenon phase to confirm its possible existence as a solid has been unsuccessful thus far. The ε-ruthenium and xenon/krypton were the only fission product phases found in the fuel sample taken from the center of Sample 103-MLA098-R.

4.6.3 Implications of AEM Analyses

The results of AEM for the radial locations examined in Sample 103-MLA098-R indicate that changes are occuring at a microscopic level in the fuel that are not visible by ceramography. Optical examination of the ceramographic samples from Rod MLA098 (see Section 4.5) indicated no grain growth or observable formation of ε-ruthenium (metallic ingots) within the fuel grains or at grain boundaries. Fission gas analyses (see Section 4.3) indicated that the ATM-103 fuel released only a small amount (0.25%) of the fission gas produced, which is typical of moderate-burnup fuel operated at typical LHGRs. However, AEM indicated variations in the distribution of fission gas and in the distribution and size of fission product particles.

The predominant fission product phase observed in ATM-103 spent fuel is the five-metal (molybdenum, ruthenium, technetium, rhodium, and palladium) alloy solid-solution phase, denoted as ε-ruthenium. Xenon and krypton were the only other fission products detected in the fuel, presumably because the rest are evenly distributed within the fuel at levels below the detection limit for EDS. The ε-ruthenium phase forms high densities of spheroidal particles, most of which are too small to observe by optical microscopy, along grain boundaries and within the UO_2 grain interiors.

Submicrometer sized bubbles are also present in very high numbers near the outer edge of the fuel rod, and are always found in association with ε-ruthenium particles. The bubbles in the edge fuel sample do not contain high enough gas concentrations to permit detection of xenon or krypton by EDS microanalysis, but are believed to contain these fission gases. However, the fission gases form a high-density phase, possibly a liquid or solid, near the mid-radius and center of the fuel from Sample 103-MLA098-R. The relative intensities of xenon and uranium in x-ray spectra from the particles (see Figure 4.32a) suggests that the xenon density is the same order of magnitude as that of UO_2 fuel.

To attain such high densities in UO_2 fuel, the xenon must be under very high pressure. The formation of dislocation tangles and diffraction evidence of high strains around the xenon-containing particles (see Figure 4.34) supports the presence of such high pressures. Relief of particle pressures by plastic deformation and dislocation multiplication in UO_2 implies pressures of 1 to 3 GPa (~150,000 to 440,000 psi) (Greenwood, Foreman, and Rimmer 1959), which would be high enough to form solid xenon at room temperature. Solid xenon and krypton at similar particle pressures are known to exist in ion-bombarded metals (Templier, Garem, and Riviere 1986).

The AEM examinations of three radial fuel samples from ATM-103, and ongoing examinations of other ATMs, suggest that xenon and krypton may form condensed phases at high pressures in the mid-radius to center fuel regions where operating temperatures during irradiation are higher than at the fuel edge. Fission gases in fuel are generally believed to exist as gas bubbles or atoms in solution in the UO_2. The existence of xenon under high pressures in

the irradiated UO_2 fuel is likely to be important to evaluations of fission gas release from the fuel during in-reactor temperature excursions and under embrittling oxidation conditions that could potentially occur during storage or disposal.

4.7 NUCLIDE INVENTORY AND RADIOACTIVITY CALCULATIONS

Burnup and decay calculations were made with the ORIGEN2 code (Croff 1980a, Croff 1980b) to estimate the nuclide inventories in the fuel and the cladding as a function of exposure and decay times. This information is useful for comparing with the measured values obtained by radiochemical methods. The comparison of measured and predicted values of radionuclides in the fuel and cladding provides a means of checking the validity of the predictions as well as the measurements. The ORIGEN2 code and the decay, photon, and cross-section libraries were obtained from the Radiation Shielding Information Center in July 1986. A summary of the input data for making the calculations is provided below, including fuel composition, cladding composition, and power history.

The fuel composition given in Table 4.10 was used as a basis for ORIGEN2 input. It is based on information reported by Combustion Engineering[a] and reproduced in Section 4.1, except for the ^{234}U content. The ^{234}U content was estimated by interpolating between published values for fuels of various ^{235}U enrichments.

The cladding composition given in Table 4.11 was also used as a basis for ORIGEN2 input. It is based on information reported by C-E[a], also reported in Section 4.1, plus nominal values assumed for the cladding. There are 4.514 g of uranium for each gram of cladding over the UO_2 bearing length of the rod.

The irradiation history shown in Figure 4.6 and tabulated in Appendix A was used as a basis for ORIGEN2 input. Nuclide inventories were calculated for decay times of 6, 8, 10, 12, 15, 20, and 1000 years after discharge from the reactor. These times bracket the period during which experimenters may be

(a) Fuel Characterization Report for DOE Spent Fuel for Repository Studies. January 1986. Report to Pacific Northwest Laboratory from Combustion Engineering, Inc., PNL P.O. MS5313F, CE Contract 12585.

TABLE 4.10. Fuel Composition of ATM-103 Assumed for ORIGEN2 Calculations

Parameter	Value[a]
Enrichment, wt%	2.72
^{234}U, ppm	221[b]
Total Uranium, wt%	88.15
Oxygen, wt%	11.85
Carbon, ppm	12
Nitrogen, ppm	24
Fluorine, ppm	5
Chlorine, ppm	5
Iron, ppm	52
Silver, ppm	1
Calcium, ppm	40
Aluminum, ppm	40
Silicon, ppm	40
Nickel, ppm	25

(a) Based on measured values (see Table 4.1).
(b) Based on other fuel enrichments.

TABLE 4.11. Cladding Composition of ATM-103 Assumed for ORIGEN2 Calculations

Parameter	Value
Zirconium, wt%	98.0
Tin, wt%	1.5[a]
Iron, wt%	0.2[a]
Chromium, wt%	0.1[a]
Aluminum, ppm	40[a]
Hafnium, ppm	55[a]
Silicon, ppm	80[a]
Oxygen, ppm	1257[b]
Carbon, ppm	137[b]
Nitrogen, ppm	30[b]
Hydrogen, ppm	14[b]

(a) Nominal values.
(b) Average of measured values (see Table 4.2).

evaluating this fuel and approximate a common time at which long-term repository calculations are made. Appendix F contains tables of the ORIGEN2 output for burnup exposures of 15, 20, 25, 30, and 35 MWd/kgM; these burnups bracket those that occur at different axial locations in the ATM-103 fuel rods.

4.8 RADIOCHEMICAL ANALYSES

This section provides the results from radiochemical analyses of the fuel and cladding from Rod MLA098 of ATM-103. Figure 4.35 provides a general view of the locations of the fuel samples used for radiochemical analyses of the ATM-103 fuel rod. Two pairs of fuel samples were taken from the upper half and three sets of three fuel sections were taken from the lower half of Rod MLA098. The analyses performed on the fuel and cladding specimens are indicated in Figure 4.35. In the lower three sets of fuel samples an additional fuel sample is included to measure the fuel burnup, the isotopes of uranium and plutonium, and specific nuclides: ^{79}Se, ^{90}Sr, ^{99}Tc, ^{126}Sn, ^{135}Cs, ^{137}Cs, ^{237}Np, ^{241}Am, and ^{244}Cm. Additional details of these fuel sections, as they relate to other samples cut from Rod MLA098, are provided in Appendix D. The procedures used in performing the radiochemistry analyses are described in Table 4.12. Results from the fuel burnup analyses are given in Sections 4.8.1. Radiochemistry of the fuel and cladding are discussed in Sections 4.8.2 and 4.8.3, respectively.

4.8.1 Fuel Burnup Measurements

Burnup analyses were completed on three fuel samples from the lower half of Rod MLA098 at positions representative of three burnup levels as indicated by the amount of ^{137}Cs activity. The measured burnup for these samples have been correlated to the ^{137}Cs gamma scan results in order to estimate the burnup and radionuclide content of any particular sample from ATM-103 that might be provided to a repository experimenter. The burnup analyses were performed according to Technical Procedure HTA-4-25, Revision 1.(a)

The results of the burnup analyses are listed in Table 4.13. Values are presented for burnups based on the measured amounts of ^{148}Nd as well as burnups derived from the ^{137}Cs contents indicated in the burnup measurements. The

(a) Copies of procedures are available upon request from the MCC.

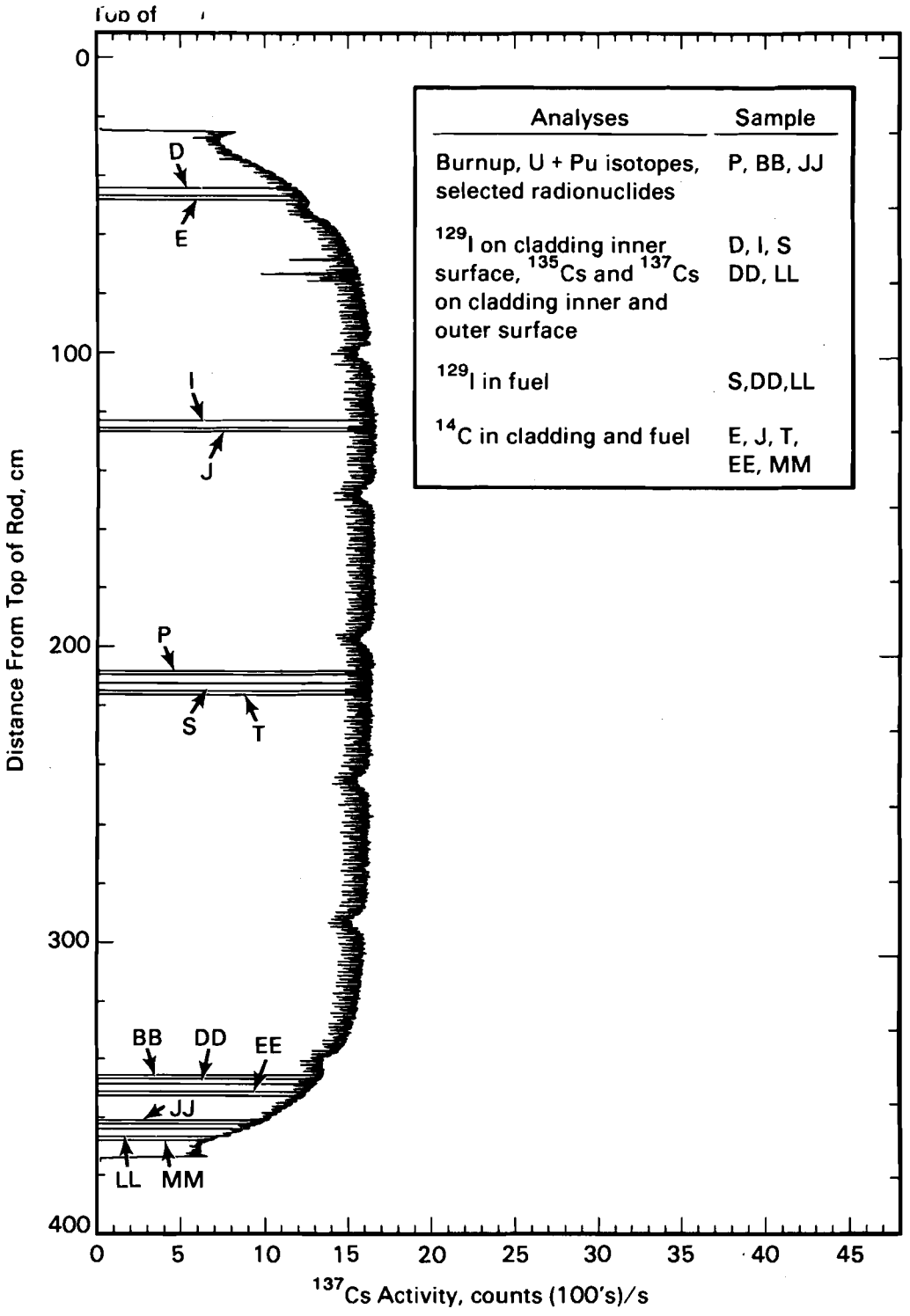


FIGURE 4.35. General Locations of Samples Used for Radiochemical Analyses of Rod MLA098

TABLE 4.12. Description of Radiochemical Analysis Procedures[a]

Analysis	Procedure	Description
Fuel		
Sample Preparation	HTA-4-24	Weighed sample is dissolved in heated 12N HNO_3 (+trace HF). Solution is separated from cladding and made up to 100 ml. Aliquots are taken for subsequent analyses.
Burnup (including U and Pu isotopes)	HTA-4-25	Fission product neodymium is chemically separated from irradiated fuel and determined by isotopic dilution mass spectrometry. Enriched ^{150}Nd is used as the neodymium isotope diluent, and mass 142 is used to determine natural neodymium contamination. Uranium and plutonium are also determined by mass spectrometry. The method uses a calibrated triple spike of ^{150}Nd, ^{233}U, and ^{242}Pu per ANSI/ASTM Standard Test Method E321-79.
^{14}C	HTA-4-28	The carbon in a specially-crushed sample of the fuel is evolved by combustion in pure oxygen. The CO_2 is collected and ^{14}C is measured by liquid scintillation counting.
^{79}Se	HTA-4-18	Selenium-79 is separated from other radioactive species by passsing the chemically-adjusted solution through a cation plus anion exchange resin column. The selenium in the column effluent is distilled from hydrobromic acid and precipitated as metal by reducing it with hydroxylamine hydrochloride. The reduced metal is dissolved in nitric acid, and the ^{79}Se is measured using liquid scintillation counting.
^{90}Sr	HTA-4-11	The ^{90}Sr is separated from other radioactive species by selective elution from a cation exchange resin using 2-methyllactic acid. Following separation, the growth of ^{90}Y is measured by beta counting. The ^{90}Sr is then calculated, based on the growth of the ^{90}Y daughter over a measured period of time.

TABLE 4.12. (contd)

Analysis	Procedure	Description
Fuel (contd)		
^{99}Tc	HTA-4-12	Technetium is separated from other radioactive species by a process that absorbs most of the other species onto a cation exchange resin. The technetium is extracted from the effluent into hexone as tetraphenylarsonium pertechnetate. The technetium activity is then measured by beta counting.
^{129}I	HTA-4-29	Iodine is separated by distillation and precipitation as AgI. Iodine-129 is determined in a GeLi well detector.
^{126}Sn	HTA-4-21	Tin is separated by combination of cation and anion exchange resins. Tin is finally eluted with dilute nitric acid and measured using a GeLi gamma spectrometer.
^{135}Cs	HTA-4-40	Cesium is separated from other elements by chromatographic elution from a cation exchange column. Isotopic abundance of cesium isotope is determined by mass spectrometry.
^{137}Cs	HTA-4-9	The cesium is determined by gamma ray spectrometry on an aliquot of the aqueous solution.
^{237}Np	HTA-4-27	Neptunium-237 is separated from other radionuclides by extraction into a mixture of tri-iso-octyl-amine (TiOA) in xylene, stripped from the TiOA phase with HCl and re-extraction into a mixture of thenoyltrifluoracetone (TTA) in xylene for additional separation. Neptunium-237 is measured by alpha counting. A ^{239}Np tracer is added to the sample and gamma-counted to determine a recovery factor.

TABLE 4.12. (contd)

Analysis	Procedure	Description
Fuel (contd)		
^{241}Am, $^{243}Cm+^{244}Cm$	HTA-4-38 or 13	Americium and curium are separated using cation and anion exchange and determined by alpha spectrometry.
Cladding		
^{14}C	HTA-4-30	The carbon in the cladding is evolved by total combustion in pure oxygen, the CO_2 collected, and the ^{14}C measured by liquid scintillation counting.
^{135}Cs Interior & Exterior Surface	HTA-4-40	The cesium is leached from (interior or exterior) surface and separated from other elements by chromatographic elution from a cation exchange column. Isotope abundance of cesium isotopes is determined by mass spectrometry.
^{137}Cs Interior & Exterior Surface	HTA-4-9	The cesium is leached from interior or exterior surface and determined by gamma ray spectrometry on an aliquot of the leachate.
^{129}I Interior Surface	HTA-4-39	The cladding interior surface is leached in nitric acid. The iodine is separated from the nitric acid leachate by distillation and precipitation as AgI. Iodine-129 is determined in a GeLi well detector.

(a) Copies of procedures are available upon request from the MCC.

TABLE 4.13. Burnup Results for ATM-103 Samples[a]

Sample No.	Burnup, (^{148}Nd Basis) Atom%	Burnup, (^{148}Nd Basis) GJ/kgM (MWd/kgM)	Measured Gamma Activity, Counts/s	Burnup (^{137}Cs Basis), GJ/kgM (MWd/kgM)[b]	Sample Location
103-MLA098-P	3.474	2866 (33.17)	1645	2911 (33.69)	Typical peak burnup in center portion of Rod MLA098.
103-MLA098-BB	2.790	2300 (26.62)	1343	2338 (27.06)	Representative of approximately 80% of peak ^{137}Cs activity in bottom portion of Rod MLA098.
103-MLA098-JJ	1.961	1614 (18.68)	964	1673 (19.36)	Representative of approximately 57% of peak ^{137}Cs activity in bottom portion of Rod MLA098.

(a) See sectioning diagrams in Appendix D for sample locations with respect to gamma activity.

(b) Calculation based on ^{137}Cs half-life of 30.174 years and effective fission yield of 6.318% for Sample 103-MLA098-P, 6.302% for Sample 103-MLA098-BB, and 6.288% for 103-MLA098-JJ. Based on ASTM Standard E-219, "Standard Test Method for Atom Percent Fission in Uranium Fuel," (Radiation Method).

gamma activity for ^{137}Cs obtained during the full-length scan of Rod MLA098 is also presented in Table 4.13. These two methods of obtaining measured burnup values provide a check on each other if there is no substantial ^{137}Cs movement in the fuel rod. The good agreement between the burnups based on ^{148}Nd and ^{137}Cs for the fuel samples lends further support to the conclusion in Section 4.3 that there was no significant axial movement of the cesium in the fuel rod.

The measured burnup values, in units of MWd/kgM for ease of interpolating in the tables of Appendix F, are plotted in Figure 4.36 against the ^{137}Cs activity measured during gamma scanning of the full length rod. The location of the fuel samples and detailed gamma scanning data are provided in Appendices D and B, respectively. Because the ^{137}Cs activity and the measured

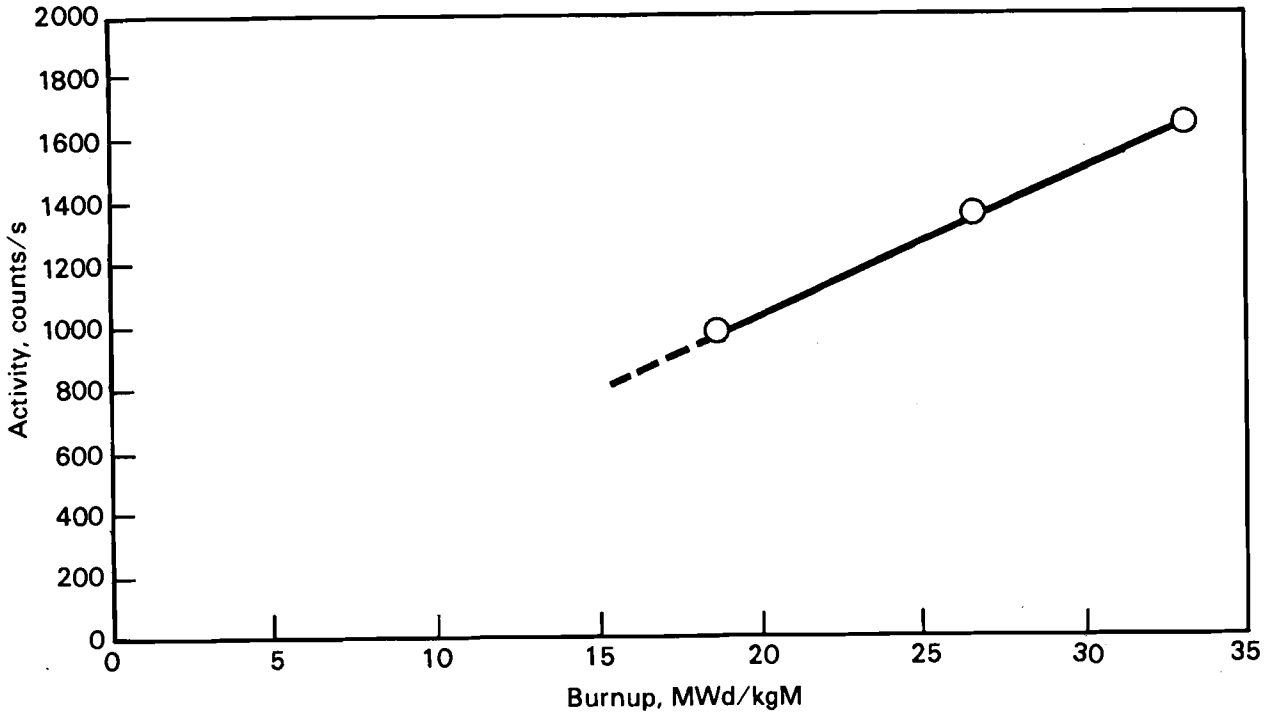


FIGURE 4.36. Correlation Between ^{137}Cs Gamma Counting and ^{148}Nd Burnup Analyses

burnup form a very linear relationship in the burnup range measured, an equation can be derived for estimating the burnup in other fuel samples from Rod MLA098. Using the measured ^{137}Cs activity and burnup values shown in Table 4.13, the relationship between burnup and ^{137}Cs activity for Rod MLA098 is:

$$BU = 0.02126\ \bar{A} - 1.855$$

where BU = the burnup of the Rod MLA098 fuel sample in question, MWd/kgM

$\bar{A}$ = the activity measured for the desired fuel sample (see the as-cut sectioning diagram in Appendix D), counts/s

This equation is valid for determining the burnup in fuel samples for Rod MLA098 as long as the ^{137}Cs activities given for Rod MLA098 in Appendix D are used. As more fuel rods from ATM-103 are gamma scanned and analyzed for fuel burnup, it will become more apparent how well this relationship will estimate

the burnup in other rods based solely on the gamma scan data. This will also require better definition of the gamma scan uncertainties than presently possible.

When ATM-103 fuel rods are gamma scanned in the future, a correction for the decay of ^{137}Cs will be incorporated in comparisons of gamma scan data. The correction is especially important in determining the relationship between burnup and ^{137}Cs activity for fuel rods in ATM-103. The rate of decrease in ^{137}Cs activity is indicated by the plot of calculated ^{137}Cs activity shown in Figure 4.37. At the time of gamma scanning, Rod MLA098 had been discharged from the reactor for 6.42 years (6 years and 5 months). At the time of burnup analyses (April 1987), Rod MLA098 had been discharged 6.5 years.

The correlation between ^{137}Cs activity and burnup values can be used in conjunction with the inventory calculations in Appendix F and the gamma scan in Appendix D to estimate the radioisotope inventory for a particular sample that might be used by an experimenter.

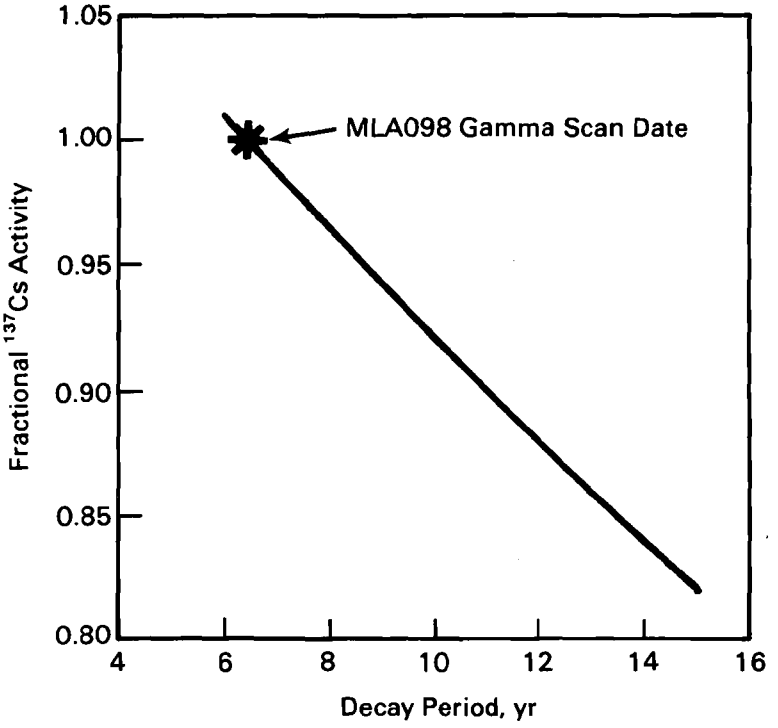


FIGURE 4.37. Fractional ^{137}Cs Activity as a Function of Decay Period

4.8.2 Fuel Radiochemical Analyses and Comparisons with ORIGEN2 Predictions

A total of eleven samples were analyzed for fuel radiochemistry as indicated in Figure 4.35 and Appendix D. For the fuel samples being analyzed for ^{14}C and ^{129}I, the burnup was estimated using the gamma scan sectioning diagram in Appendix D and the equation relating ^{137}Cs activity and fuel burnup in Section 4.8.1 The results of the radiochemical analyses for the fuel are provided in Table 4.14 and are compared with the ORIGEN2 predictions.

As seen in the table, nearly all of the radiochemical results agreed with ORIGEN2 predictions within about ±12%. The biggest exceptions are ^{79}Se and ^{126}Sn, for which the measured values are about 16% and 23% of their respective ORIGEN2 predictions. Unpublished results of ATM-101 analyses for ^{79}Se and ^{126}Sn also indicated similar differences.

4.8.3 Cladding Radiochemical Analyses

The results of analyses for cesium and iodine on 2.5-cm (1.0-in.) cladding sections taken from five locations along the length of the rod are given in Table 4.15. The fuel was removed from the cladding with a specially constructed punch, and the interior cladding surface was wiped four to five times with fresh, dry Q-tips to remove loose particles. The first Q-tip swabs were black-streaked, thus it may be inferred that some "loose" cesium and iodine may have been removed by the swabs. After stoppering the open ends, the cladding was immersed in 8N HNO_3, and the resulting solution was analyzed for ^{137}Cs and ^{135}Cs to obtain the exterior surface values listed in Table 4.15 for cesium and iodine. Then the stoppers were removed before another 8N HNO_3 treatment was made to obtain the interior surface values for cesium and iodine listed in Table 4.15.

The ^{135}Cs concentration on the exterior cladding surface was generally one to two orders of magnitude lower than the concentration on the interior surface. The ratios of ^{135}Cs to ^{137}Cs activity are approximately as expected based on the data in Appendix F. The amounts of these isotopes are somewhat similar in terms of grams, but the shorter half life for ^{137}Cs results in a much greater activity. The concentrations of both cesium and iodine on the inner surfaces tended to follow the burnup profile; that is, the concentrations

TABLE 4.14. Fuel Radiochemical Analyses Results and Comparisons with ORIGEN2-calculated Radionuclide Inventory

Sample ID and Radionuclide	Burnup,[a] MWd/kgM	Analytical Value	ORIGEN2 Value[b]	Ratio, Analytical to ORIGEN2
103-MLA098-E				
C-14	24.83	5.40×10^{-7} Ci/gUO$_2$[c]	4.562×10^{-7} Ci/gUO$_2$	1.18
103-MLA098-J				
C-14	33.44	7.33×10^{-7} Ci/gUO$_2$[c]	6.367×10^{-7} Ci/gUO$_2$	1.15
103-MLA098-P				
U-234	33.17	1.2×10^{-4} g/gUO$_2$	1.226×10^{-4} g/gUO$_2$	0.98
U-235		4.78×10^{-3} "	5.116×10^{-3} "	0.94
U-236		3.26×10^{-3} "	3.061×10^{-3} "	1.07
U-238		8.422×10^{-1} "	8.342×10^{-1} "	1.01
Pu-238		1.483×10^{-4} "	1.456×10^{-4} "	1.02
Pu-239		4.187×10^{-3} "	4.472×10^{-3} "	0.94
Pu-240		2.111×10^{-3} "	2.145×10^{-3} "	0.98
Pu-241		8.125×10^{-4} "	8.532×10^{-4} "	0.95
Pu-242		5.474×10^{-4} "	4.909×10^{-4} "	1.12
Np-237		2.41×10^{-7} Ci/gUO$_2$	2.730×10^{-7} Ci/gUO$_2$	0.88
Am-241		1.20×10^{-3} "	1.213×10^{-3} "	0.99
Cm-243 & 244		2.11×10^{-3} "	2.079×10^{-3} "	1.01
Se-79		5.54×10^{-8} "	3.576×10^{-7} "	0.15
Sr-90		5.23×10^{-2} "	5.128×10^{-2} "	1.02
Tc-99		1.13×10^{-5} "	1.142×10^{-5} "	0.99
Sn-126		1.69×10^{-7} "	7.328×10^{-7} "	0.23
Cs-135		3.32×10^{-7} "	3.377×10^{-7} "	0.98
Cs-137		8.06×10^{-2} "	7.813×10^{-2} "	1.03
103-MLA098-S				
I-129	33.01	3.36×10^{-8} Ci/gUO$_2$	2.869×10^{-8} Ci/gUO$_2$	1.17
103-MLA098-T				
C-14	33.01	7.69×10^{-7} Ci/gUO$_2$[c]	6.262×10^{-7} Ci/gUO$_2$	1.23
103-MLA098-BB				
U-234	26.62	1.21×10^{-4} g/gUO$_2$	1.338×10^{-4} g/gUO$_2$	0.90
U-235		6.94×10^{-3} "	7.242×10^{-3} "	0.96
U-236		2.99×10^{-3} "	2.807×10^{-3} "	1.07
U-238		8.538×10^{-1} "	8.393×10^{-1} "	1.02
Pu-238		9.69×10^{-5} "	9.106×10^{-5} "	1.06
Pu-239		4.252×10^{-3} "	4.348×10^{-3} "	0.98
Pu-240		1.766×10^{-3} "	1.800×10^{-3} "	0.98
Pu-241		6.822×10^{-4} "	6.959×10^{-4} "	0.98
Pu-242		3.301×10^{-4} "	3.084×10^{-4} "	1.07
Np-237		2.11×10^{-7} Ci/gUO$_2$	2.066×10^{-7} Ci/gUO$_2$	1.02
Am-241		9.91×10^{-4} "	10.07×10^{-4} "	0.98
Cm-243 & 244		8.15×10^{-4} "	7.60×10^{-4} "	1.07
Se-79		4.59×10^{-8} "	29.18×10^{-8} "	0.16
Sr-90		4.41×10^{-2} "	4.333×10^{-2} "	1.02

TABLE 4.14. (contd)

Sample ID and Radionuclide	Burnup,[a] MWd/kgM	Analytical Value	ORIGEN2 Value[b]	Ratio, Analytical to ORIGEN2
103-MLA098-BB (contd)				
Tc-99		9.37×10^{-6} Ci/gUO$_2$	9.43×10^{-6} Ci/gUO$_2$	0.99
Sn-126		1.36×10^{-7} "	5.673×10^{-7} "	0.24
Cs-135		3.12×10^{-7} "	3.134×10^{-7} "	1.00
Cs-137		6.53×10^{-2} "	6.265×10^{-2} "	1.04
103-MLA098-DD				
I-129	25.49	2.41×10^{-8} Ci/gUO$_2$	2.185×10^{-8} Ci/gUO$_2$	1.10
103-MLA098-EE				
C-14	24.61	5.03×10^{-7} Ci/gUO$_2$[c]	4.501×10^{-7} Ci/gUO$_2$	1.12
103-MLA098-JJ				
U-234	18.68	1.4×10^{-4} g/gUO$_2$	1.491×10^{-4} g/gUO$_2$	0.94
U-235		1.025×10^{-2} "	1.067×10^{-2} "	0.96
U-236		2.50×10^{-3} "	2.310×10^{-3} "	1.08
U-238		8.551×10^{-1} "	8.450×10^{-1} "	1.01
Pu-238		4.85×10^{-5} "	4.060×10^{-5} "	1.19
Pu-239		3.954×10^{-3} "	4.042×10^{-3} "	0.98
Pu-240		1.243×10^{-3} "	1.281×10^{-3} "	0.97
Pu-241		4.543×10^{-4} "	4.623×10^{-4} "	0.98
Pu-242		1.394×10^{-4} "	1.308×10^{-4} "	1.07
Np-237		1.23×10^{-7} Ci/gUO$_2$	1.279×10^{-7} Ci/gUO$_2$	0.96
Am-241		6.67×10^{-4} "	6.800×10^{-4} "	0.98
Cm-243 & 244		1.64×10^{-4} "	1.380×10^{-4} "	1.19
Se-79		3.43×10^{-8} "	2.091×10^{-7} "	0.16
Sr-90		3.36×10^{-2} "	3.253×10^{-2} "	1.03
Tc-99		7.07×10^{-6} "	6.837×10^{-6} "	1.03
Sn-126		8.60×10^{-8} "	3.778×10^{-7} "	0.23
Cs-135		2.79×10^{-7} "	2.771×10^{-7} "	1.01
Cs-137		4.59×10^{-2} "	4.390×10^{-2} "	1.05
103-MLA098-LL				
I-129	15.58	1.45×10^{-8} Ci/gUO$_2$	1.291×10^{-8} Ci/gUO$_2$	1.12
103-MLA098-MM				
C-14	12.92	2.82×10^{-7} Ci/gUO$_2$[c]	2.270×10^{-7} Ci/gUO$_2$	1.24

(a) Burnup values were measured for Samples 103-MLA098-P, 103-MLA098-BB, and 103-MLA098-JJ. All other burnups estimated using equation in Section 4.8.1 and ^{137}Cs activity in Appendix D for specific sample.

(b) Interpolated ORIGEN2 values obtained from Appendix F using burnup derived with equation in Section 4.8.1 and ^{137}Cs activity in Appendix D, except for specimens 103-MLA098-P, 103-MLA098-BB, and 103-MLA098-JJ, for which these values were specifically calculated using ORIGEN2 and the given sample burnup.

(c) Average of triplicate portions which varied within less than ±8%.

TABLE 4.15. Cladding Radiochemical Analyses Results

Sample No.	Exterior Surface Activity, μCi/cm²		Interior Surface Activity, μCi/cm²		
	^{137}Cs	^{135}Cs	^{137}Cs	^{135}Cs	^{129}I
103-MLA098-D	1.09	6.3×10^{-6}	8.33	3.92×10^{-5}	7.3×10^{-6}
103-MLA098-I	2.07	9.5×10^{-6}	354	214×10^{-5}	30.2×10^{-6}
103-MLA098-S	2.82	12.0×10^{-6}	18.7	7.39×10^{-5}	23.4×10^{-6}
103-MLA098-DD	1.25	5.9×10^{-6}	9.46	4.5×10^{-5}	9.9×10^{-6}
103-MLA098-LL	2.13	13.0×10^{-6}	5.77	3.6×10^{-5}	2.5×10^{-6}

were lower towards the ends of the rods. The concentrations of both cesium and iodine on the exterior surface were roughly uniform along the rod.

Based on the values shown in Table 4.15, it is estimated that a minimum of about 0.03% of the cesium and 0.04% of the iodine in Rod MLA098 were released from the fuel and deposited rather firmly on the interior surface of the cladding.

Analyses of ^{14}C were also performed on cladding sections taken from five locations along the length of the rod. The fuel was removed from these 1.3-cm (0.50-in.) samples, and the cladding was broken into two portions that were analyzed separately. The analytical results are compared with ORIGEN2 predictions in Table 4.16. The analyzed concentrations average 60% of the predicted concentrations, but there is wide scatter in the as-analyzed values, possibly a result of measurement uncertainties for these small quantities or input uncertainties in the nitrogen levels assumed for the cladding.

TABLE 4.16. Radiochemical Analyses of Carbon-14 in Cladding and Comparison with ORIGEN2 Predictions

Sample No.	Analyzed Activity, μCi/g Cladding	Interpolated ORIGEN2 Activity, μCi/g Cladding	Ratio, Analytical to ORIGEN2
103-MLA098-E	0.190[a]	0.4758	0.40
103-MLA098-J	0.976[b]	0.6656	1.47
		0.250[b]	0.66560.38
103-MLA098-T	0.180[c]	0.6559	0.27
103-MLA098-EE	0.446[c]	0.4713	0.95
103-MLA098-MM	0.0409[d]	0.2380	0.17

(a) Average of two values: 0.162 and 0.218.
(b) There was no apparent reason for the large difference between these two duplicates. The first duplicate appears high compared with other cladding samples; it may have picked up some contamination, but no obvious problem was identified.
(c) One of duplicate samples was lost, so this is a single value.
(d) Average of two values: 0.0428 and 0.039.

5.0 DISTRIBUTION OF ATM-103 SPENT FUEL

When Rod MLA098 was sectioned, the Basalt Waste Isolation Program (BWIP) and the Office of Nuclear Waste Isolation (ONWI) projects were actively investigating basalt and salt formations, respectively, as sites for a geologic repository. Therefore, samples of Rod MLA098 were reserved for these projects, as shown in Table 5.1 and in Appendix D. After the rod was sectioned, the number of repository sites being investigated was narrowed to the Nevada Nuclear Waste Storage Investigations (NNWSI). In the future, the NNWSI will be the major user of spent fuel ATMs prepared by the MCC. Six additional short fuel and cladding sections were cut from Rod MLA098 for Oak Ridge National Laboratory (ORNL) for their work with spark source mass spectrometry. Samples of fuel and cladding that were cut from Rod MLA098 but not analyzed were placed in inerted storage tubes. Sufficient ATM-103 spent fuel is available to satisfy any foreseeable needs of the repository project.

TABLE 5.1. Initially Planned Distributions of ATM-103 Spent Fuel Rod MLA098

Section	Planned Recipient	Approximate Fuel Length, cm (in.)
B	ONWI	2.54 (1)
G1	ONWI	2.54 (1)
M	NNWSI	74 (29)
Q1	ORNL	0.6 (0.25)
Q2	ORNL	0.6 (0.25)
V	ONWI	2.54 (1)
X	BWIP	38 (15)
CC1	ORNL	0.6 (0.25)
CC2	ORNL	0.6 (0.25)
GG	ONWI	2.54 (1)
KK1	ORNL	0.6 (0.25)
KK2	ORNL	0.6 (0.25)

6.0 REFERENCES

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APPENDIX A

POWER HISTORY FOR ASSEMBLY D101

APPENDIX A

POWER HISTORY FOR ASSEMBLY D101

The detailed power history for Rod MLA098 from Assembly D101 (Figure 4.6 and Table A.1) was used as the basis for generating the irradiation times and power densities for the ORIGEN2 code. Rod MLA098 is assumed to be representative of all of the ATM-103 rods. The average burnup of the rod is

TABLE A.1. Detailed Power History of Rod MLA098

Cycle 2		Cycle 3[a]		Cycle 4	
Time Interval, Days	LHGR, kW/m (kW/ft)	Time Interval, Days	LHGR, kW/m (kW/ft)	Time Interval, Days	LHGR, kW/m (kw/ft)
7.1	19.1 (5.81)	6.8	19.1 (5.83)	47.0	17.4 (5.30)
30.8	23.5 (7.17)	14.3	18.6 (5.68)	24.1	17.2 (5.25)
16.4	23.5 (7.17)	19.5	13.1 (3.98)	22.5	17.3 (5.26)
11.4	23.5 (7.17)	16.5	20.7 (6.32)	25.5	17.3 (5.28)
12.5	23.5 (7.17)	16.1	21.1 (6.42)	30.7	8.4 (2.56)
23.4	23.5 (7.16)	15.1	22.4 (6.83)	41.0	8.6 (2.63)
22.8	23.4 (7.14)	38.8	21.1 (6.43)	50.1	8.6 (2.61)
22.9	23.3 (7.11)	31.0	21.3 (6.48)	10.9	14.9 (4.55)
8.5	23.3 (7.09)	31.6	21.1 (6.44)	10.7	17.7 (5.40)
31.4	23.5 (7.16)	31.6	20.9 (6.37)	45.1	17.9 (5.45)
34.2	23.3 (7.11)	43.9	20.9 (6.37)	29.3	17.6 (5.37)
16.6	23.7 (7.22)	61.7	21.1 (6.43)	28.0	18.1 (5.51)
19.1	23.3 (7.11)	30.2	22.0 (6.71)	65.1	18.0 (5.50)
12.8	23.5 (7.15)			35.7	18.2 (5.54)
34.3	22.2 (6.77)				
1.9	22.2 (6.78)				

(a) Reactor was shut down for 25 days starting with day 270 of Cycle 3.

2580 GJ/kgM (29.8 MWd/kgM) as compared with the assembly average of 2650 GJ/kgM (30.7 MWd/kgM). Both of these burnups were calculated by C-E. The detailed power history data for Rod MLA098 (given in Table A.1) were averaged over periods when the power did not change by more than 30%. The results are given in Table A.2. The power densities given in Table A.2 were then normalized to give burnups of 15, 20, 25, 30, and 35 MWd/kgM at discharge. Normalization is required because some portions of the fuel (such as at the ends of the rod) do not achieve the peak or rod-average burnups. Results of the ORIGEN2 calculations are provided in Appendix F.

TABLE A.2. ATM-103 Power History, Based on Rod MLA098

Cycle No.	Time Interval, days	Power Density, w/g
2	306.0	32.09
down	71.0	0
3	21.1	25.21
3	19.5	17.59
3	228.4	28.51
3	25.0	0
3	88.0	28.51
down	81.0	0
4	119.1	24.56
4	121.8	12.13
4	225.1	25.25

APPENDIX B

GAMMA SCANNING FOR ATM-103

APPENDIX B

GAMMA SCANNING FOR ATM-103

The Materials Characterization Center (MCC) gamma scan system consists of three major components: 1) the Data Acquisition (DA) System, 2) the in-cell hardware, and 3) an IBM host computer that supervises and controls the gamma scan process and logs all pertinent data. The DA system and the IBM host system are illustrated in the schematic representation shown in Figure B.1. The in-cell hardware is shown in Figure B.2. The fuel rod is drawn by a motor-driven chuck past the germanium-lithium gamma ray detector, which is located in a wall plug in the front face of the hot cell. The wall plug contains a collimator and normally a 0.254-cm (0.1-in) slit, although a 0.0254-cm (0.01-in) slit may be installed. A stepping motor controls the position of the fuel rod relative to the detector and controls the rate at which the fuel rod is stepped past the detector. The available hot cell space was insufficient for gamma scanning full-length PWR and BWR fuel rods from top to bottom. Thus, this system is designed to scan from the center of the fuel rod to one end. The rod is then rotated 180°, and the process is repeated to scan the other half. The stepping motors determine the center of the fuel rod from an overall fuel rod length measurement made before scanning is started.

The software used to complete gamma scanning operations was written to use a variable counting time at each position. The counting time is set to maintain a fixed statistical uncertainty (set at 1%) until the counting time reaches a maximum preset value. Typically, the counting time is 40 to 60 s in the center of the fuel rod (area of maximum activity) and gradually increases to 5 min (preset maximum value) as the activity decreases near the end of a fuel rod. With this approach, gamma scan results have been obtained for the following isotopes: ^{134}Cs (0.6 MeV), ^{137}Cs, and ^{134}Cs (0.8 MeV). These are the only isotopes present that meet the predetermined requirements. Other isotopes can be selected and counted, but the error associated with them

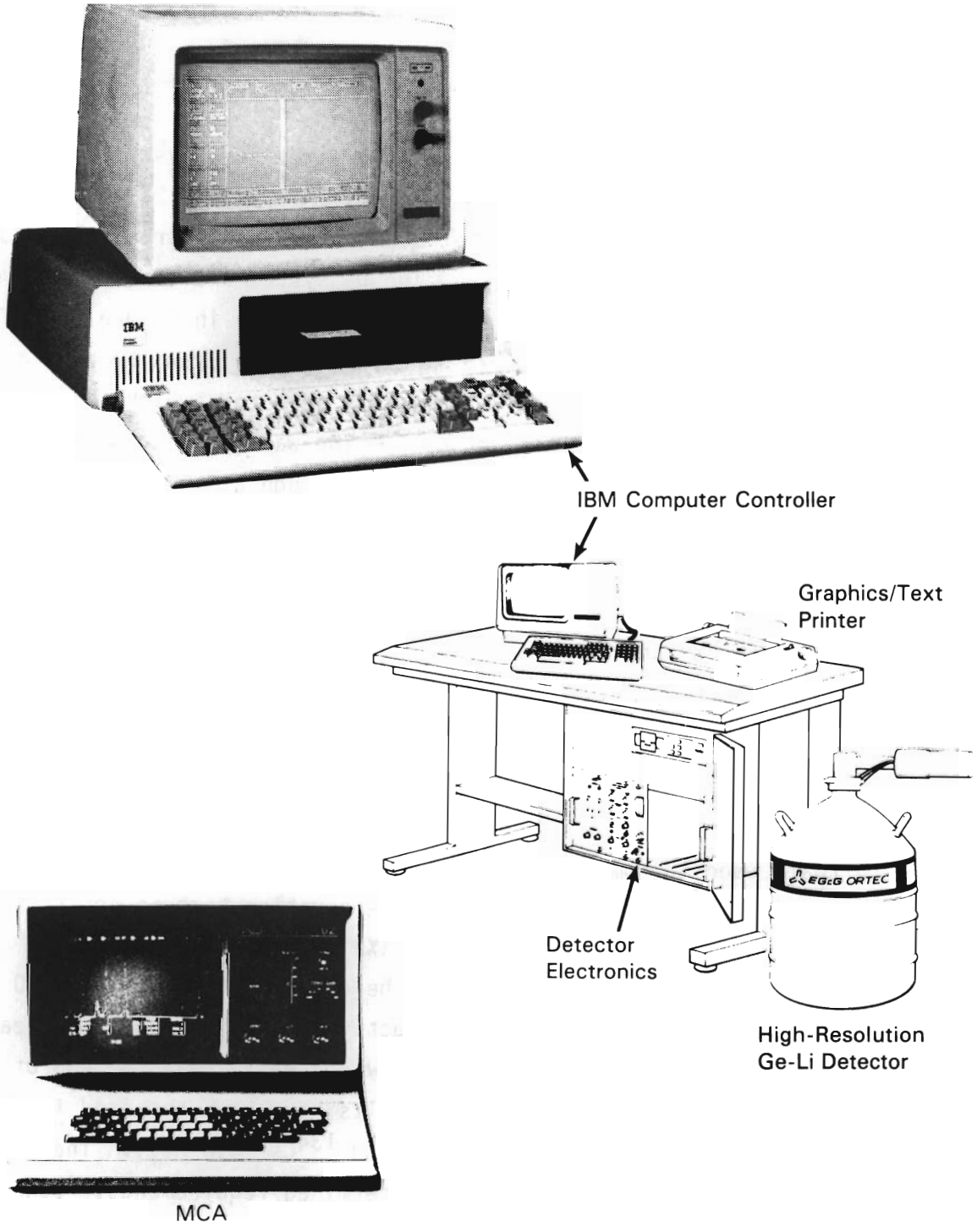


FIGURE B.1. Data Acquisition System and IBM Host System for Gamma Scanning Spent Fuel Rods

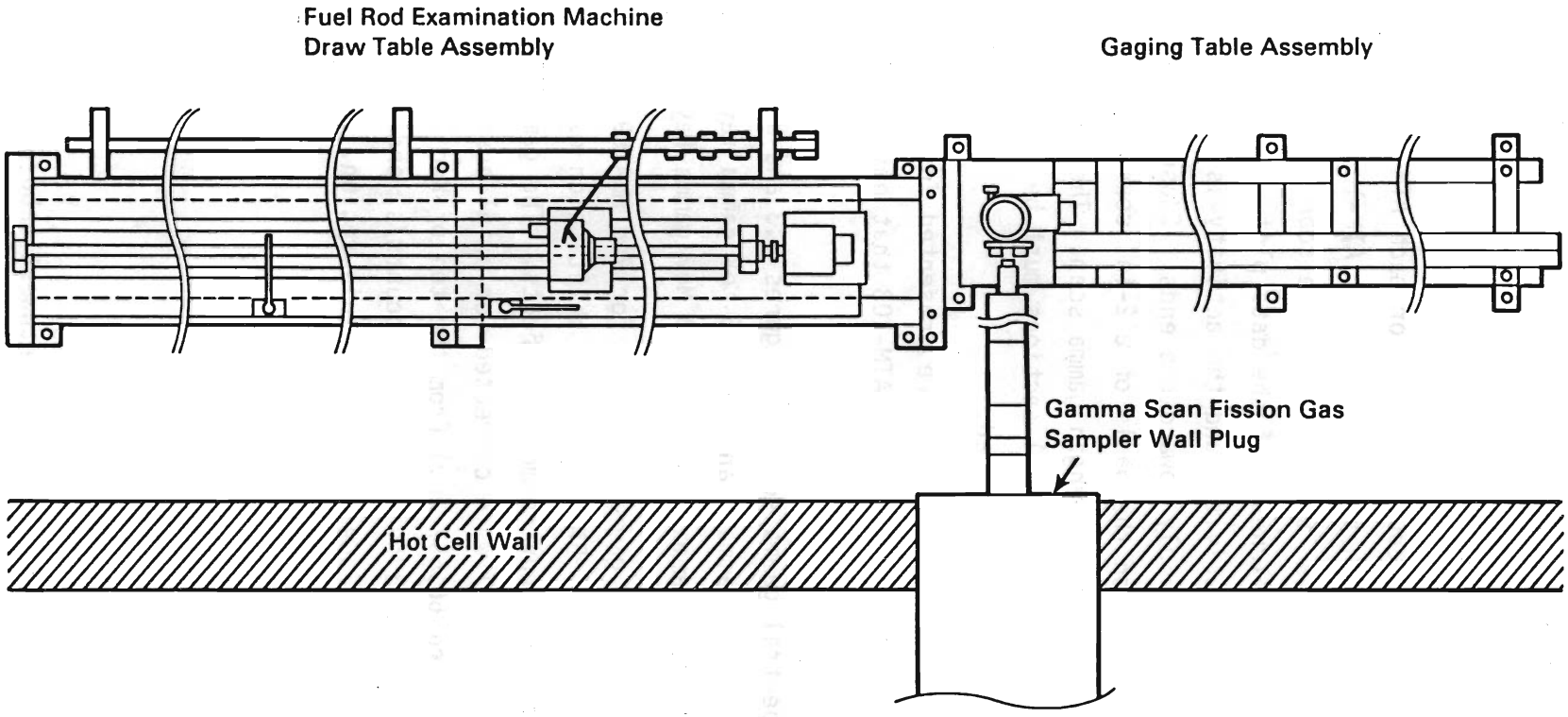


FIGURE B.2. Plan View of Hardware for Gamma Scanning of MCC Spent Fuel Rods

will force the use of maximum counting times. A ^{60}Co external source is also tracked to identify whether the multichannel analyzer (MCA) is functioning correctly.

The following procedure is used for each ATM.[a] One rod is designated as the reference rod for that ATM (MLA089 for ATM-103). A full-length gamma scan is completed. The data is plotted and the scan is accepted or rejected on the basis of the "reasonableness" of the data plot. For example, there should be no sudden shifts in activity; and the activity is normally highest near the middle, decreasing rapidly toward the ends. Subsequent scans of fuel rods are accepted or rejected on the basis of a 2-in. scan of the reference rod taken before and after the full-length gamma scan. The variability in the average activity for those 5-cm (2-in.) sections must be less than 5% for ^{137}Cs for the rod being scanned to be accepted.

Spectral gamma scan results are presented in this appendix in alpha-numeric order for the two rods of ATM-103 that have been examined. A summary of the figures is provided below:

^{137}Cs spectral gamma scans - Figures B.3 and B.4
^{134}Cs spectral gamma scans for 0.6 MeV gamma rays - Figures B.5 and B.6
^{134}Cs spectral gamma scans for 0.8 Mev gamma rays - Figures B.7 and B.8.

A portion of the gamma scan data for Rod MLA089 was determined to have experienced a slight (~5%) electronic shift which occasionally results from temperature or other environmental effects. The gamma activity data presented in Figures B.3 and B.7 were corrected for axial positions between 0.946 and 1.69 m (37.257 and 66.557 in.) from the top of Rod MLA089. The data in Figure B.3 were corrected by adding 92.3 counts/s, and the data in Figure B.7 were corrected by adding 16.04 counts/s in this region.

(a) "Fuel Rod Scanning Procedure," MCC-TP-9, Rev. 0, 1987, Materials Characterization Center, Pacific Northwest Laboratory, Richland, Washington.

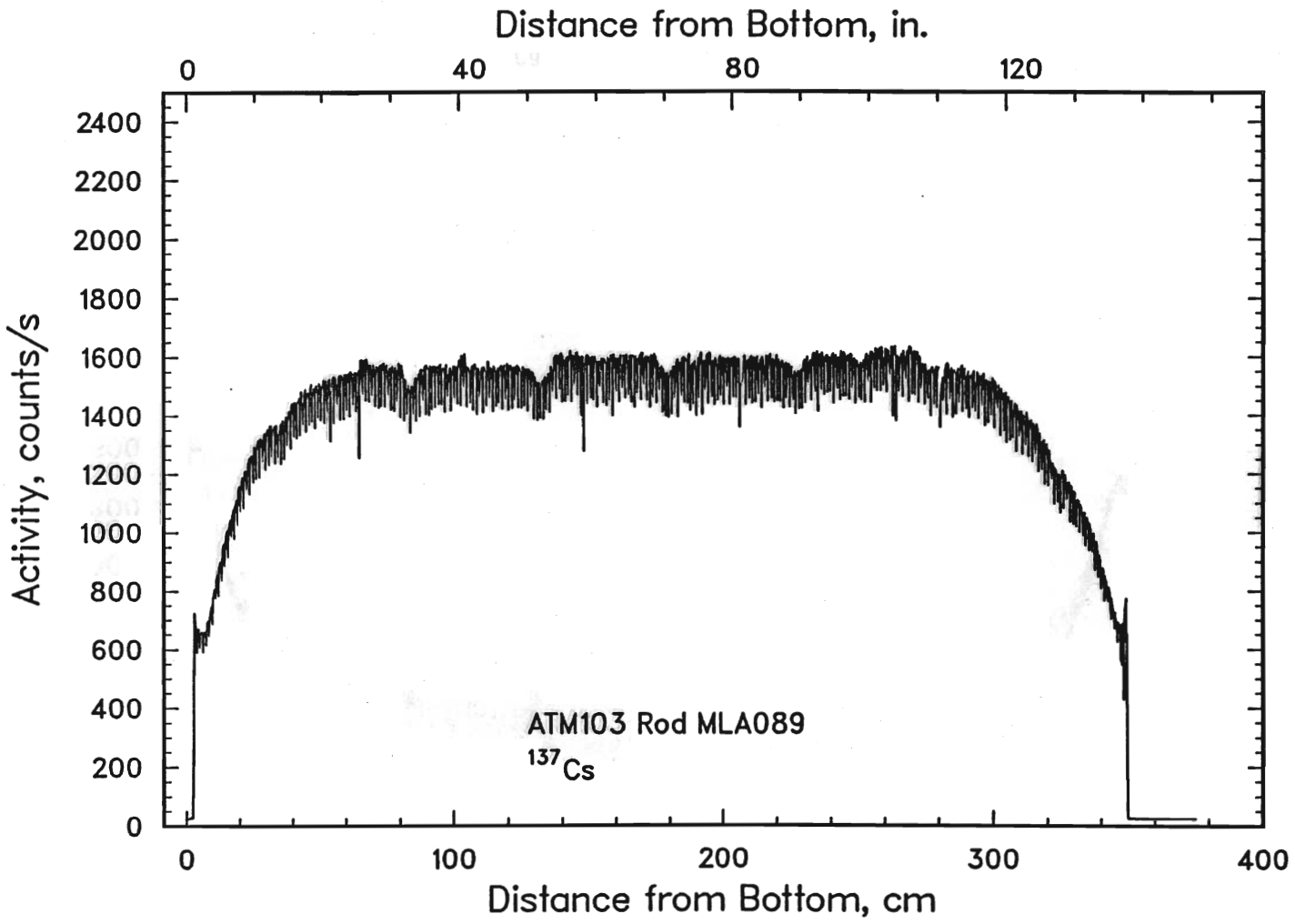


FIGURE B.3. Spectral Gamma Scan for ^{137}Cs - Rod MLA089

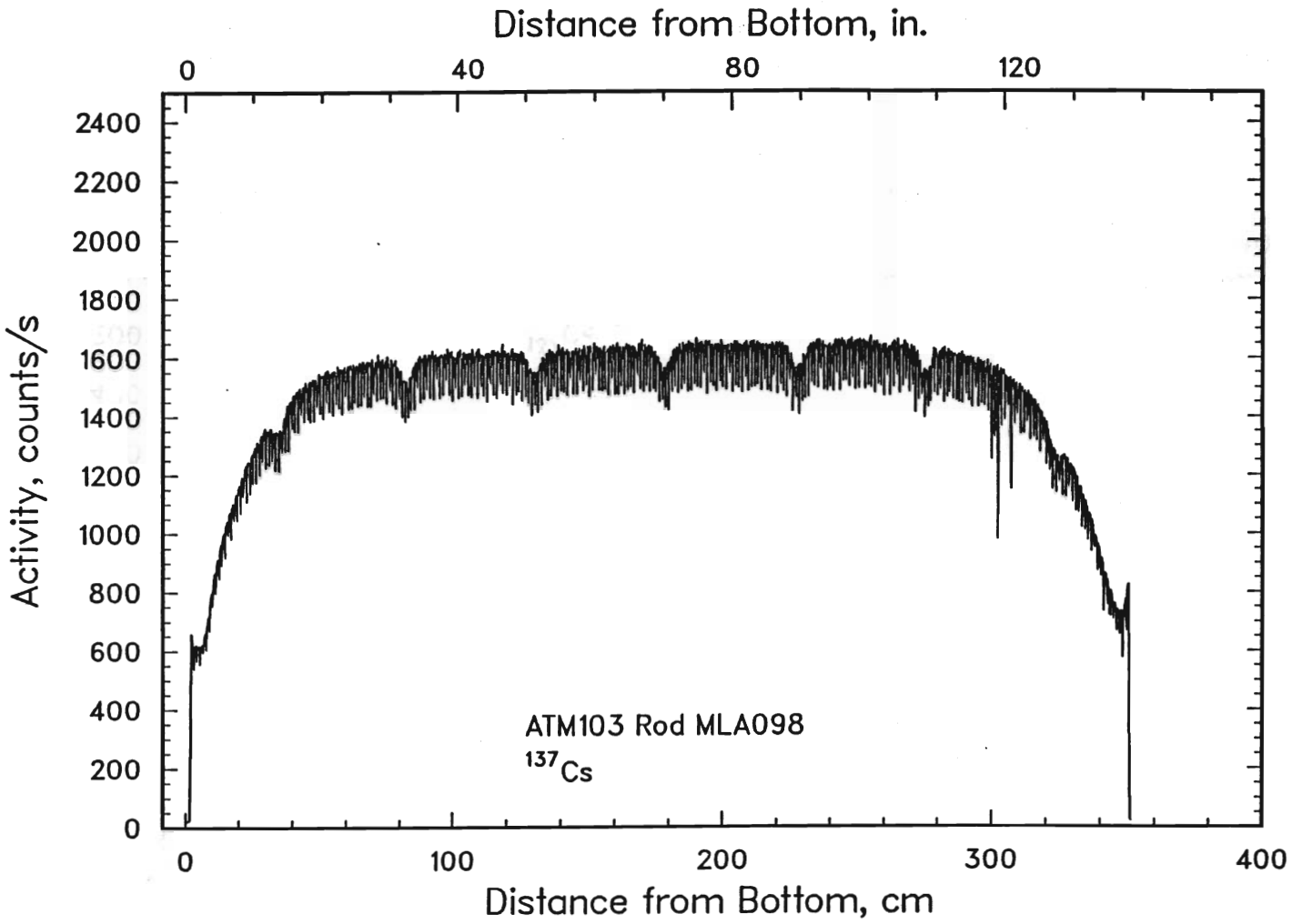


FIGURE B.4. Spectral Gamma Scan for ^{137}Cs - Rod MLA098

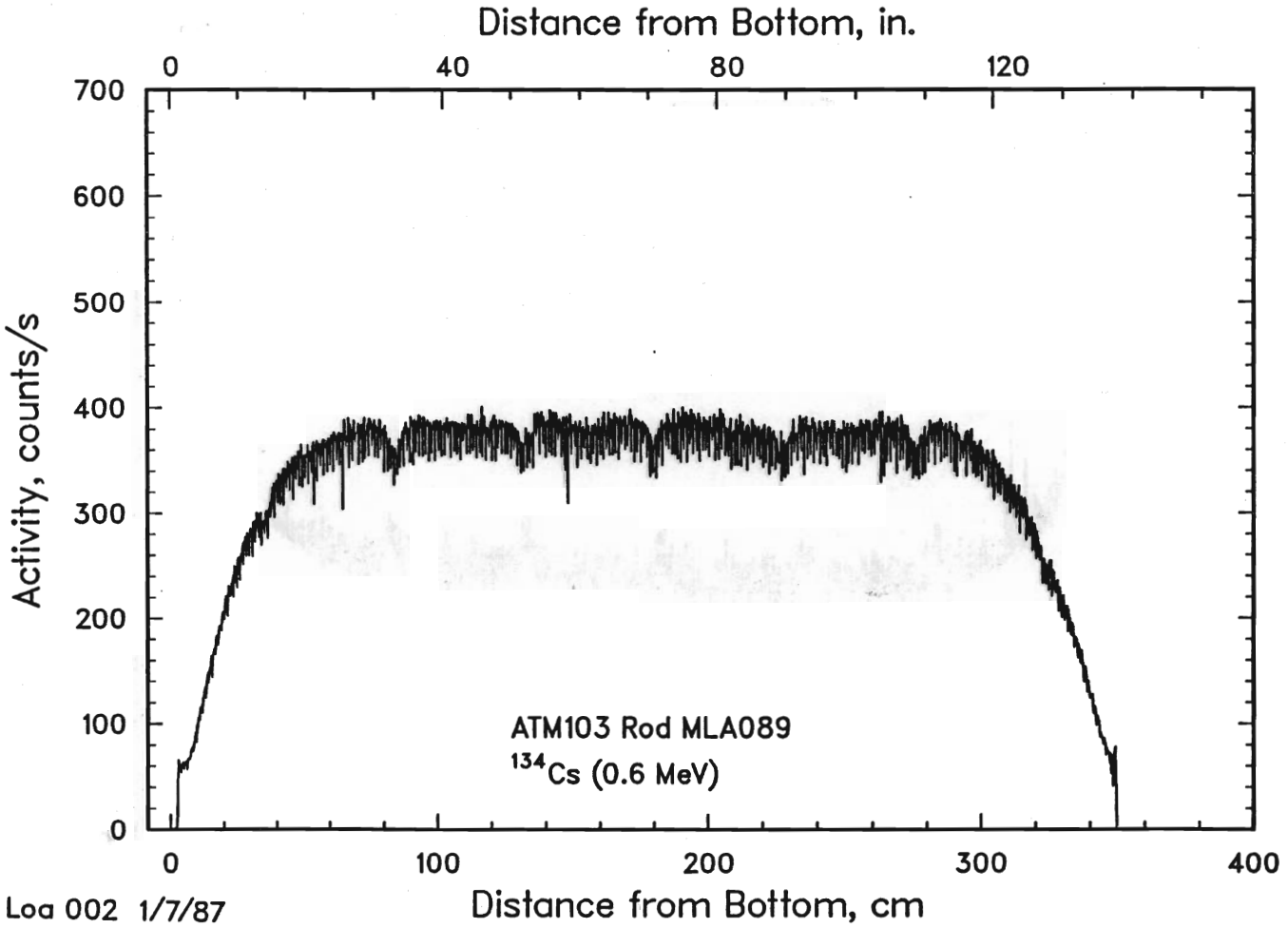


FIGURE B.5. Spectral Gamma Scan for ^{134}Cs (0.6 MeV) - Rod MLA089

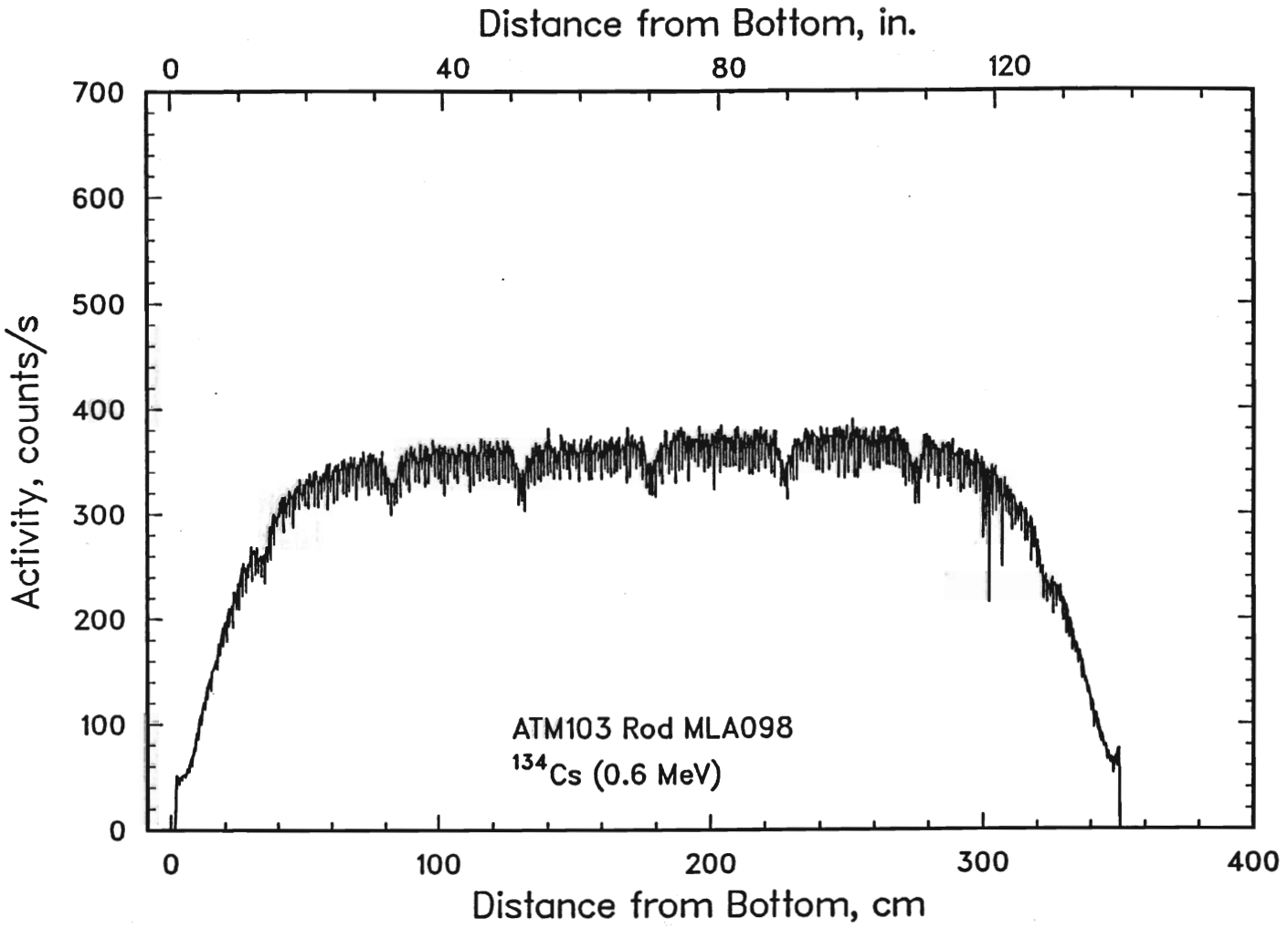


FIGURE B.6. Spectral Gamma Scan for ^{134}Cs (0.6 MeV) - Rod MLA098

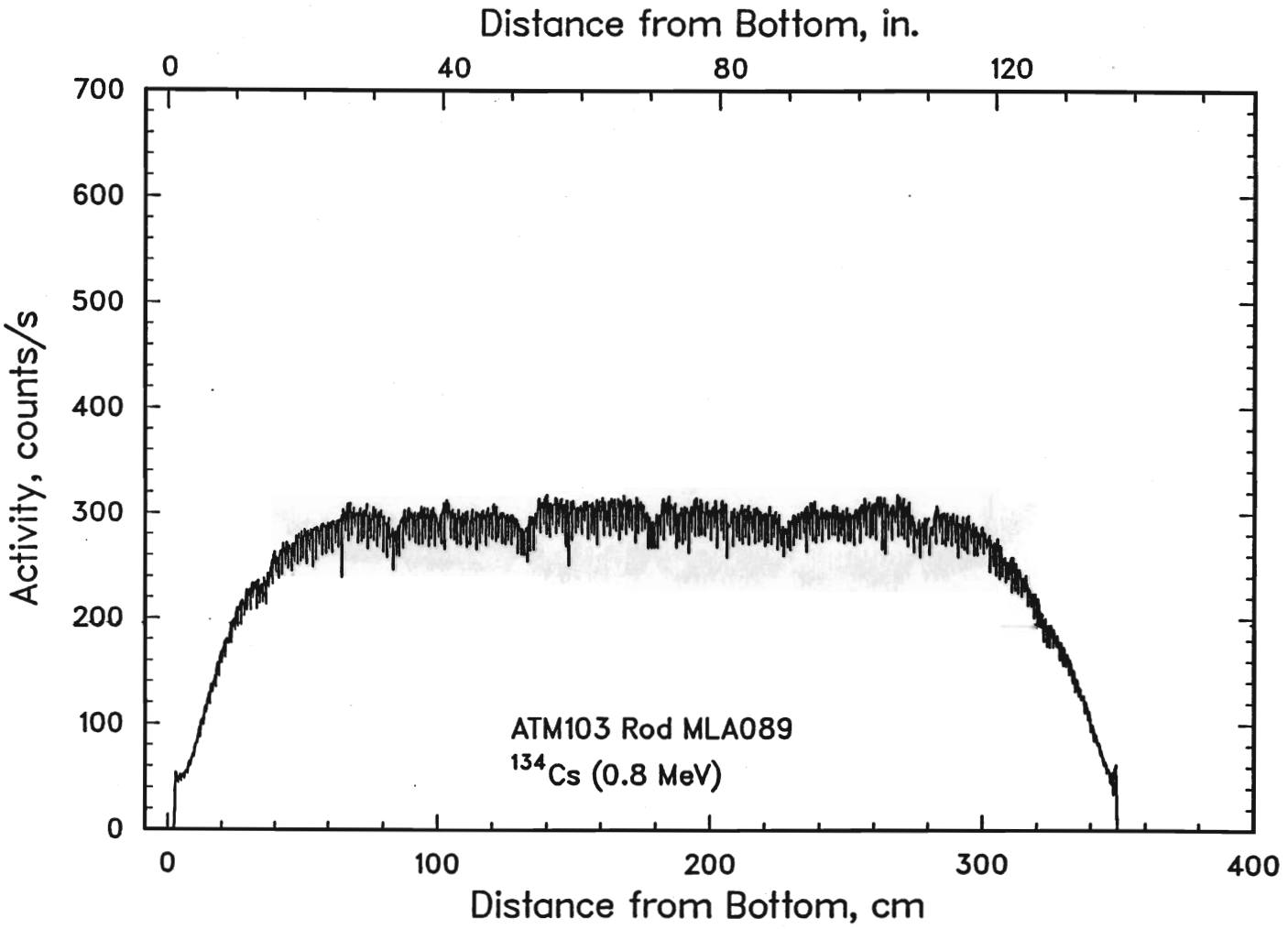


FIGURE B.7. Spectral Gamma Scan for ^{134}Cs (0.8 MeV) - Rod MLA089

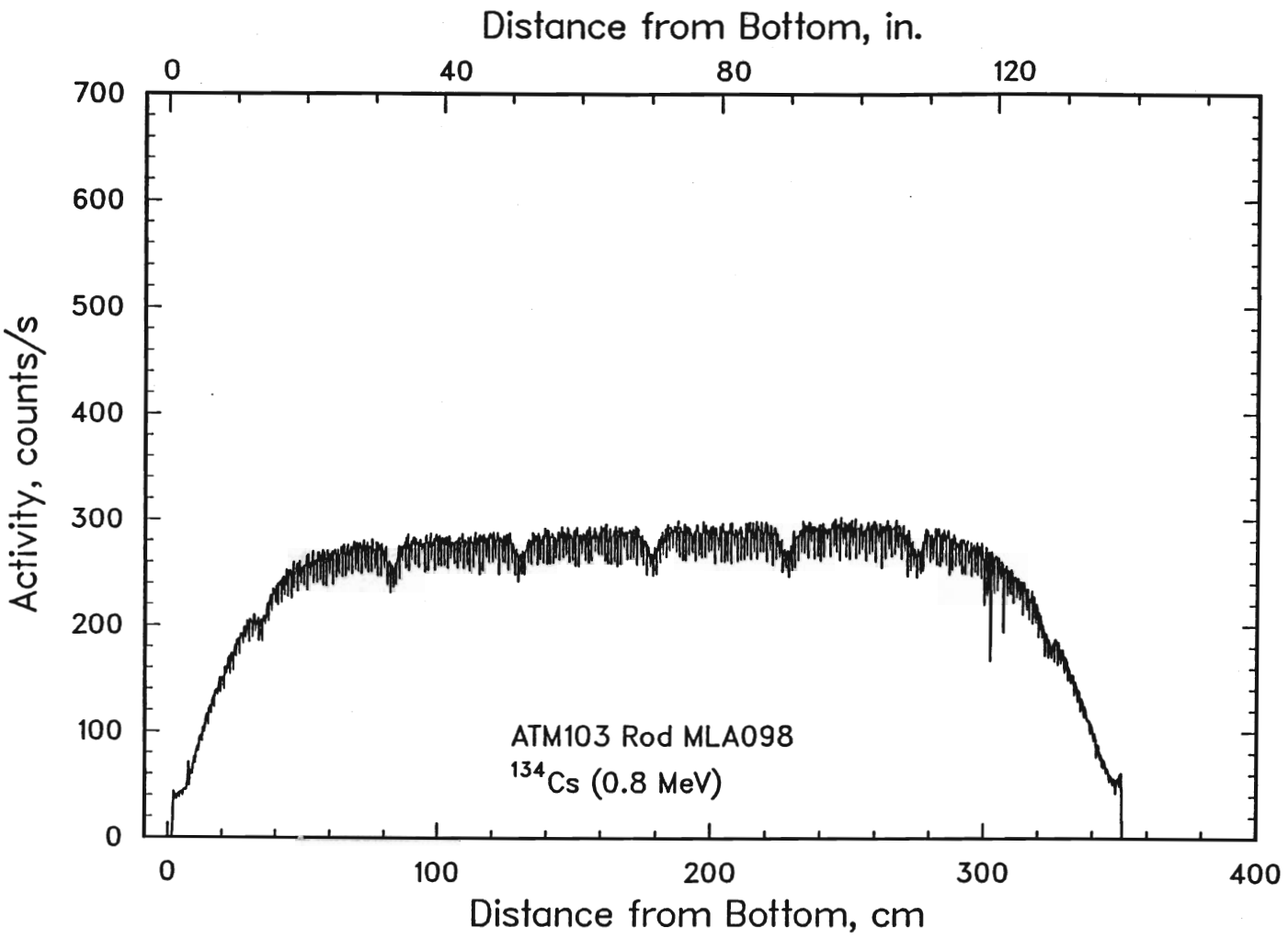


FIGURE B.8. Spectral Gamma Scan for ^{134}Cs (0.8 MeV) - Rod MLA098

APPENDIX C

FISSION GAS SAMPLING

APPENDIX C

FISSION GAS SAMPLING

OPERATING PROCEDURE

There are three objectives for fission gas sampling operations. The first objective is to collect the fission gas from the fuel rods for analysis without contaminating the sample with air. The other two objectives are to determine the volume of fission gas present in the fuel rod and to determine the fuel rod void volume. To accomplish these objectives a system of leak-tight piping, valves, and calibrated flasks connected to vacuum pumps was fabricated. This system (referred to as the fission gas sample cart) is located in the operating gallery or the "cold" side of the hot cell facility. Piping runs from this cart to a wall plug that extends through the wall of the hot cell. All operations of the system are carried out with a partial vacuum using the current procedure.(a) The top of the fuel rod is inserted into the machined "head" with a flange which, when clamped to the other end of the wall plug, makes a leak-tight connection between the fuel rod and the fission gas sample cart (Figure C.1).

The entire system is evacuated by vacuum pumps to the lowest pressure obtainable, as indicated by a Baratron® gage. This pressure is usually less than 10^{-1} mm Hg. The system is purged with argon and re-evacuated to remove residual air or other contaminants. The valve to the vacuum pumps is closed, and the readout on the pressure gauge is observed for at least 1 min to determine whether there are any leaks in the system. If no leaks are indicated, the valves to all of the calibrated flasks are closed and fission gas sampling can be conducted. A laser is used to make a small hole in the fuel rod by focusing the laser to a pinhole-sized beam to breach the cladding. The rod gas flows into the evacuated sample cart system. Valves to the calibrated flasks

(a) "Fission Gas Sampling," MCC-TP-10, Rev 0, March 1987, Materials Characterization Center, Pacific Northwest Laboratory, Richland, Washington.
® Manufactured by MKS Instruments, Inc., Burlington, Massachusetts.

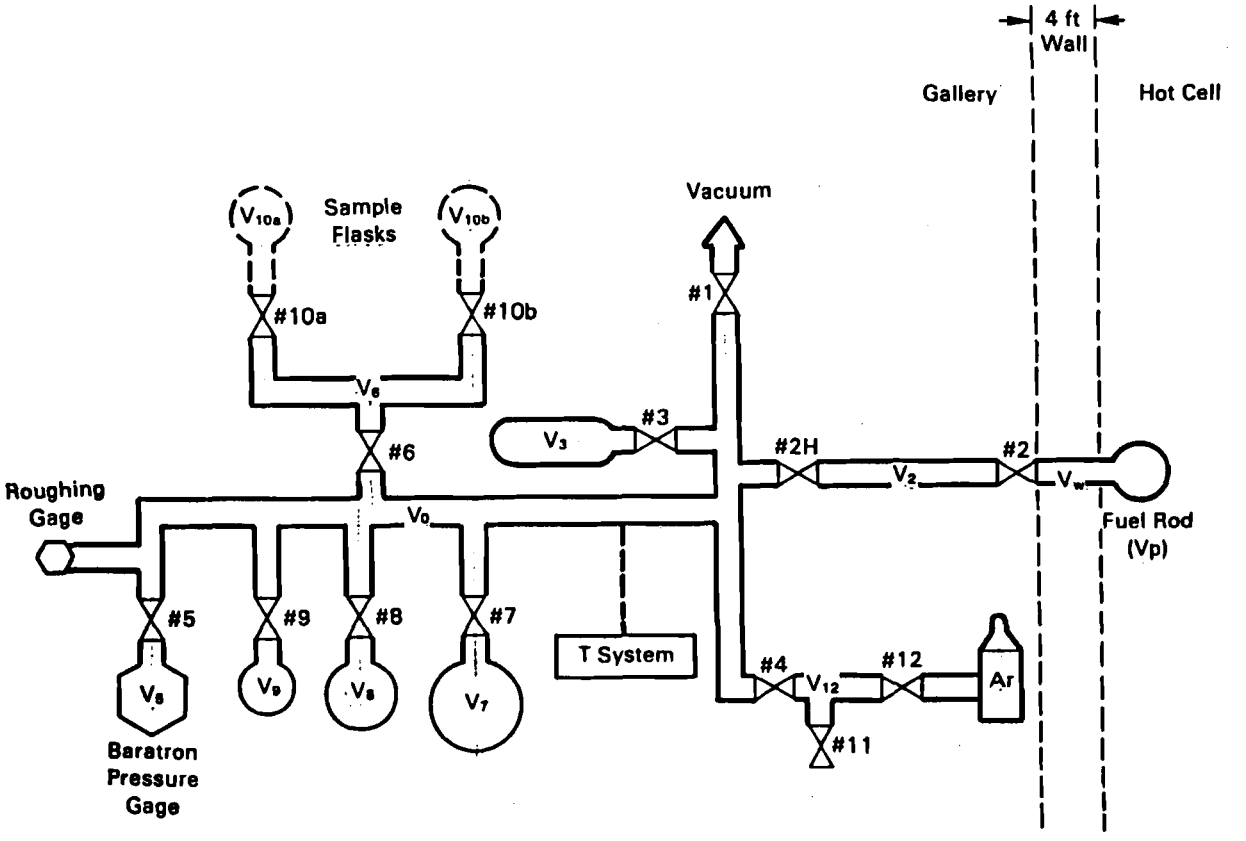


FIGURE C.1. Schematic of Rod Gas Sampling System

are opened until the Baratron gauge is on scale. This pressure, referred to as the system pressure P_S, is recorded. Valves are then opened to the evacuated analytical sample flasks (to obtain the samples for analysis). Two samples are taken in case the fission gas analysis needs to be repeated. The valves to these flasks are closed and the entire system is again evacuated to remove residual gas in the rod. The sample flasks are removed from the cart and transferred to the analytical lab.

FUEL ROD VOID VOLUME

After the fuel rod gas is collected, fuel rod void volume is determined. The entire piping system is evacuated. Then, the valves to the evacuated calibrated flasks are closed, and the fission gas system piping and the fuel rod are pressurized with argon. The argon is permitted to flow into the fuel rod

until equilibrium is reached (as indicated by no change in pressure on the Baratron gauge). This pressure is recorded, and the valve is opened to one of the calibrated flasks. When a second equilibrium is reached, the void volume calculation can be completed. The fuel rod void volume is calculated from Boyles' Law.

$$V_p = \frac{(P_2)\ (V_s)\ + P_2\ (V_x)\ - P_1\ (V_s)}{P_1 - P_2}$$

where: P_1 = first pressure reading, mm Hg
P_2 = second pressure reading, mm Hg
V_s = volume of fission gas system piping, cm^3
V_x = volume of selected calibrated flask, cm^3
v_p = fuel rod void volume, cm^3.

QUANTITY OF GAS COLLECTED

Once V_p has been determined, the number of moles of gas collected from the fuel rod can be determined according to the ideal gas law.

$$n = \frac{(P_s)\ (\Sigma V_i)}{(62360)\ (273 + T)}$$

where: P_s = system pressure recorded after fuel rod puncture, mm Hg
T = system temperature, °C
ΣV_i = volume of system piping (V_s plus volume of all calibrated flasks opened to obtain P_s plus V_p)
n = moles of gas.

Because V_p is a very small value compared with the other volumes used to determine ΣV_i, normal errors in V_p have only a minor effect on the values reported for n.

APPENDIX D

SECTIONING DIAGRAM

APPENDIX D

SECTIONING DIAGRAM

The sectioning diagram for Rod MLA098 is shown in a continuous four-part graph of the ^{137}Cs gamma scan (Figure D.1). Each letter along the top of the graph identifies a specific section of the rod and is keyed to the detailed section assignment and location description (Table D.1) that follows the graph. It should be noted that the graph is referenced to the top end of the rod. Also, note that dashed lines represent cuts that had not been made when this report was prepared.

Sections were cut from the rod using a circular saw with an aluminum oxide blade; the saw is operated without coolant. Each cut required less than 1 min. After cutting, the small fuel samples were placed in glass vials for transfer to the analytical facilities. The remaining longer segments (for repository testing or MCC spare material) were marked at the top end for orientation purposes and were placed in individual stainless steel storage tubes that were filled with argon before being capped with a Swagelok® fitting. Two operators were used during sectioning operations to verify that the sections were cut correctly and placed in the proper prelabeled transfer or storage containers. As the sections longer than 2.5 cm (1.0 in.) were cut, as-cut measurements were made. These as-cut measurements were used to prepare an as-cut sectioning diagram as shown in this appendix.

® Swagelock fittings are manufactured by the Crawford Fitting Company, Solon, Ohio.

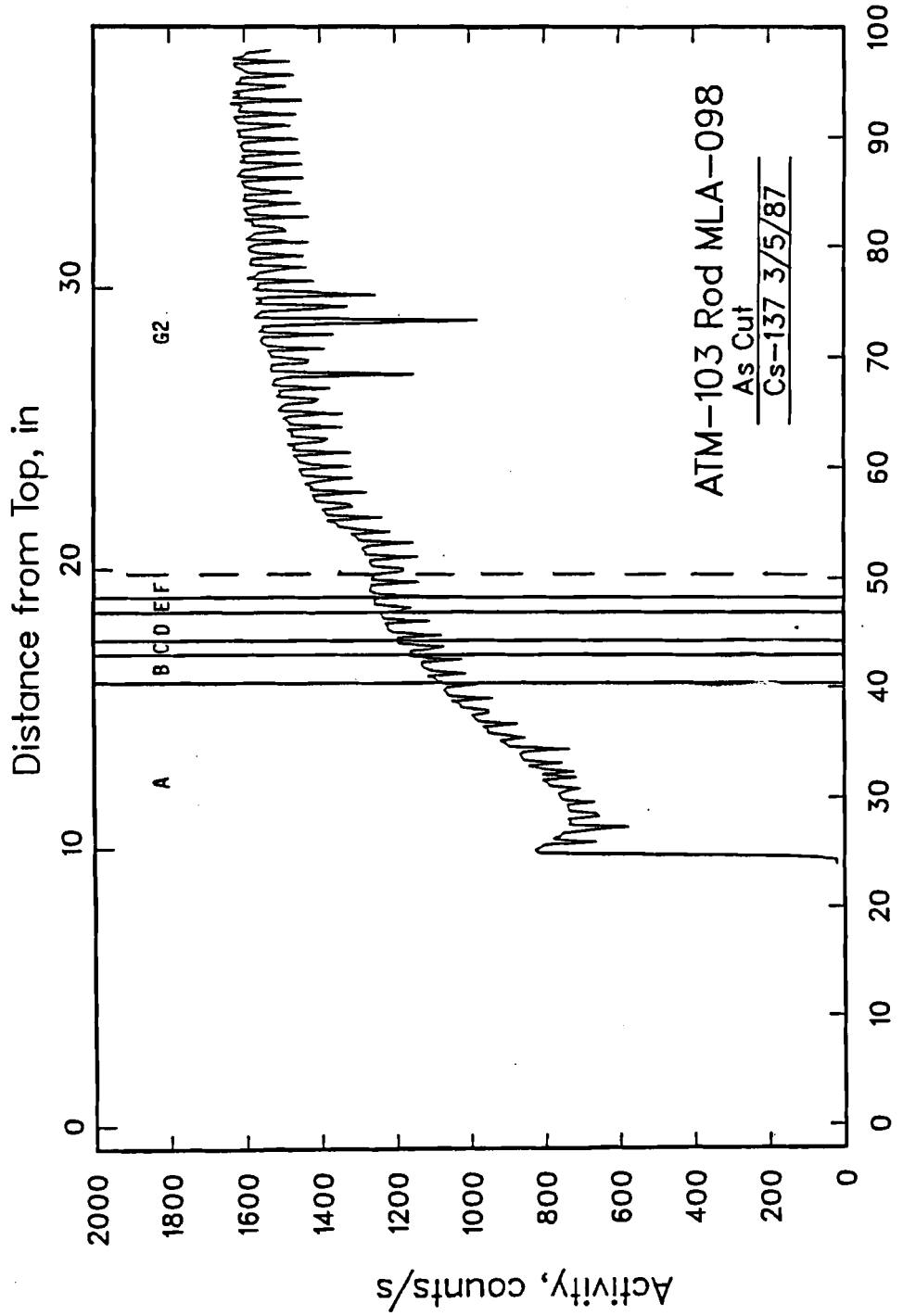


FIGURE D.1. As-Cut Sectioning Diagram for Rod MLA098

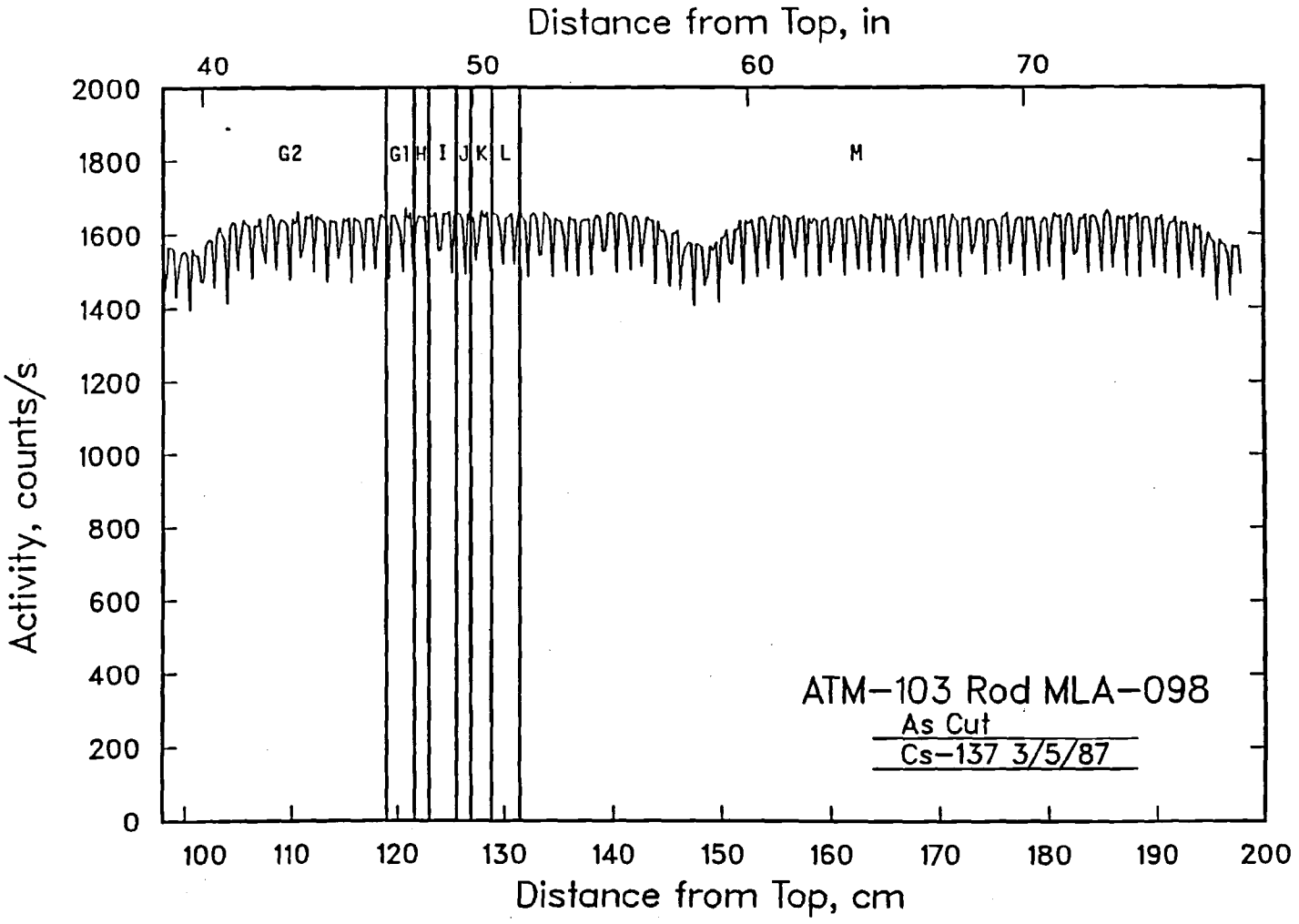


FIGURE D.1. As-Cut Sectioning Diagram for Rod MLA098 (contd)

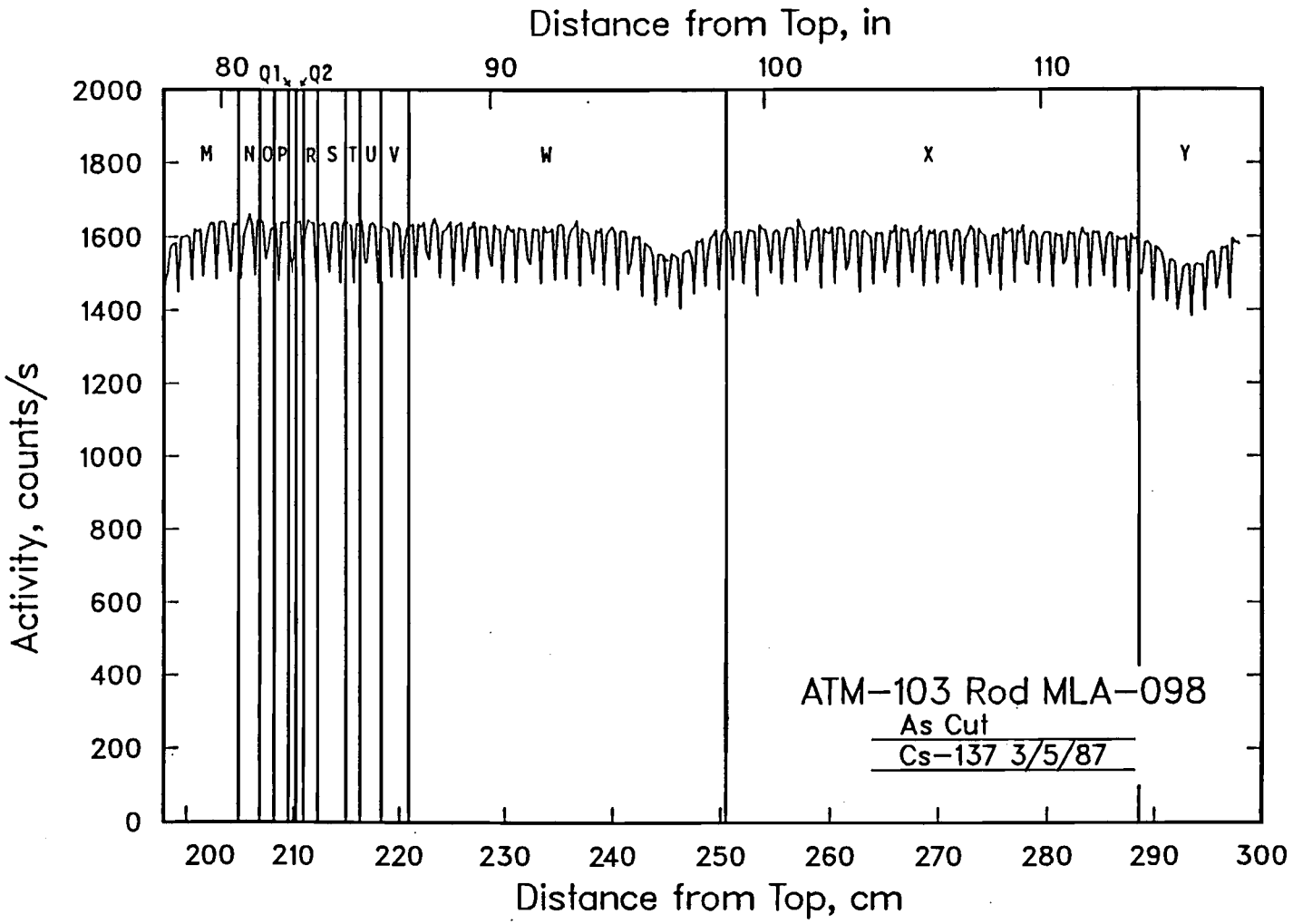


FIGURE D.1. As-Cut Sectioning Diagram for Rod MLA098 (contd)

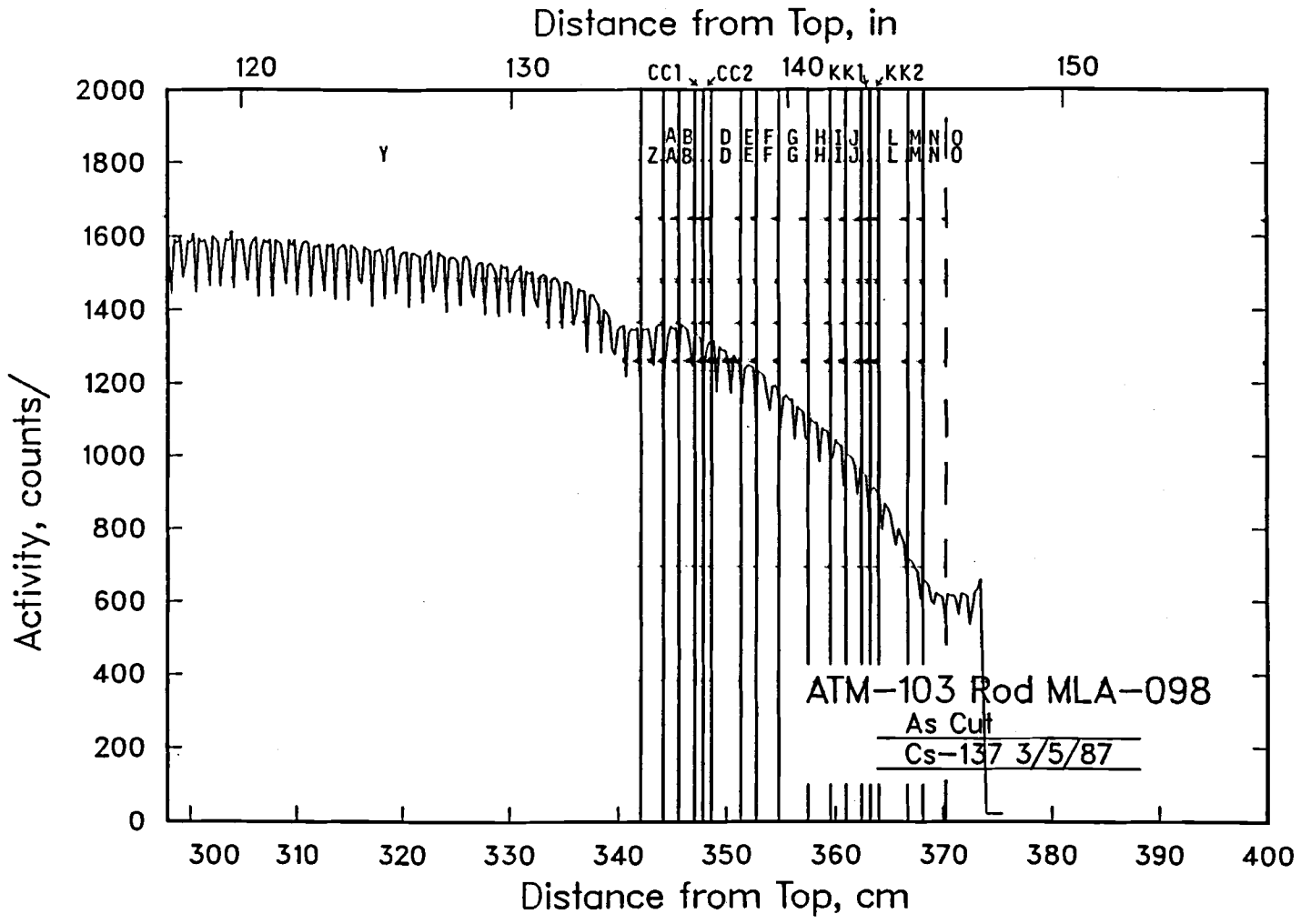


FIGURE D.1. As-Cut Sectioning Diagram for Rod MLA098 (contd)

TABLE D.1. Description of As-Cut Sections of ATM-103, Rod MLA098 (Key to Figure D.1)

Section Identification	Section Assignment	Distance From Top,[a] cm (in.)	Length,[b] cm (in.)	Notes
A.	MCC Spare Material	0-40.323 (0-15.875)	40.32 (15.88)	c
B.	ONWI Material	40.386-42.926 (15.900-16.900)	2.54 (1.00)	
C.	MCC Transverse Metallography-Cermography	42.990-44.260 (16.925-17.425)	1.27 (0.50)	
D.	MCC I-129 on Cladding ID, MCC Cs-135 and Cs-137 on Cladding ID and OD	44.323-46.863 (17.450-18.450)	2.54 (1.00)	
E.	MCC C-14 in Fuel and Cladding	46.927-48.197 (18.475-18.975)	1.27 (0.50)	
F.	MCC Spare Material	48.260-50.165* (19.000-19.750*)	1.91 (0.75)	c,d
G2.	MCC Spare Material	50.229*-118.936 (19.775*-46.825)	68.71 (27.05)	c,d
G1.	ONWI Material	118.999-121.539 (46.850-47.850)	2.54 (1.00)	c,e
H.	MCC Transverse Metallography-Ceramography	121.603-122.873 (47.875-48.375)	1.27 (0.50)	
I.	MCC I-129 on Cladding ID, MCC Cs-135 and Cs-137 on Cladding ID and OD	122.936-125.476 (48.400-49.400)	2.54 (1.00)	
J.	MCC C-14 in Fuel and Cladding	125.540-126.810 (49.425-49.925)	1.27 (0.50)	
K.	MCC Spare Material	126.873-128.778 (49.950-50.700)	1.91 (0.75)	
L.	MCC Spare Material	128.842-131.382 (50.725-51.725)	2.54 (1.00)	f
M.	NNWSI Material	131.445-204.788 (51.750-80.625)	73.34 (28.88)	c
N.	MCC Longitudinal Metallography-Cermography	204.851-206.781 (80.650-81.410)	1.93 (0.76)	g
O.	MCC Transverse Metallography-Ceramography	206.845-208.140 (81.435-81.945)	1.30 (0.51)	g
P.	MCC Burnup, Isotopes, and Radionuclides	208.204-209.499 (81.970-82.480)	1.30 (0.51)	g
Q1.	ORNL Spark Source	209.563-210.223 (82.505-82.765)	0.66 (0.26)	g

TABLE D.1. (contd)

Section Identification	Section Assignment	Distance From Top,[a] cm (in.)	Length,[b] cm (in.)	Notes
Q2.	ORNL Spark Source	210.287-210.947 (82.790-83.050)	0.66 (0.26)	g
R.	MCC Transmission Electron Microscopy	211.011-212.306 (83.075-83.585)	1.30 (0.51)	g
S.	MCC I-129 in Fuel and on Cladding ID, MCC Cs-135 and Cs-137 on Cladding ID and OD	212.369-214.935 (83.610-84.620)	2.57 (1.01)	g
T.	MCC C-14 in Fuel and Cladding	214.998-216.294 (84.645-85.155)	1.30 (0.51)	g
U.	MCC Spare Material	216.357-218.288 (85.180-85.940)	1.93 (0.76)	g
V.	ONWI Material	218.351-220.917 (85.965-86.975)	2.57 (1.01)	g
W.	MCC Spare and Archive Material	220.980-250.444 (87.000-98.600)	29.46 (11.60)	c
X.	BWIP Material	250.508-288.544 (98.625-113.600)	38.04 (14.98)	c
Y.	MCC Spare Material	288.608-342.044 (113.625-134.663)	53.44 (21.04)	c,h,i
Z.	MCC Longitudinal Metallography-Ceramography	342.108-344.109 (134.688-135.476)	2.00 (0.79)	h
AA.	MCC Transverse Metallography-Ceramography	344.173-345.539 (135.501-136.039)	1.37 (0.54)	h
BB.	MCC Burnup, Isotopes, and Radionuclides	345.603-346.969 (136.064-136.602)	1.37 (0.54)	h
CC1.	ORNL Spark Source	347.033-347.764 (136.627-136.915)	0.73 (0.29)	h
CC2.	ORNL Spark Source	347.828-348.559 (136.940-137.228)	0.73 (0.29)	h
DD.	MCC I-129 in Fuel and on Cladding ID, MCC Cs-135 and Cs-137 on Cladding ID and OD	348.623-351.259 (137.253-138.291)	2.64 (1.04)	h,j
EE.	MCC C-14 in Fuel and Cladding	351.323-352.689 (138.316-138.854)	1.37 (0.54)	h
FF.	MCC Spare Material	352.753-354.754 (138.879-139.667)	2.00 (0.79)	h
GG.	ONWI Material	354.818-357.454 (139.692-140.730)	2.64 (1.04)	h

TABLE D.1. (contd)

Section Identification	Section Assignment	Distance From Top,[a] cm (in.)	Length,[b] cm (in.)	Notes
HH.	MCC Longitudinal Metallography-Cermography	357.518-359.519 (140.755-141.543)	2.00 (0.79)	h
II.	MCC Transverse Metallography-Ceramography	359.583-360.949 (141.568-142.106)	1.37 (0.54)	h
JJ.	MCC Burnup, Isotopes, and Radionuclides	361.013-362.379 (142.131-142.669)	1.37 (0.54)	h
KK1.	ORNL Spark Source	362.443-363.174 (142.694-142.982)	0.73 (0.29)	h
KK2.	ORNL Spark Source	363.238-363.969 (143.007-143.295)	0.73 (0.29)	h
LL.	MCC I-129 in Fuel and on Cladding ID, MCC Cs-135 and Cs-137 on Cladding ID and OD	364.033-366.669 (143.320-144.358)	2.64 (1.04)	h
MM.	MCC C-14 in Fuel and Cladding	366.733-368.099 (144.383-144.921)	1.37 (0.54)	h
NN.	MCC Spare Material	368.163-370.067* (144.946-145.696*)	1.91 (0.75)	c,h,d
OO.	MCC Spare Material	370.131*-375.59 (145.721*-147.87)	5.46 (2.15)	c,h,d

(a) Distance from top reported to three decimal places only to keep account of saw loss between sections.
(b) Section lengths reported to two decimal places. Length does not include 0.064 cm (0.025 in.) saw loss. This is accounted for between sections.
(c) Within ±0.16 cm (1/16 in.) of as-measured length. Section F-G measured before cutting into Sections F-G2 and G1.
(d) Sections are one section of fuel. Asterisk (*) indicates a theoretical distance from top of the rod specified in the pre-cut plan.
(e) This section was cut to replace Section L.
(f) Approximately 0.64 cm (0.25 in.) of fuel lost from top side of this piece, originally designated as ONWI material.
(g) Added 0.025 cm (0.01 in.) to each of 10 sections (N-V) to compensate for 0.25 cm (0.10 in.) difference between as-cut length measurements and "theoretical" summation of sections N through V after accounting for saw loss.
(h) Added 0.097 cm (0.038 in.) to each of 18 sections (Y-NN/OO) to compensate for 1.729 cm (0.681 in.) difference between as-cut length measurements and "theoretical" summation of sections Y through NN/OO after accounting for saw loss.
(i) Approximately 0.95 cm (0.38 in.) of fuel vibrated loose from the top end of Segment Y during cutting.
(j) Fuel fragments vibrated from the cladding during cutting. Fuel fragments were picked up from the cutting channel and placed in a vial with section DD.

APPENDIX E

DETAILS OF CERAMOGRAPHY/METALLOGRAPHY

APPENDIX E

DETAILS OF CERAMOGRAPHY/METALLOGRAPHY

This appendix includes the results of all ceramographic and metallographic examinations conducted to date on ATM-103 fuel. Photographs presented in the text are also presented here for completeness. Table E.1 gives a summary of specimen locations. Refer to Figure 4.8 and Appendix D (Sectioning Diagram) for further details.

The organization of the Figures in the Appendix E is given below:

Figure E.1.a - E.1.e	Photomacrographs of As-Polished Transverse Samples
Figure E.1.f - E.1.h	Photomacrographs of As-Polished Longitudinal Samples
Figure E.2.a - E.2.e	Photomicrographs of As-Polished Transverse Samples
Figure E.2.f - E.2.h	Photomicrographs of As-Polished Longitudinal Samples
Figure E.3.a - E.3.e	Photomicrographs of Argon Ion-etched Transverse Samples
Figure E.3.f - E.3.h	Photomicrographs of Argon Ion-etched Longitudinal Samples
Figure E.4.a - E.4.d	Exterior/Interior Cladding Surfaces of As-Polished Samples
Figure E.5.a - E.5.e	Etched Cladding of Transverse Samples
Figure E.5.f - E.5.h	Etched Cladding of Longitudinal Samples
Figure E.6.a - E.6.j	Alpha and Beta-Gamma Autoradiographs of Transverse Samples
Figure E.6.k - E.6.p	Alpha and Beta-Gamma Autoradiographs of Longitudinal Samples

TABLE E.1. Summary of Ceramographic/Metallographic Samples

Sample ID	Distance from Top,[a] cm	(in.)	Sample Type
103-MLA098-C	42.99-44.26	(16.93-17.43)	Transverse
103-MLA098-H	121.60-122.87	(47.88-48.38)	Transverse
103-MLA098-N	204.85-206.78	(80.65-81.41)	Longitudinal
103-MLA098-O	206.85-208.14	(81.44-81.95)	Transverse
103-MLA098-Z	342.11-344.11	(134.69-135.48)	Longitudinal
103-MLA098-AA	344.17-345.54	(135.50-136.04)	Transverse
103-MLA098-HH	357.52-359.52	(140.76-141.54)	Longitudinal
103-MLA098-II	359.58-360.95	(141.57-142.11)	Transverse

(a) Rod distance referenced from top end of rod.

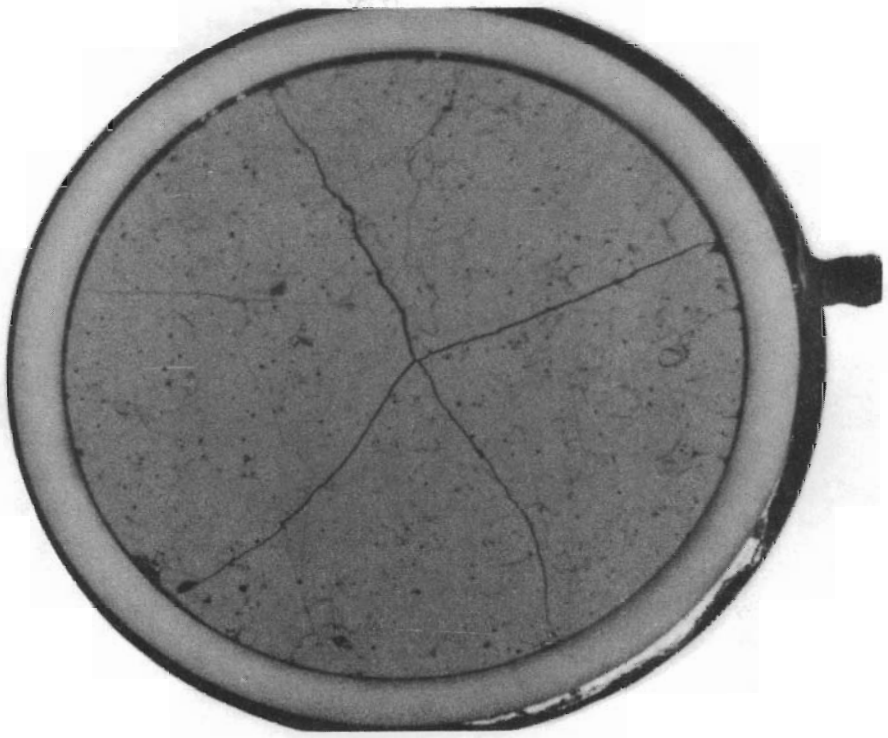


FIGURE E.1.a. Photomacrograph of As-Polished Transverse Sample 103-MLA098-C (~10x) (Neg. No. 8704494-11)

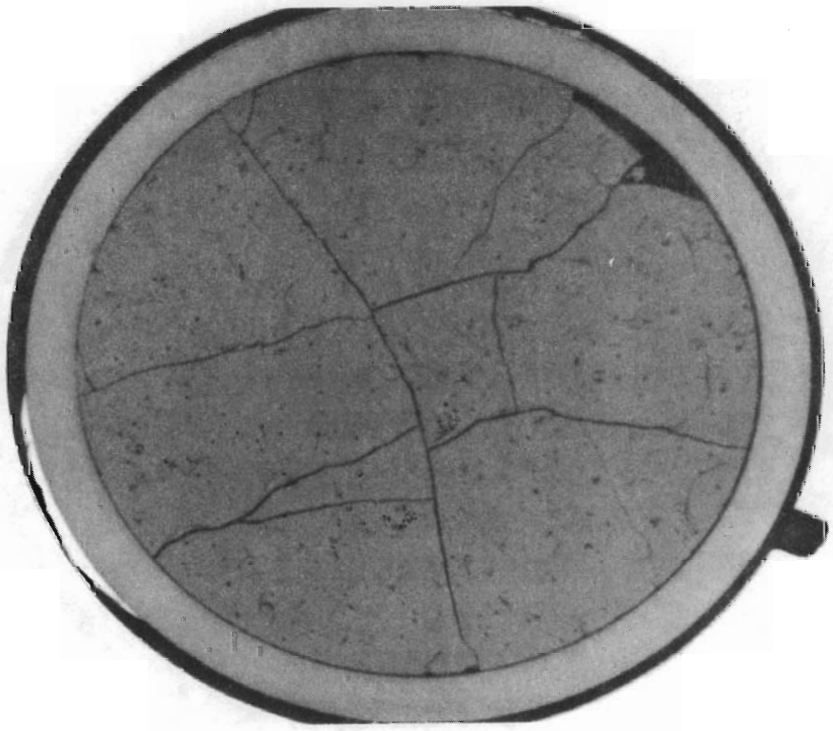


FIGURE E.1.b. Photomacrograph of As-Polished Transverse Sample 103-MLA098-H (~10x) (Neg. No. 8704494-18)

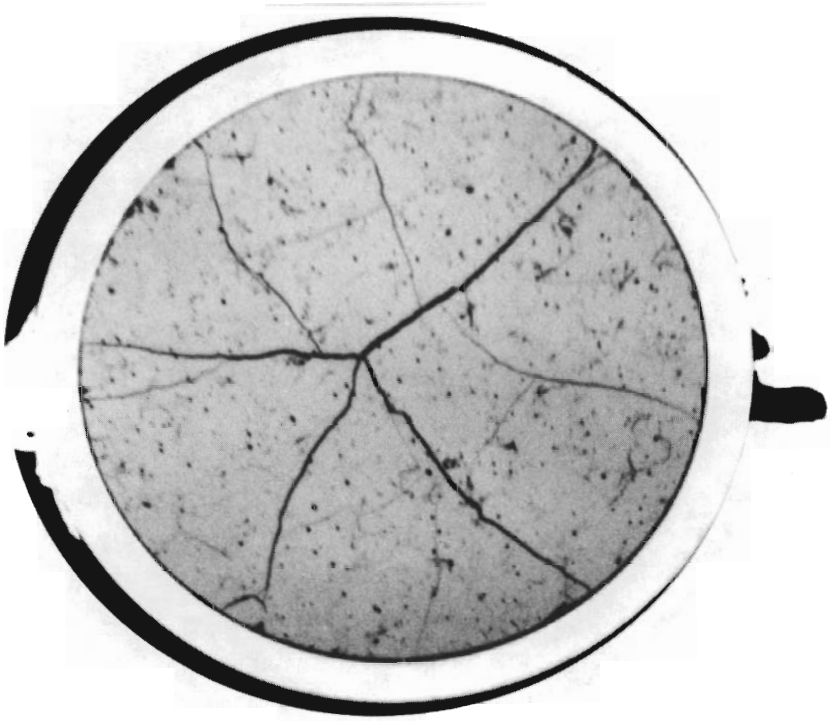


FIGURE E.1.c. Photomacrograph of As-Polished Transverse Sample 103-MLA098-0 (~10x) (Neg. No. 8704675-24)

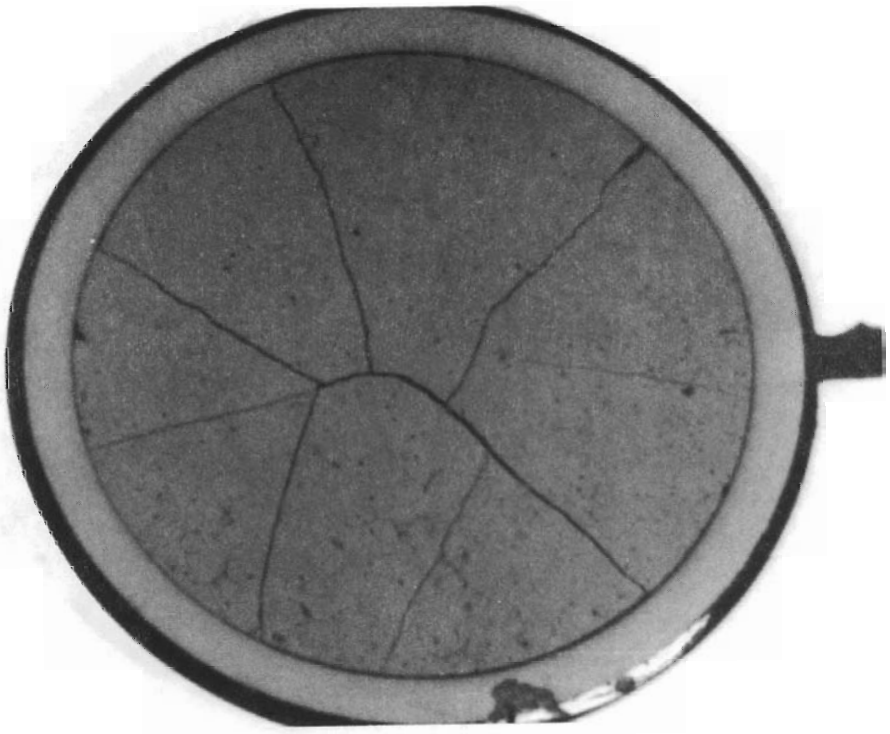


FIGURE E.1.d. Photomacrograph of As-Polished Transverse Sample 103-MLA098-AA (~10x) (Neg. No. 8704494-23)

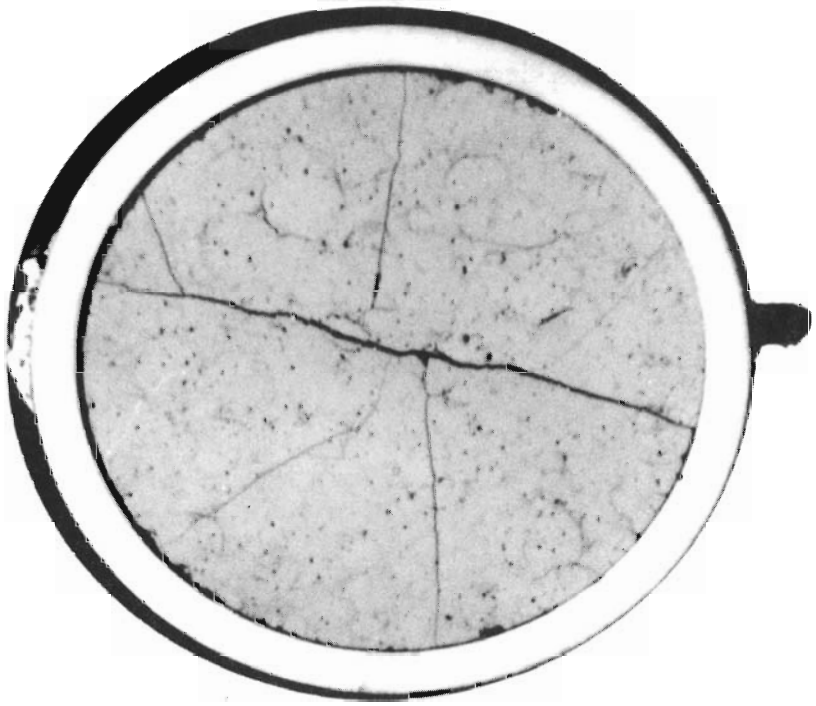


FIGURE E.1.e. Photomacrograph of As-Polished Transverse Sample 103-MLA098-II (~10x) (Neg. No. 8704675-12)

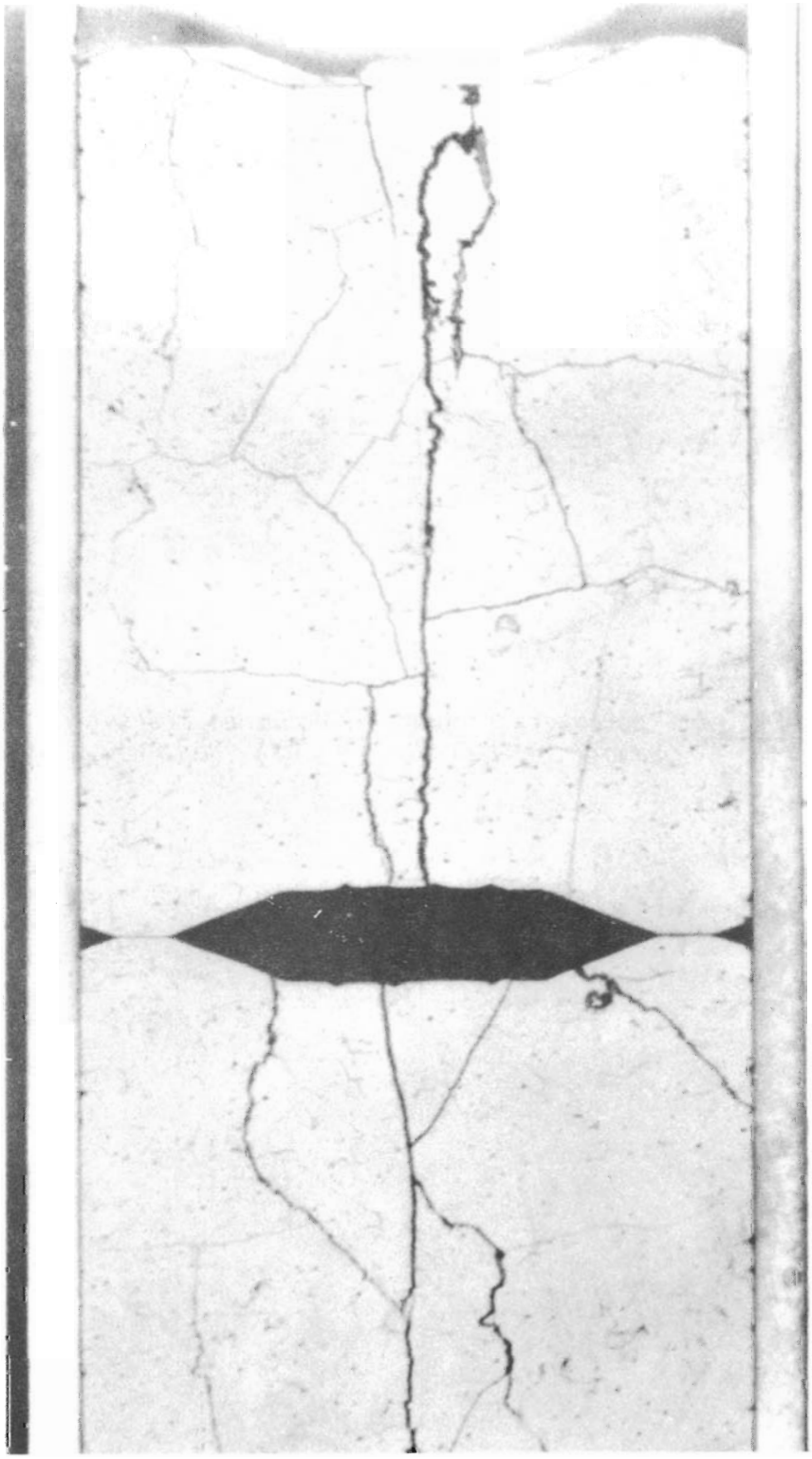


FIGURE E.1.f. Photomacrograph of As-Polished Longitudinal Sample 103-MLA098-N (~10x) (Neg. No. 8704675-2)

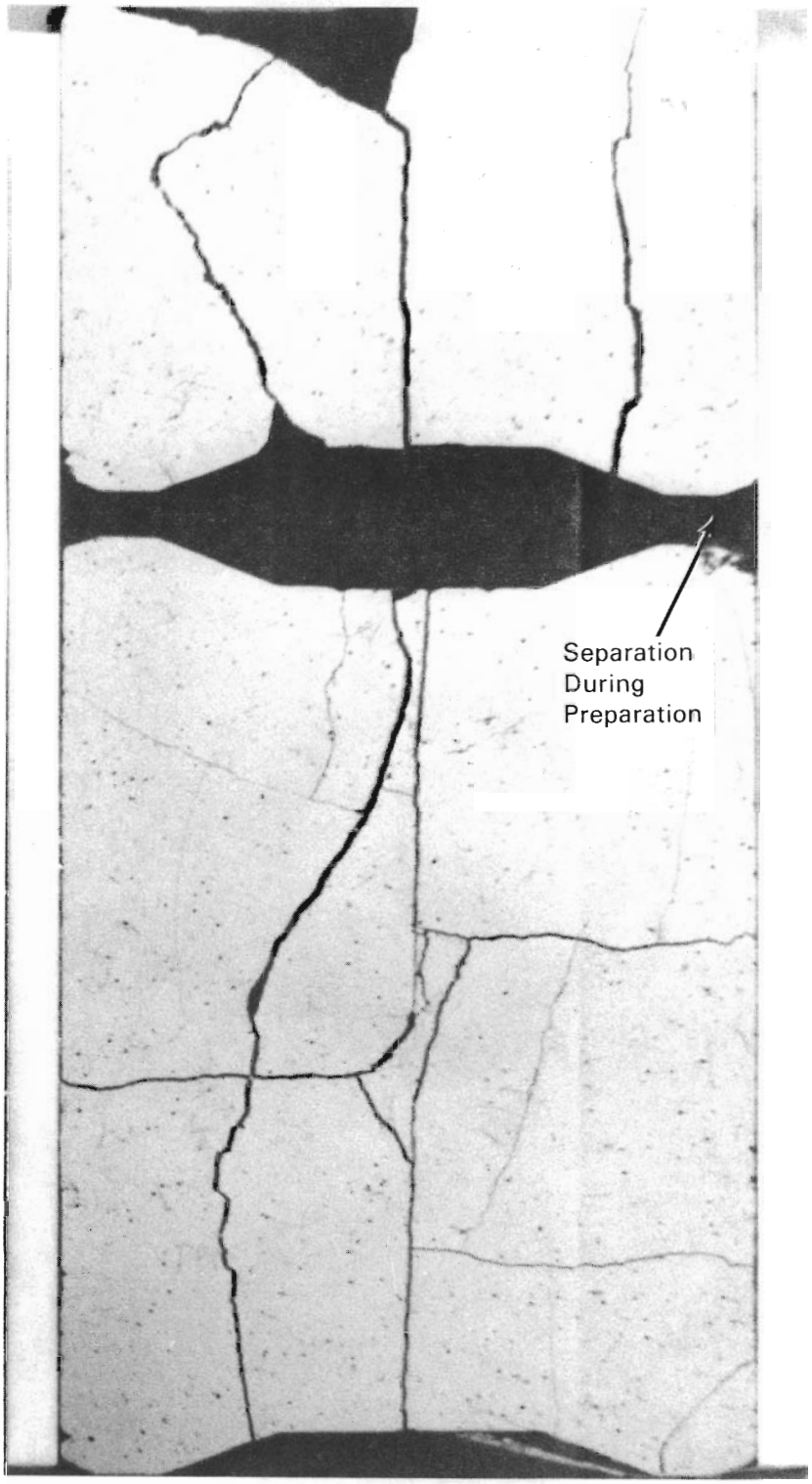


FIGURE E.1.g. Photomacrograph of As-Polished Longitudinal Sample 103-MLA098-Z (~10x) (Neg. No. 8704494-3)

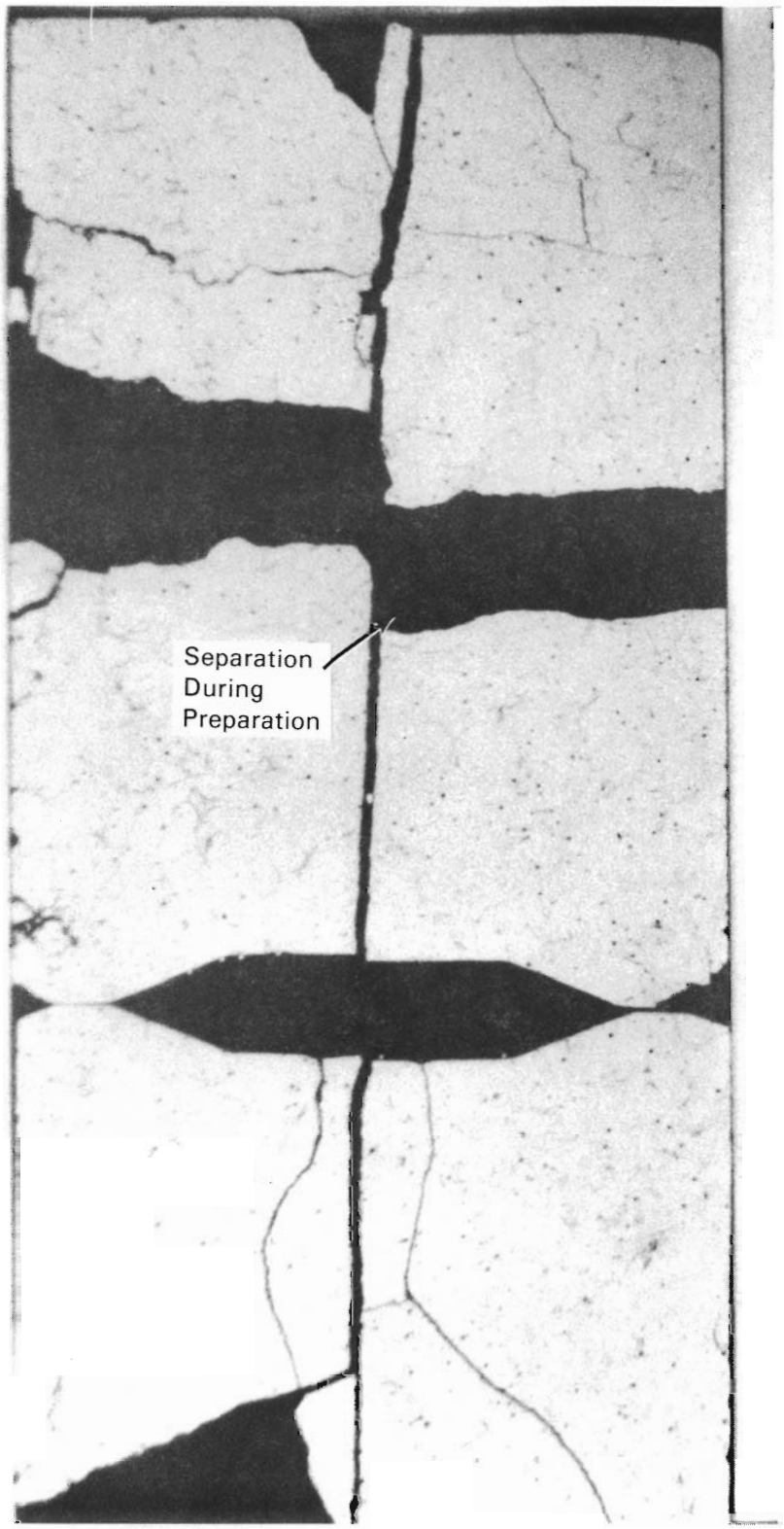
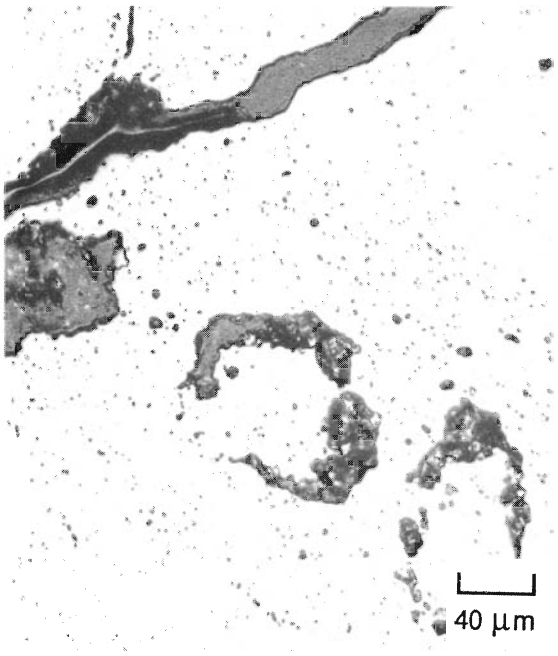
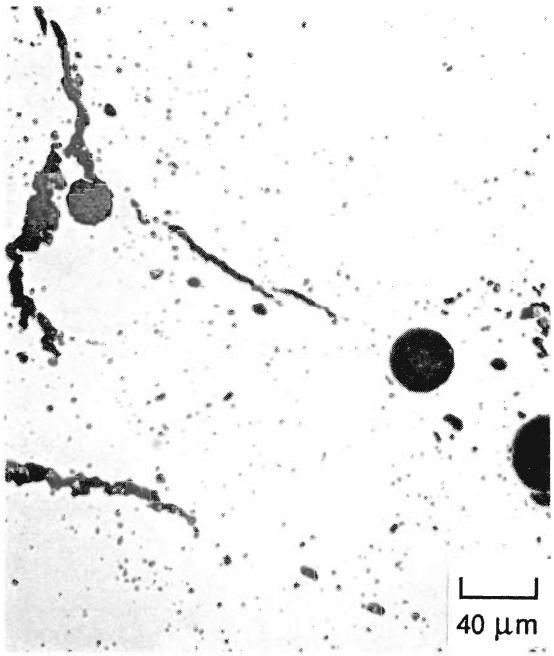


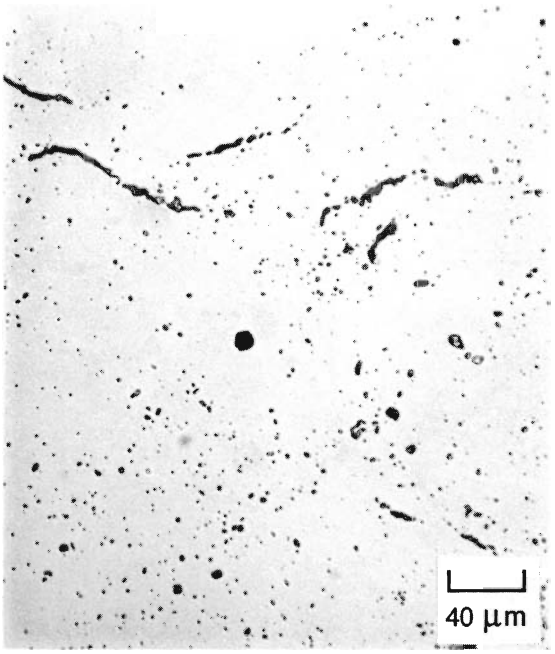
FIGURE E.1.h. Photomacrograph of As-Polished Longitudinal Sample 103-MLA098-HH (~10x) (Neg. No. 8704494-10)



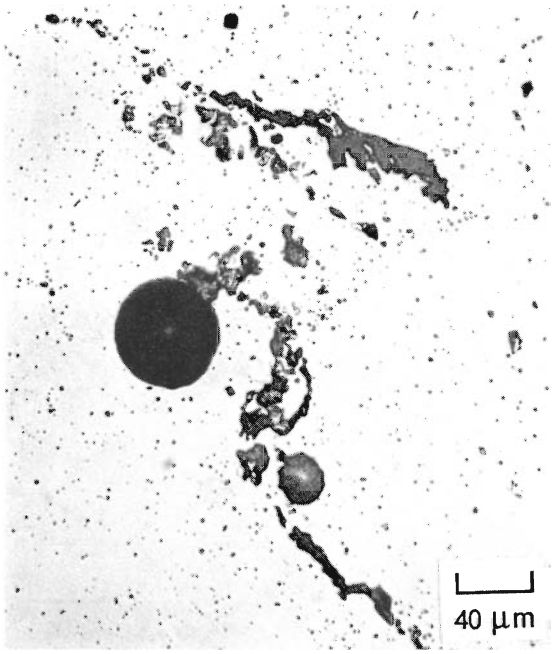
a) Center (Neg. No. P-3034)



b) 1/3 Radius (Neg. No. P-3033)

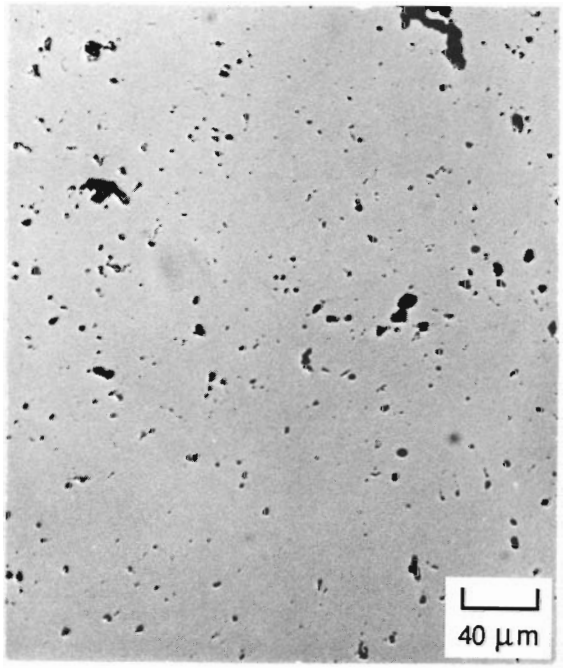


c) 2/3 Radius (Neg. No. P-3032)

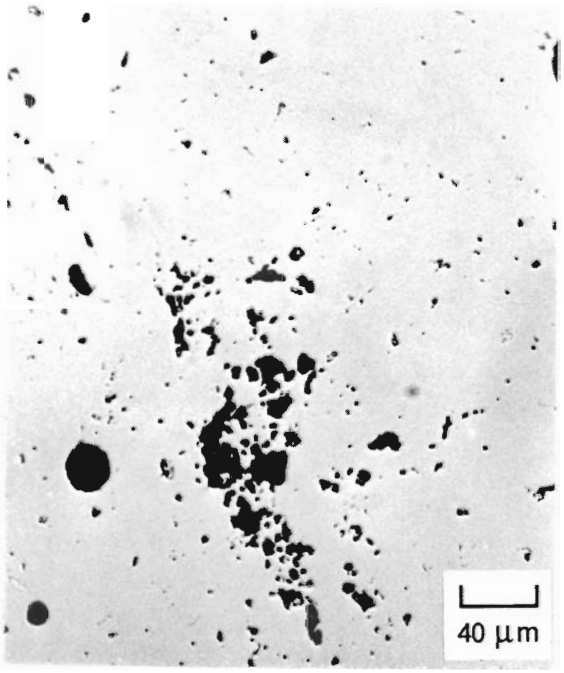


d) Edge (Neg. No. P-3031)

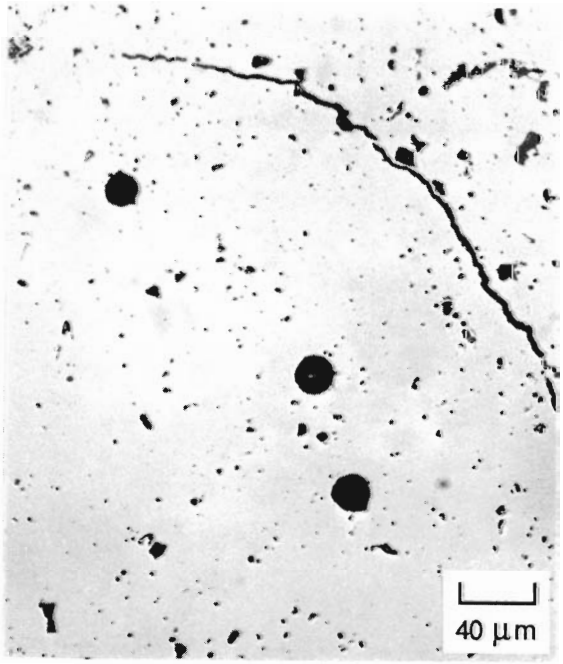
FIGURE E.2.a. Photomicrographs of As-Polished Transverse Sample 103-MLA098-C



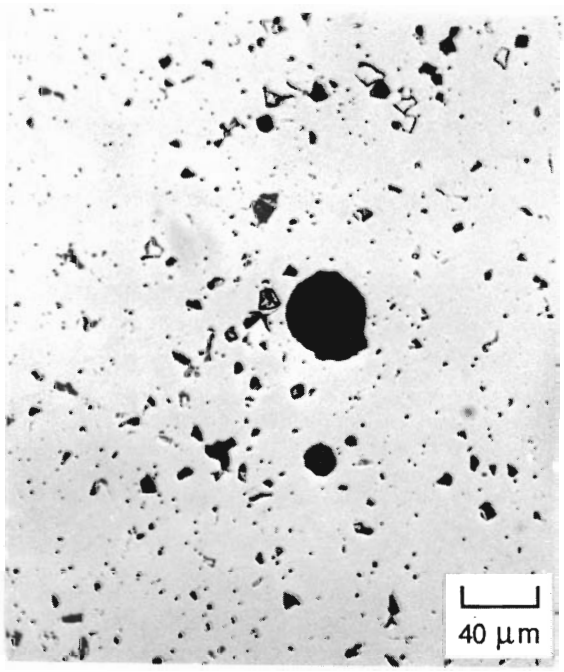
a) Center (Neg. No. P-3022)



b) 1/3 Radius (Neg. No. P-3021)

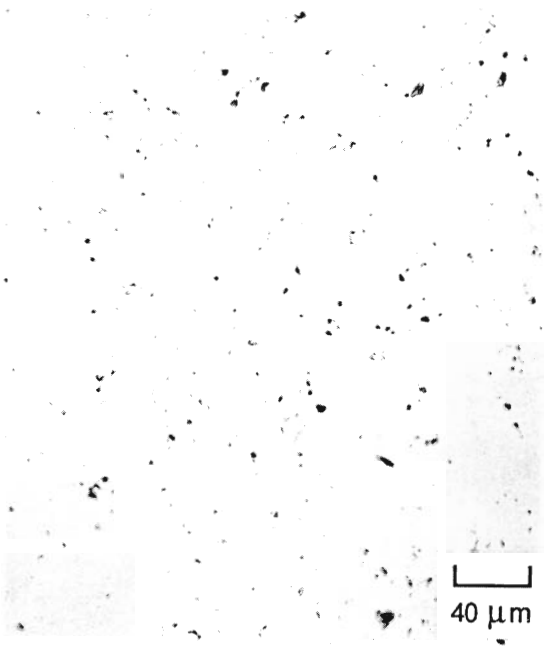


c) 2/3 Radius (Neg. No. P-3020)

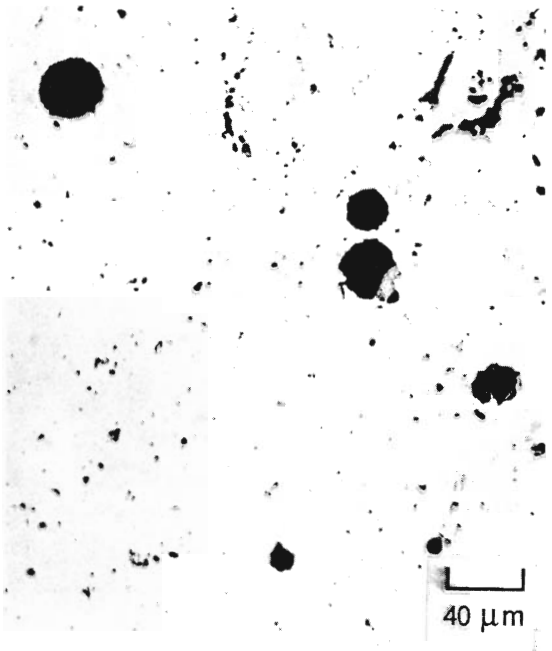


d) Edge (Neg. No. P-3019)

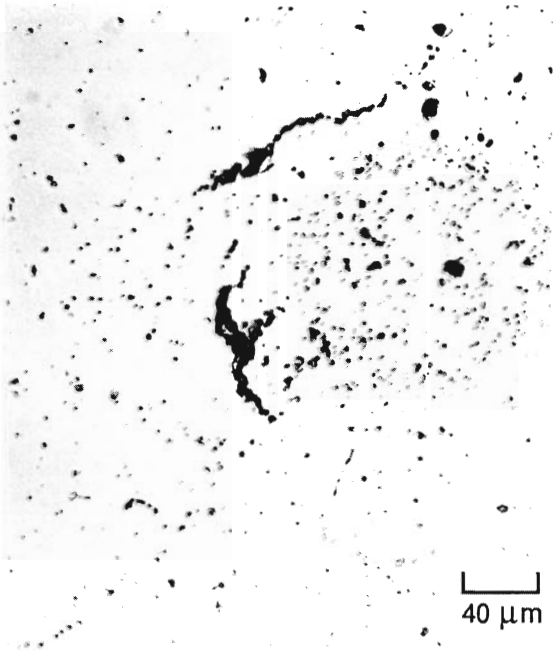
FIGURE E.2.b. Photomicrographs of As-Polished Transverse Sample 103-MLA098-H



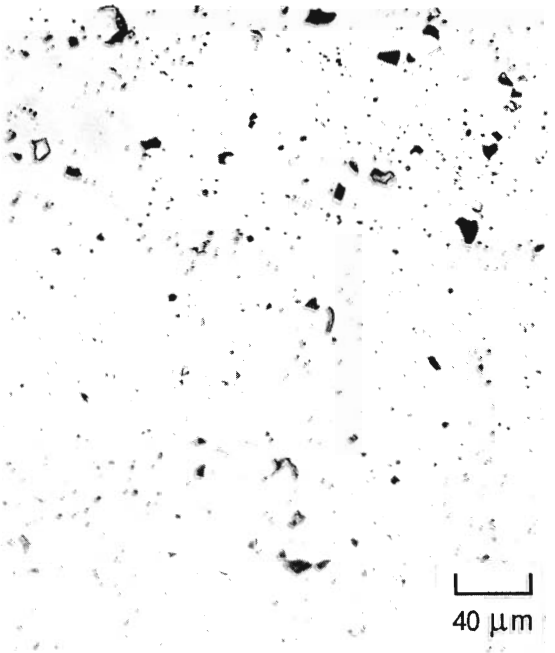
a) Center (Neg. No. P-2692)



b) 1/3 Radius (Neg. No. P-2691)

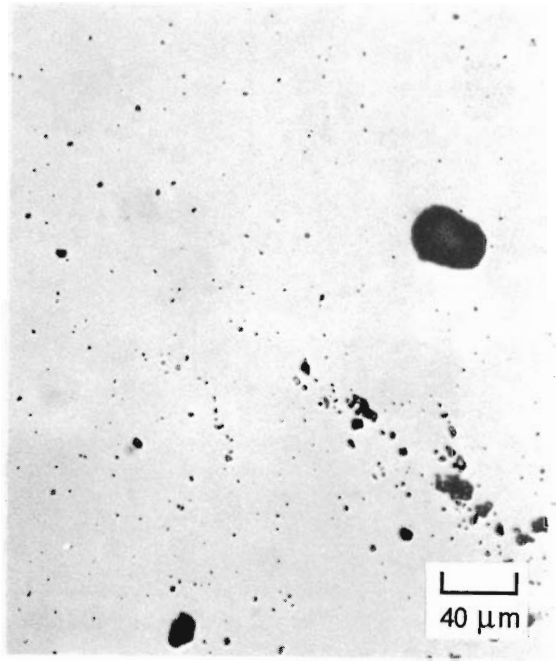


c) 2/3 Radius (Neg. No. P-2690)

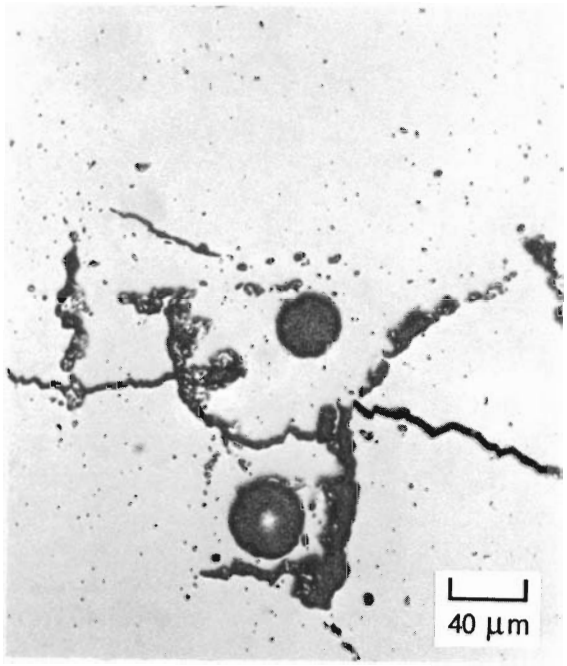


d) Edge (Neg. No. P-2689)

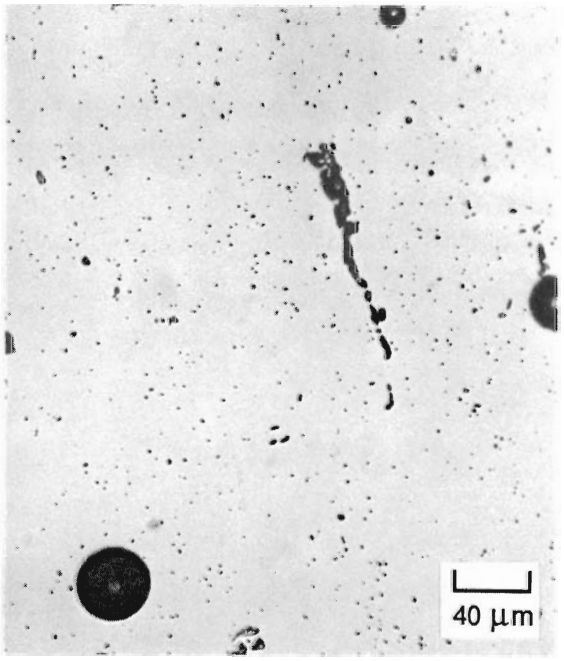
FIGURE E.2.c. Photomicrographs of As-Polished Transverse Sample 103-MLA098-0



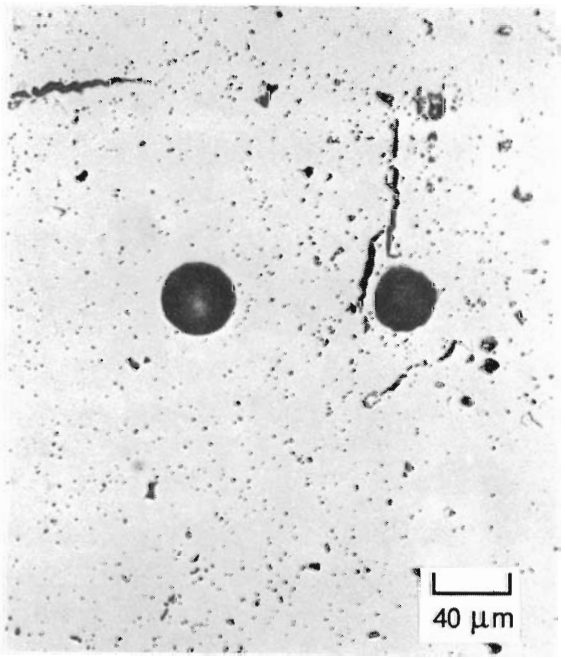
a) Center (Neg. No. P-3045)



b) 1/3 Radius (Neg. No. P-3044)

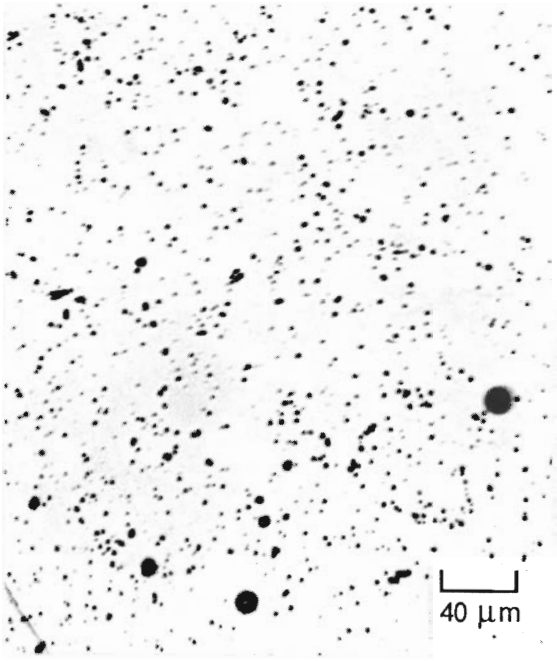


c) 2/3 Radius (Neg. No. P-3043)

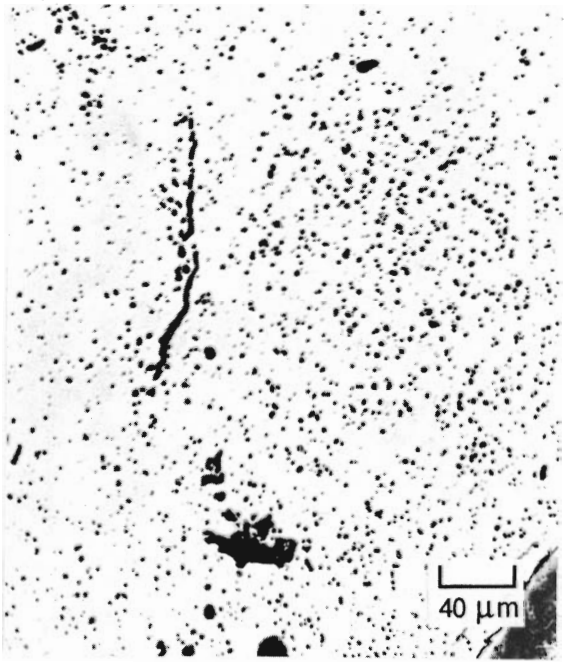


d) Edge (Neg. No. P-3042)

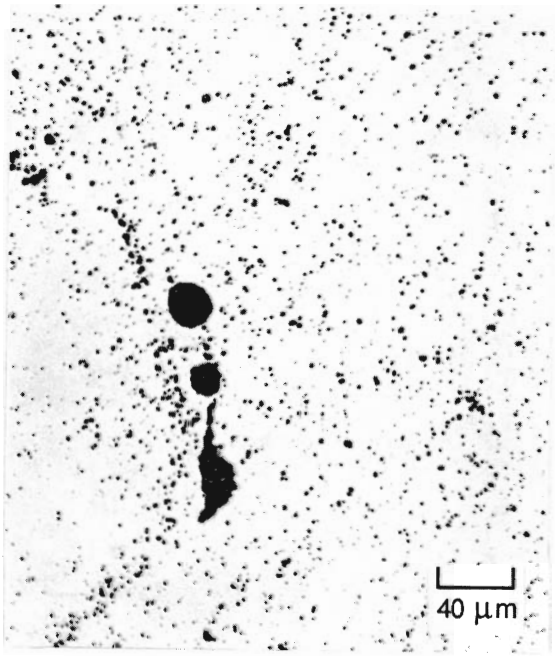
FIGURE E.2.d. Photomicrographs of As-Polished Transverse Sample 103-MLA098-AA



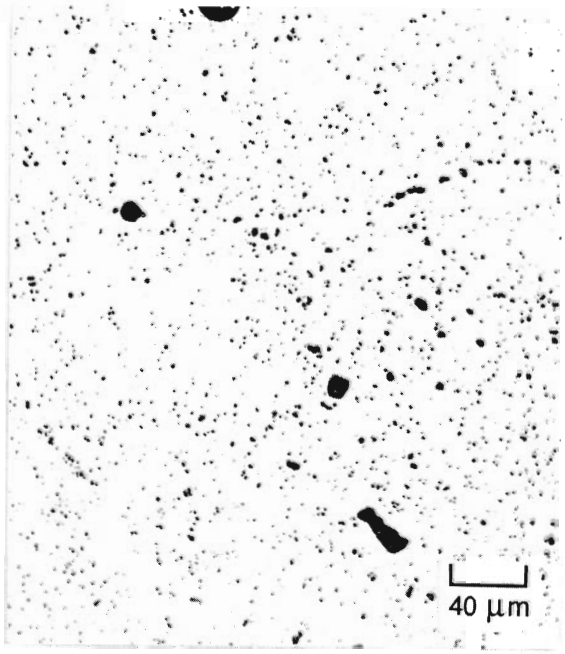
a) Center (Neg. No. P-2763)



b) 1/3 Radius (Neg. No. P-2762)

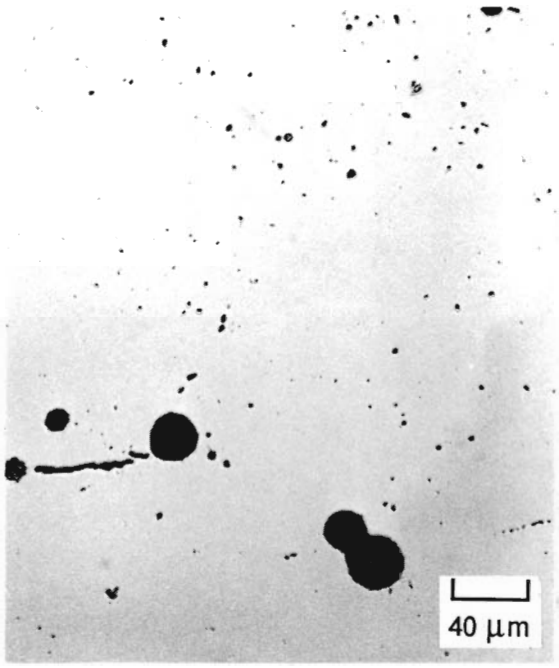


c) 2/3 Radius (Neg. No. P-2761)

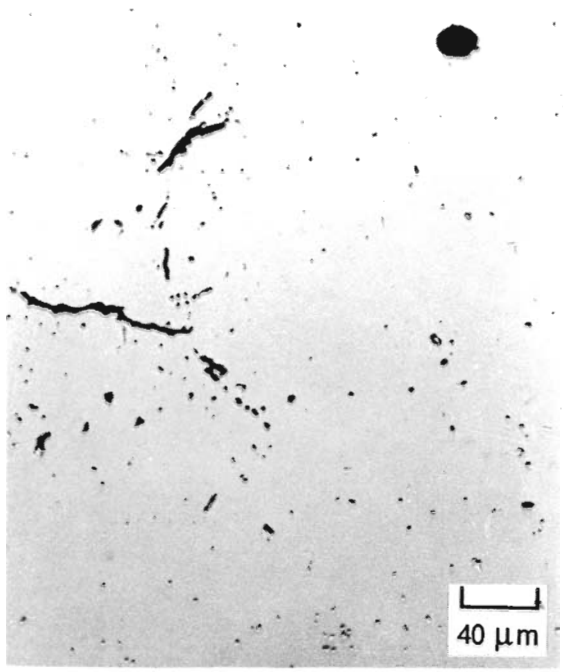


d) Edge (Neg. No. P-2760)

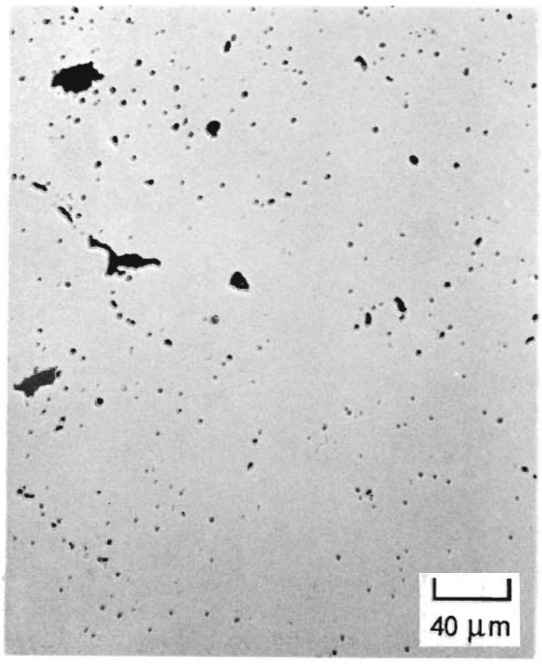
FIGURE E.2.e. Photomicrographs of As-Polished Transverse Sample 103-MLA098-II



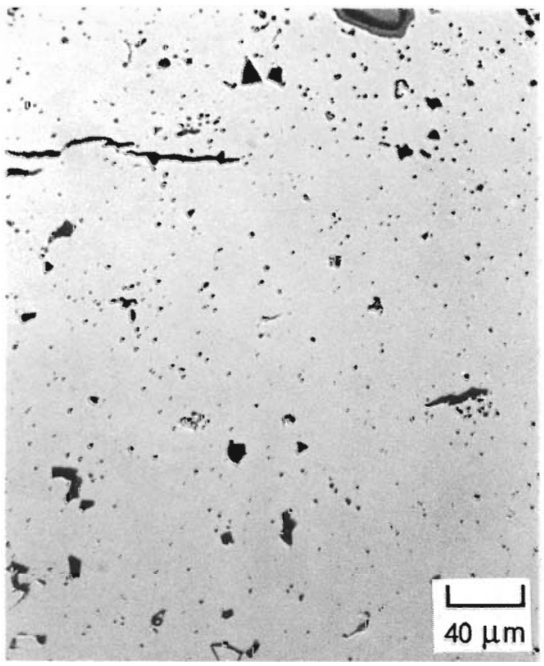
a) Center (Neg. No. P-2675)



b) 1/3 Radius (Neg. No. P-2674)

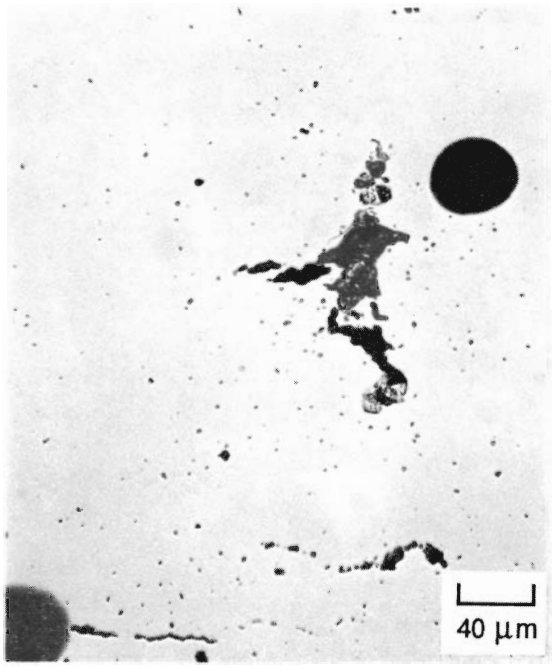


c) 2/3 Radius (Neg. No. P-2673)

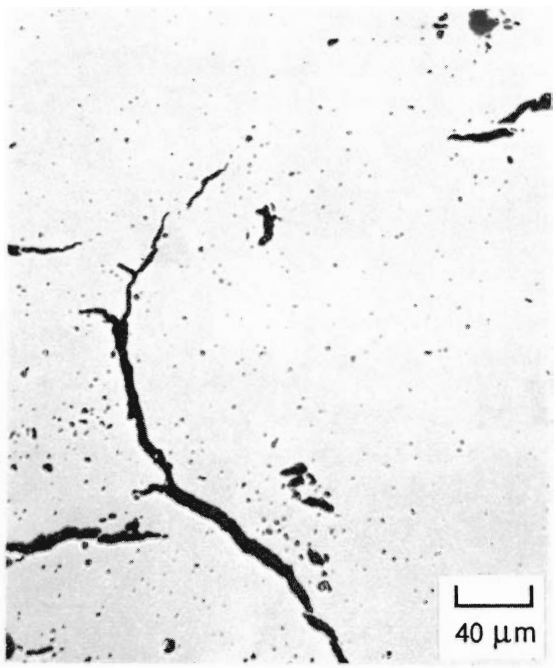


d) Edge (Neg. No. P-2672)

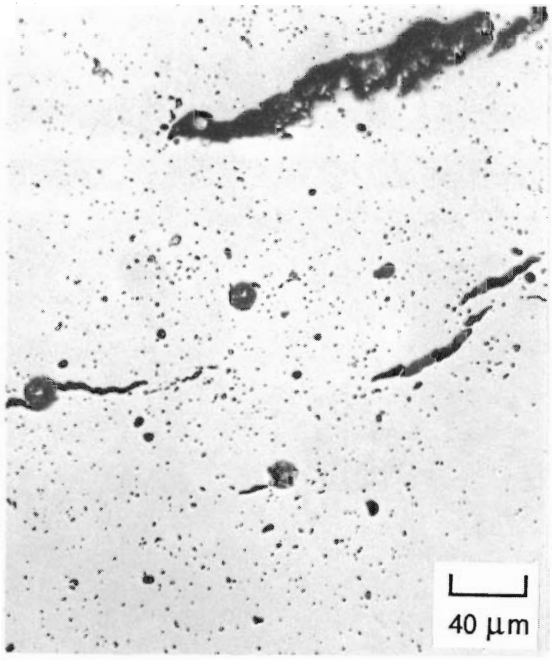
FIGURE E.2.f. Photomicrographs of As-Polished Longitudinal Sample 103-MLA098-N



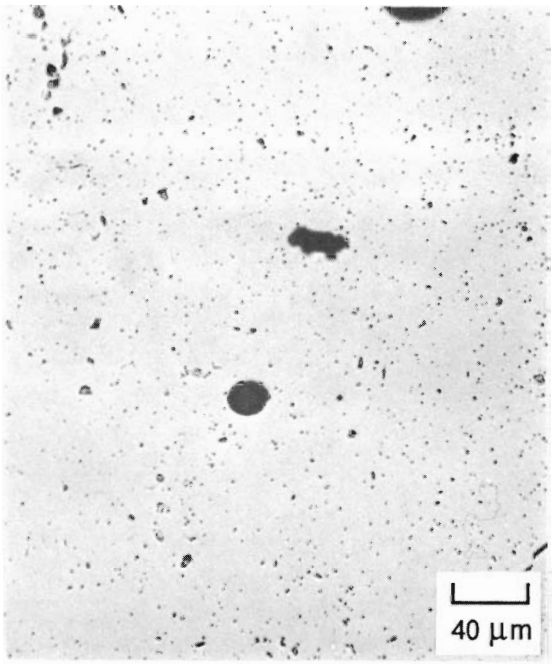
a) Center (Neg. No. P-2986)



b) 1/3 Radius (Neg. No. P-2985)

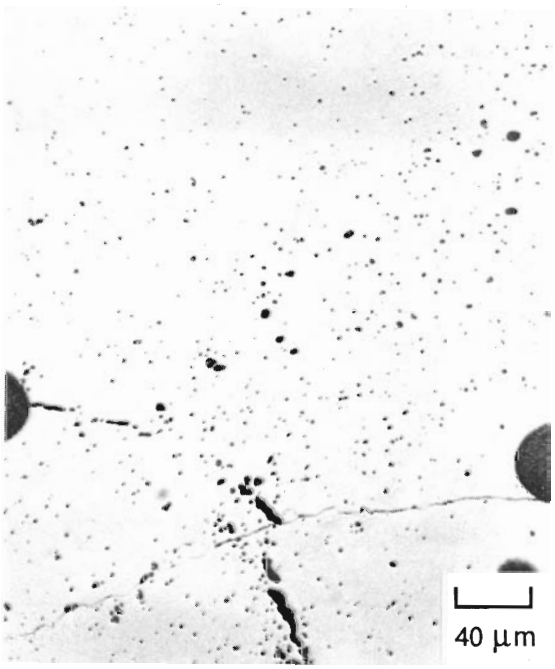


c) 2/3 Radius (Neg. No. P-2984)

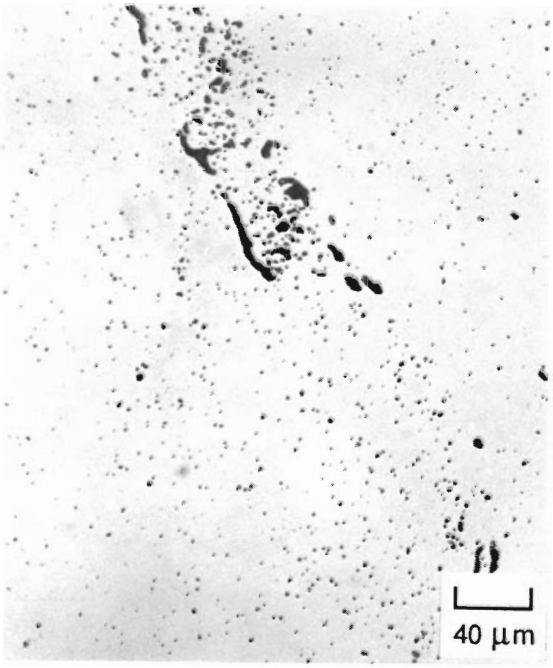


d) Edge (Neg. No. P-2983)

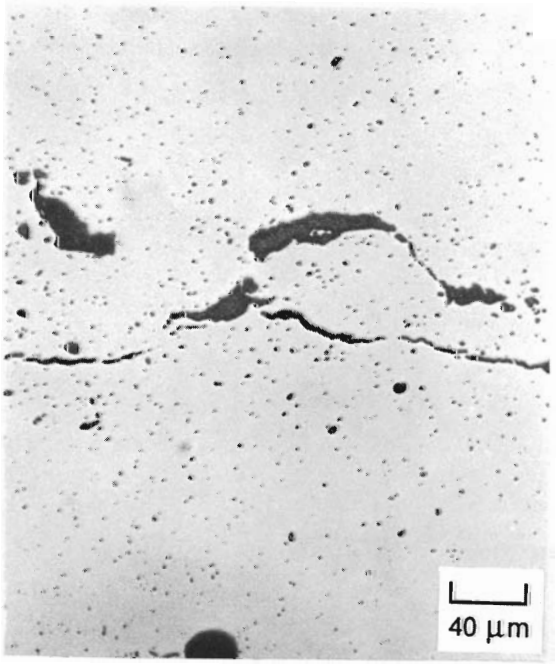
FIGURE E.2.g. Photomicrographs of As-Polished Longitudinal Sample 103-MLA098-Z



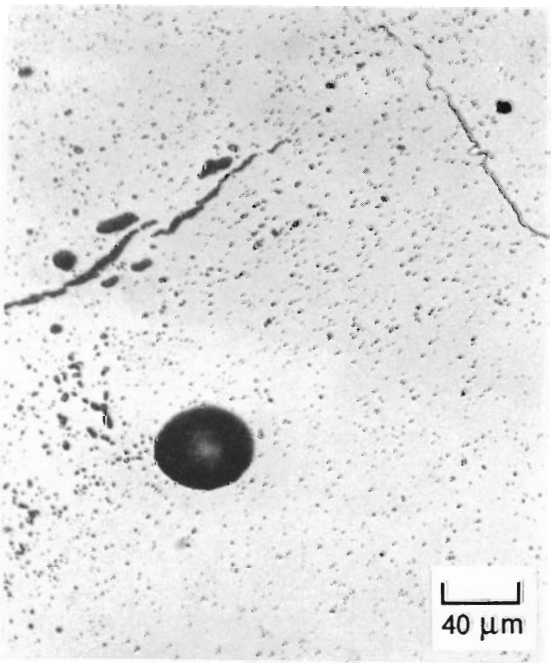
a) Center (Neg. No. P-2980)



b) 1/3 Radius (Neg. No. P-2979)

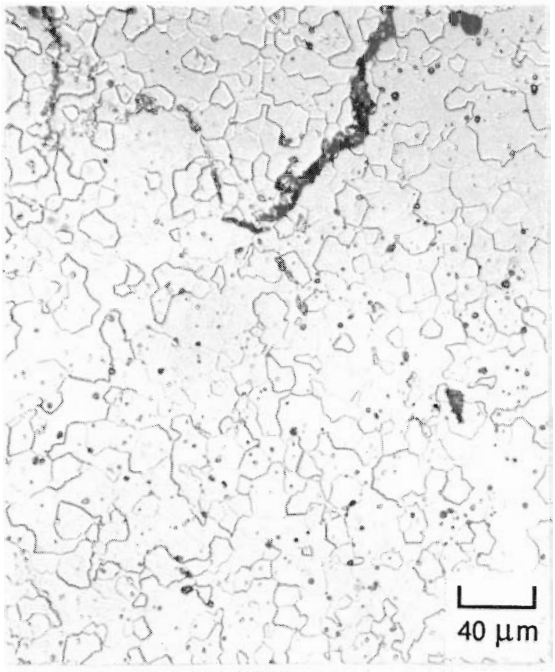


c) 2/3 Radius (Neg. No. P-2978)

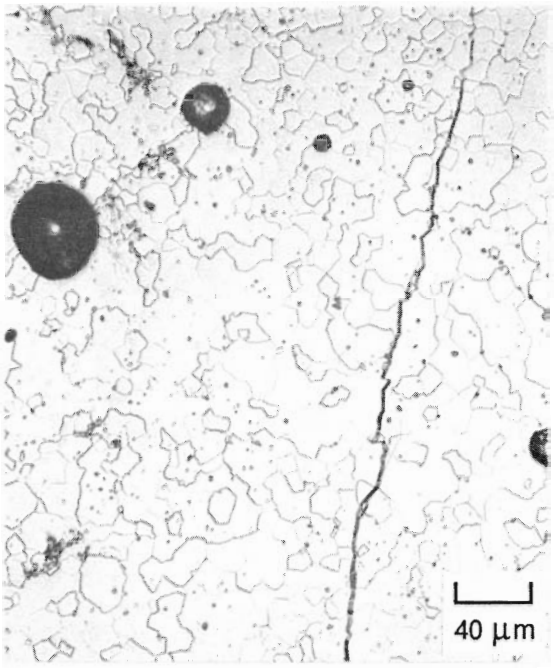


d) Edge (Neg. No. P-2977)

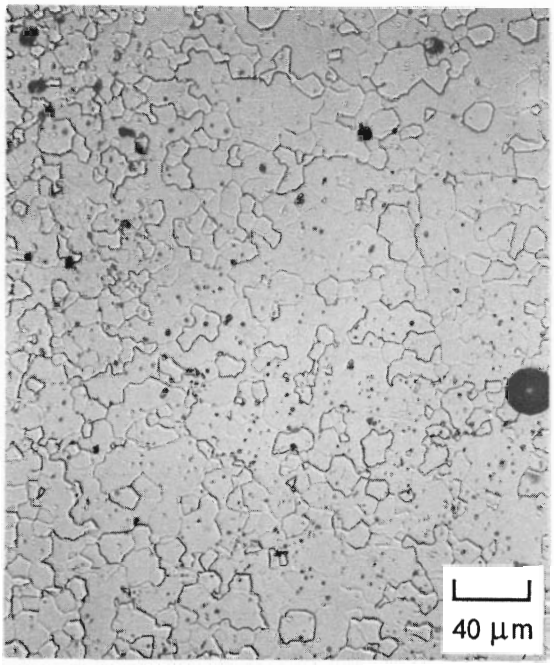
FIGURE E.2.h. Photomicrographs of As-Polished Longitudinal Sample 103-MLA098-HH



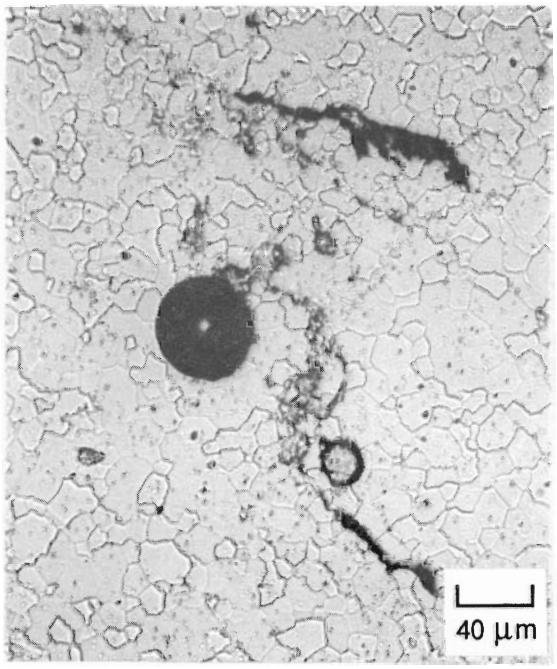
a) Center (Neg. No. P-3172)



b) 1/3 Radius (Neg. No. P-3171)

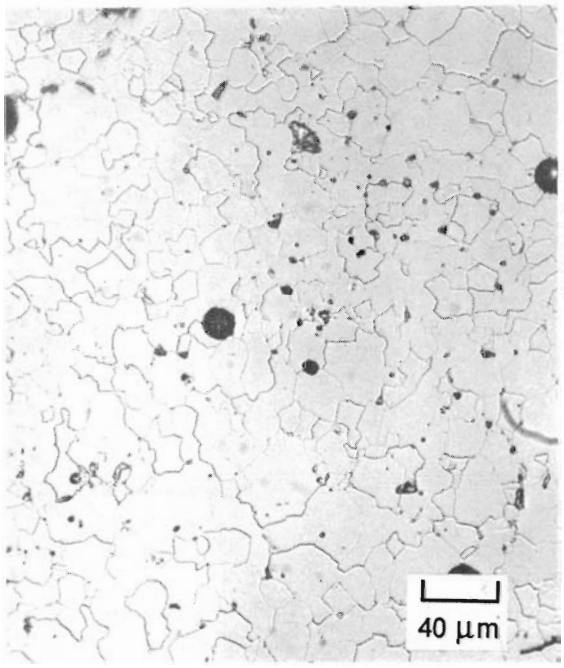


c) 2/3 Radius (Neg. No. P-3170)

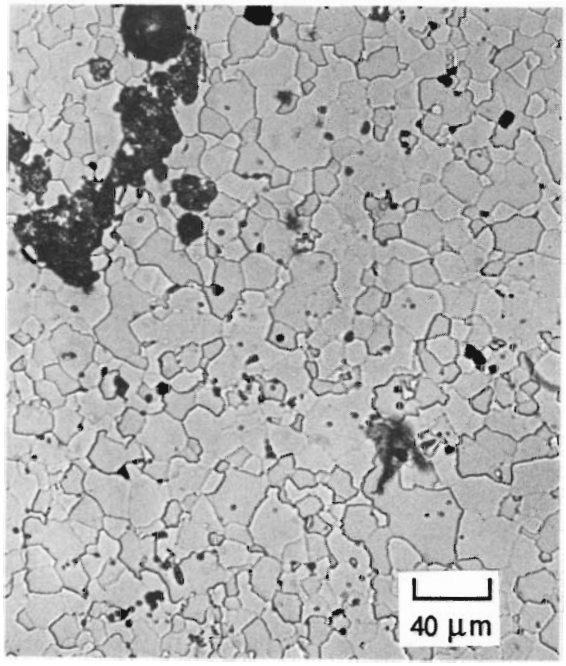


d) Edge (Neg. No. P-3169)

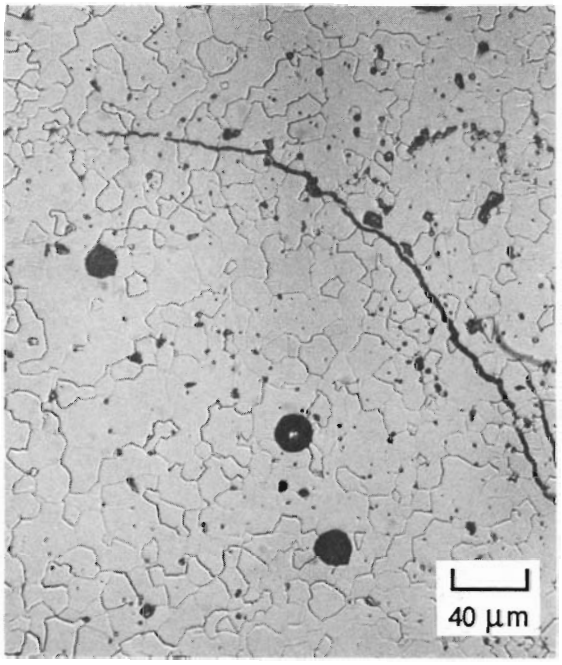
FIGURE E.3.a. Photomicrographs of Argon Ion-Etched Transverse Sample 103-MLA098-C



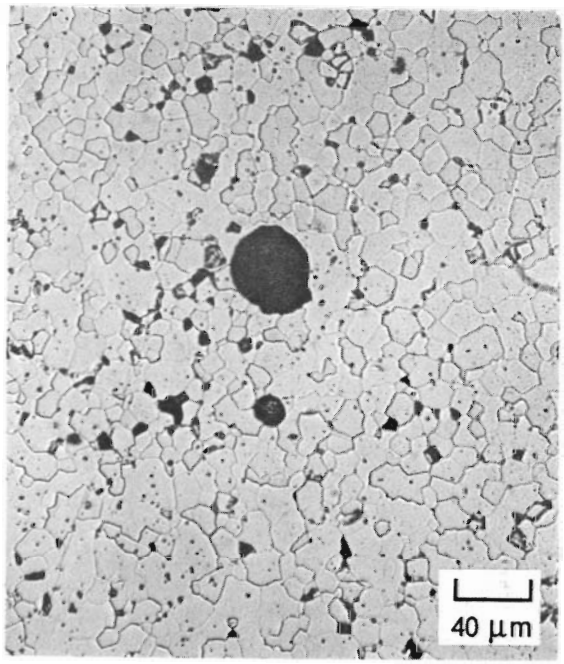
a) Center (Neg. No. P-3083)



b) 1/3 Radius (Neg. No. P-3082)

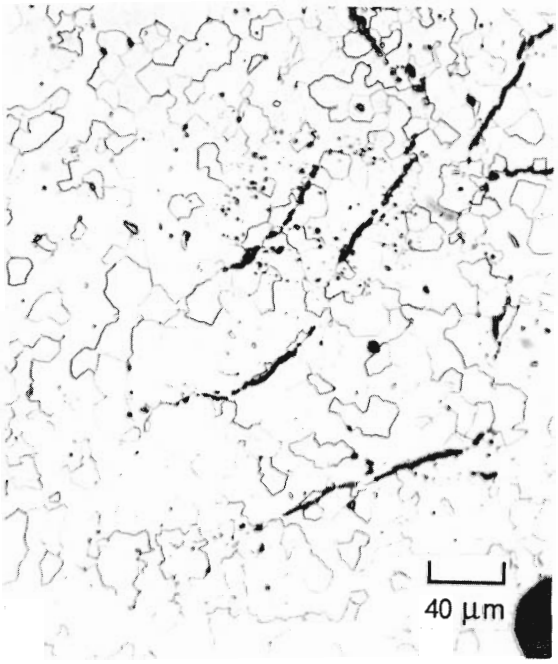


c) 2/3 Radius (Neg. No. P-3081)

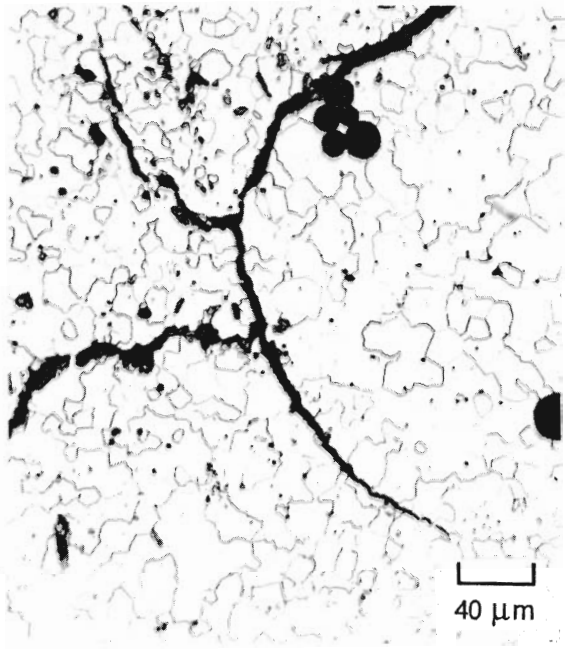


d) Edge (Neg. No. P-3080)

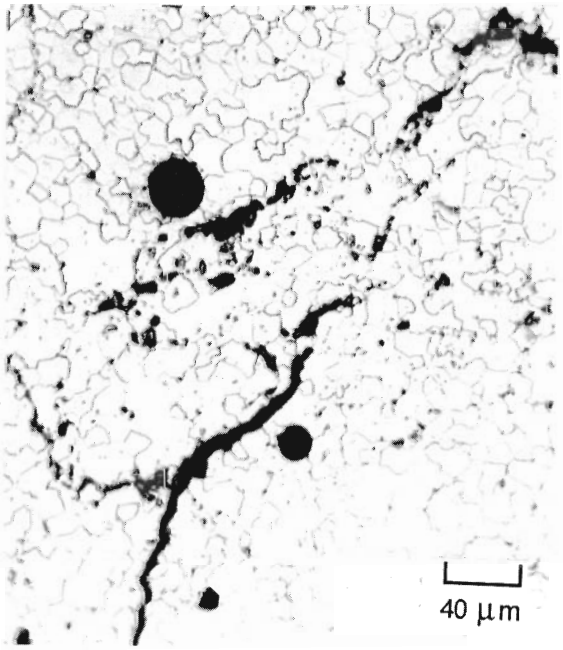
FIGURE E.3.b. Photomicrographs of Argon Ion-Etched Transverse Sample 103-MLA098-H



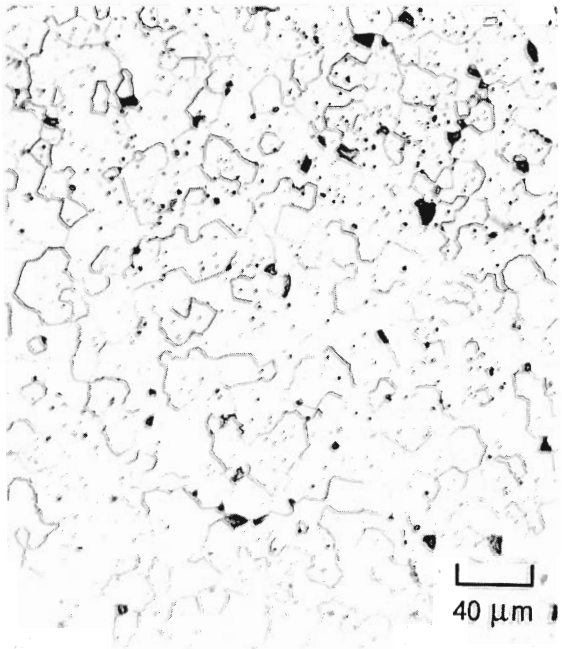
a) Center (Neg. No. P-2904)



b) 1/3 Radius (Neg. No. P-2903)

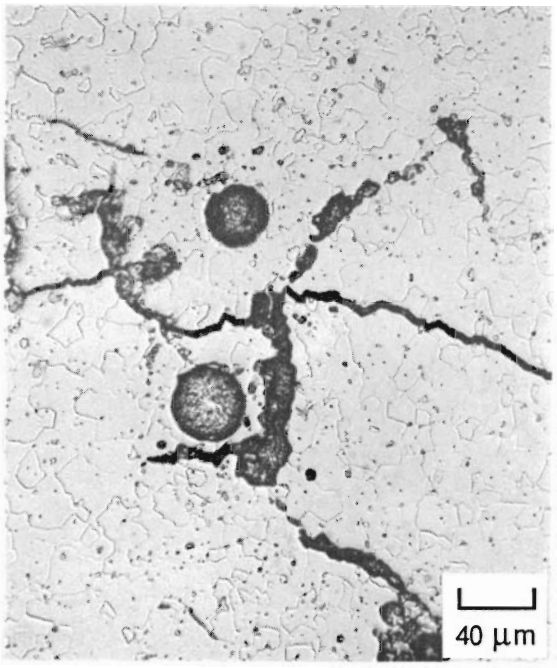


c) 2/3 Radius (Neg. No. P-2902)

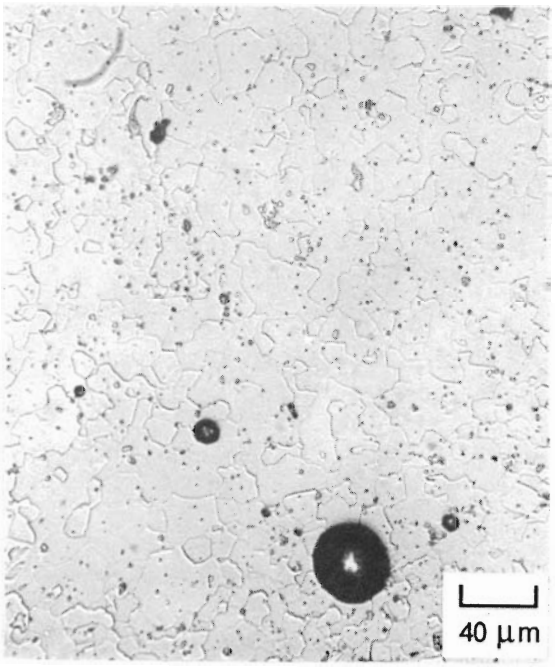


d) Edge (Neg. No. P-2901)

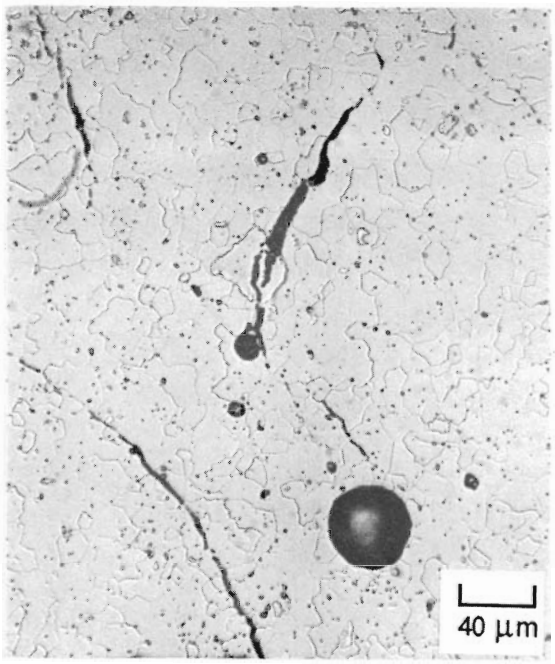
FIGURE E.3.c. Photomicrographs of Argon Ion-Etched Transverse Sample 103-MLA098-0



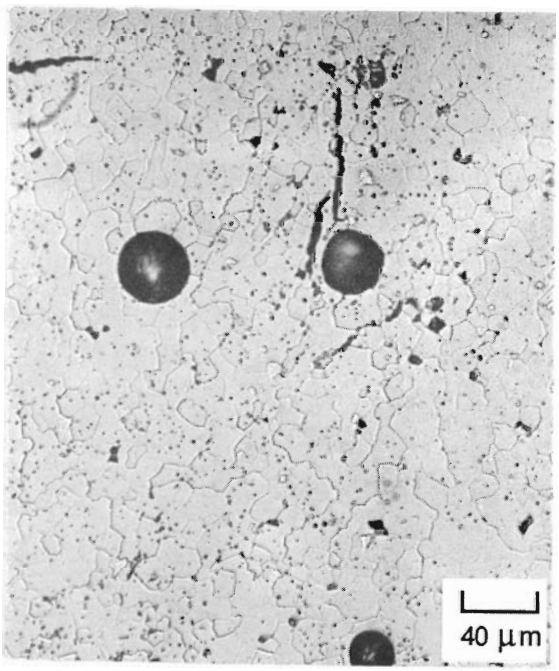
a) Center (Neg. No. P-3087)



b) 1/3 Radius (Neg. No. P-3086)

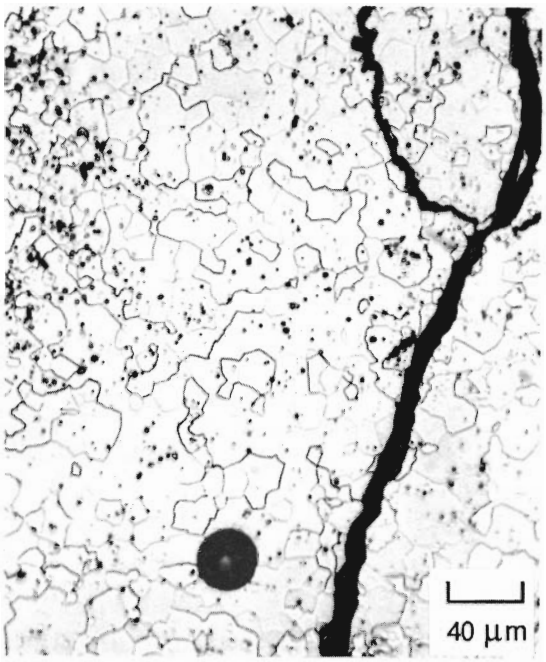


c) 2/3 Radius (Neg. No. P-3085)

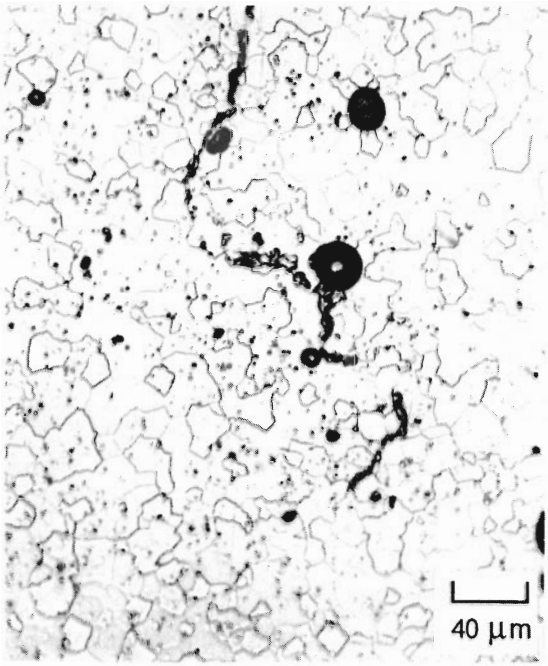


d) Edge (Neg. No. P-3084)

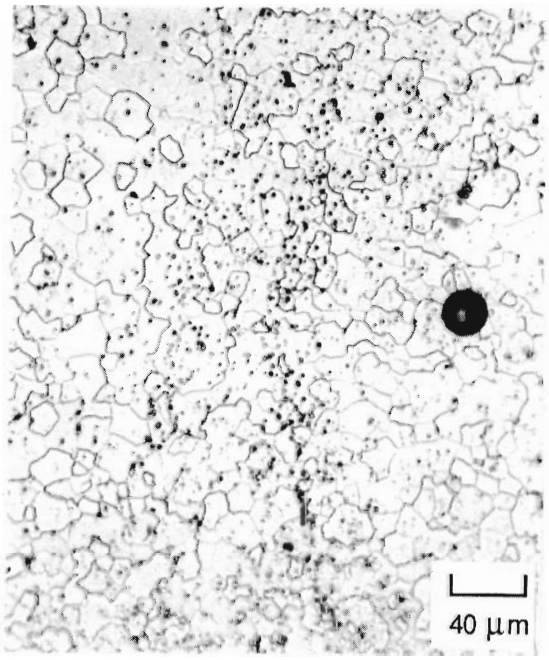
FIGURE E.3.d. Photomicrographs of Argon Ion-Etched Transverse Sample 103-MLA098-AA



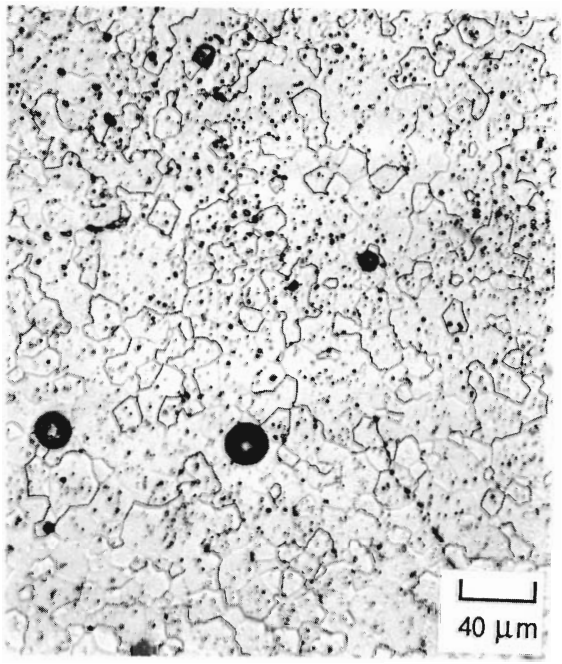
a) Center (Neg. No. P-2932)



b) 1/3 Radius (Neg. No. P-2931)



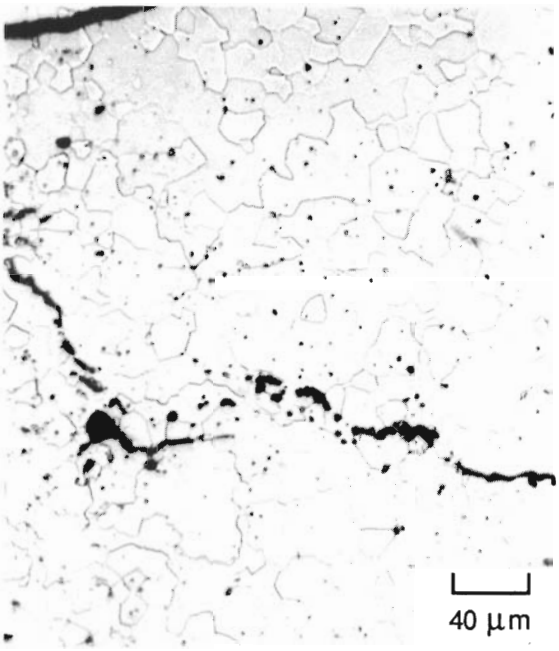
c) 2/3 Radius (Neg. No. P-2930)



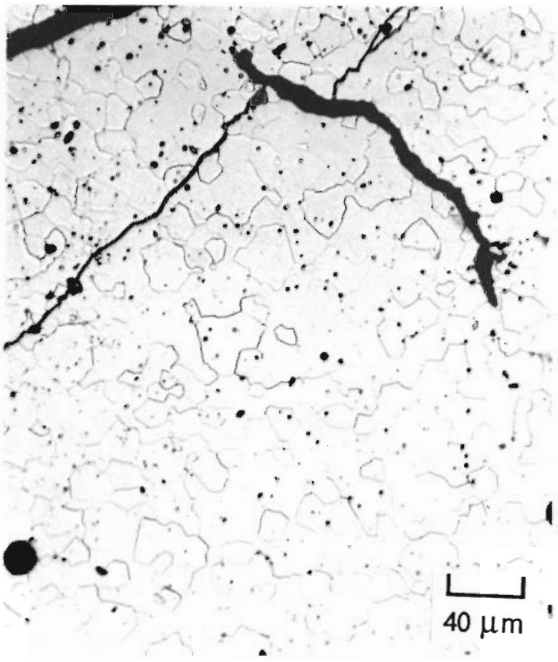
d) Edge (Neg. No. P-2929)

FIGURE E.3.e. Photomicrographs of Argon Ion-Etched Transverse Sample 103-MLA098-II

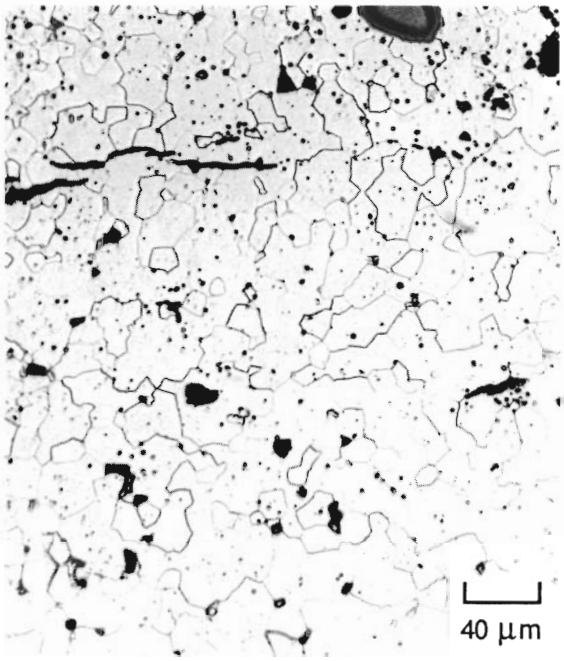
a) Center (Neg. No. P-2924)



b) 1/3 Radius (Neg. No. P-2923)

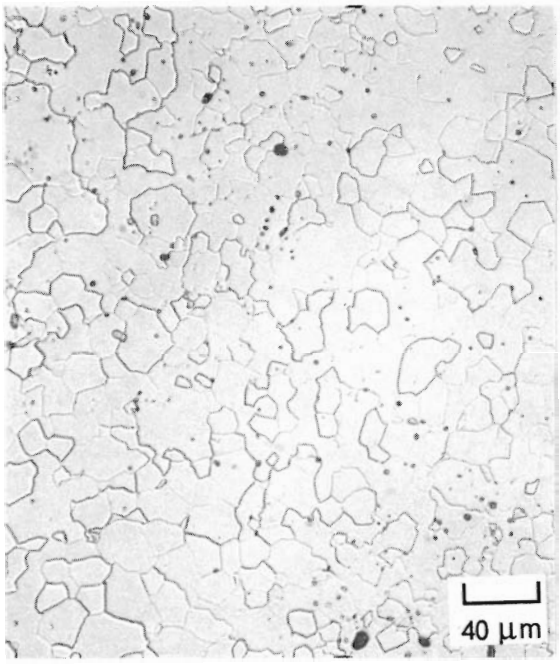


c) 2/3 Radius (Neg. No. P-2922)

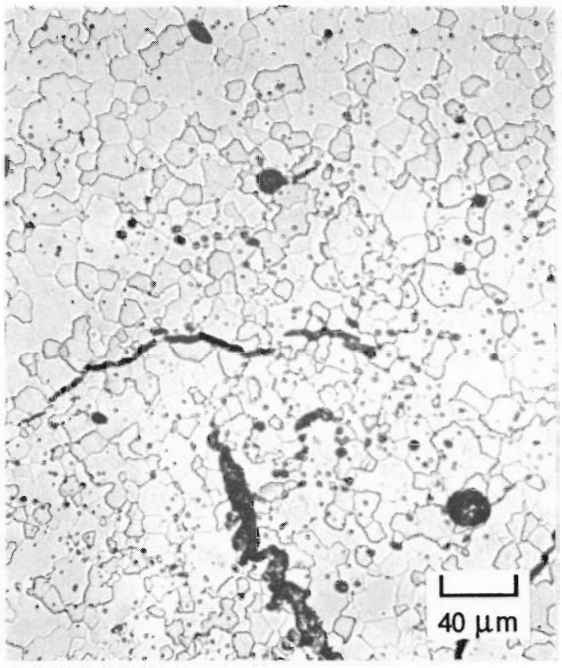


d) Edge (Neg. No. P-2921)

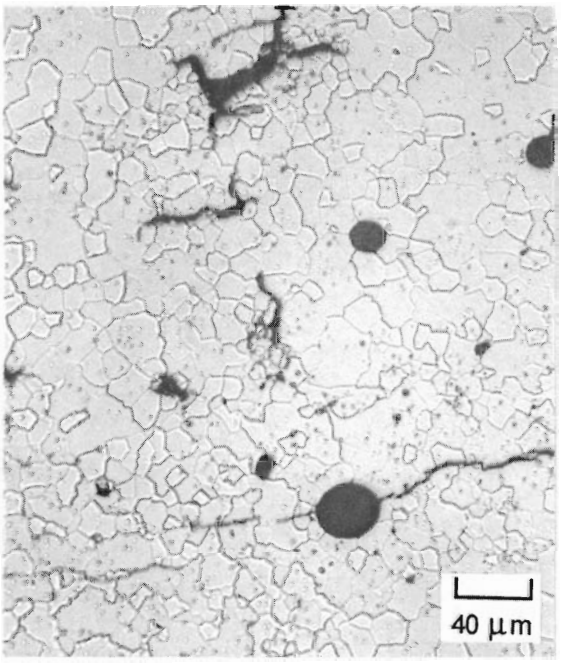
FIGURE E.3.f. Photomicrographs of Argon Ion-Etched Longitudinal Sample 103-MLA098-N



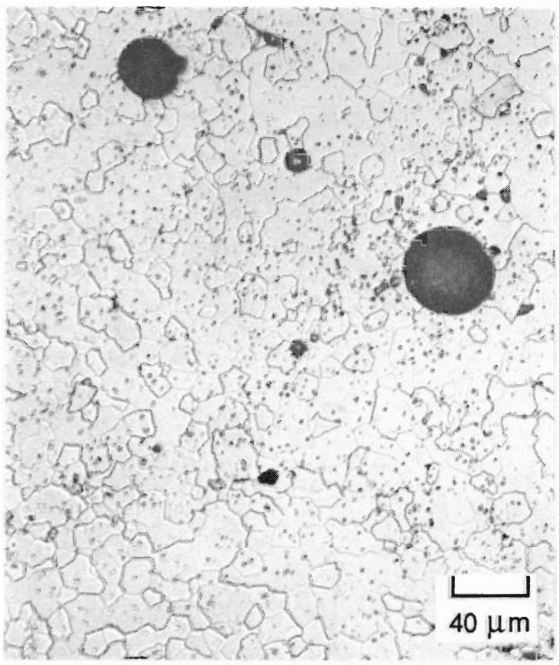
a) Center (Neg. No. P-3176)



b) 1/3 Radius (Neg. No. P-3175)

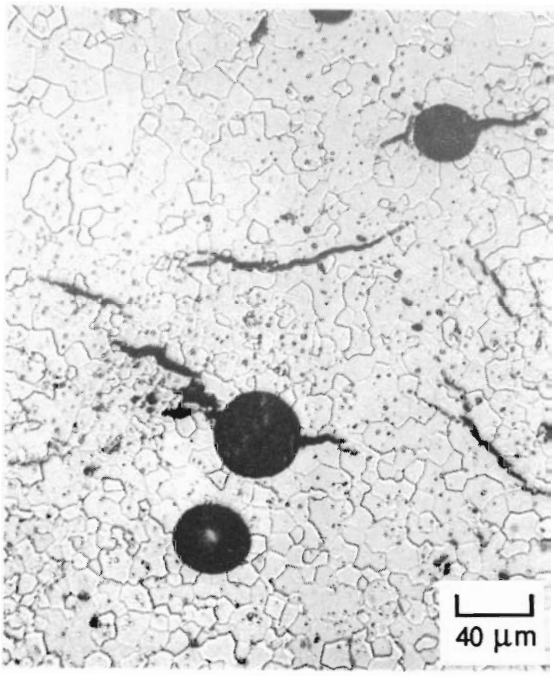


c) 2/3 Radius (Neg. No. P-3174)

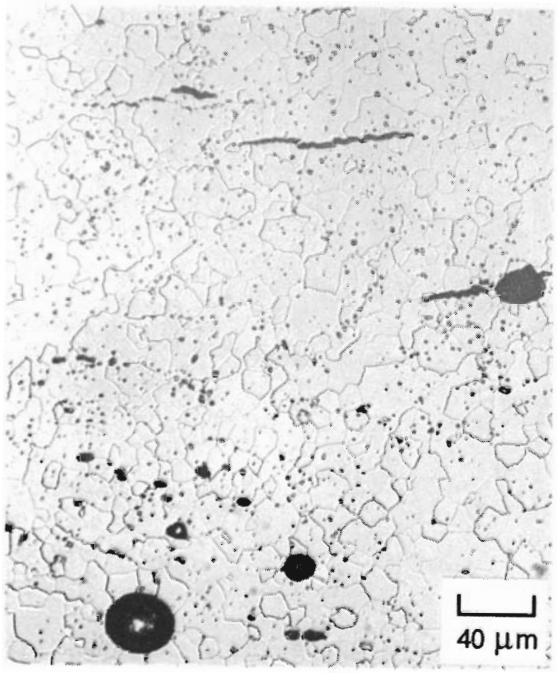


d) Edge (Neg. No. P-3173)

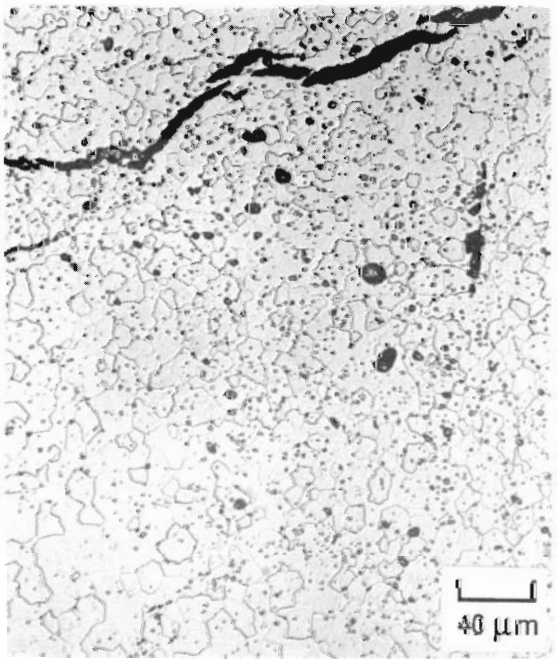
FIGURE E.3.g. Photomicrographs of Argon Ion-Etched Longitudinal Sample 103-MLA098-Z



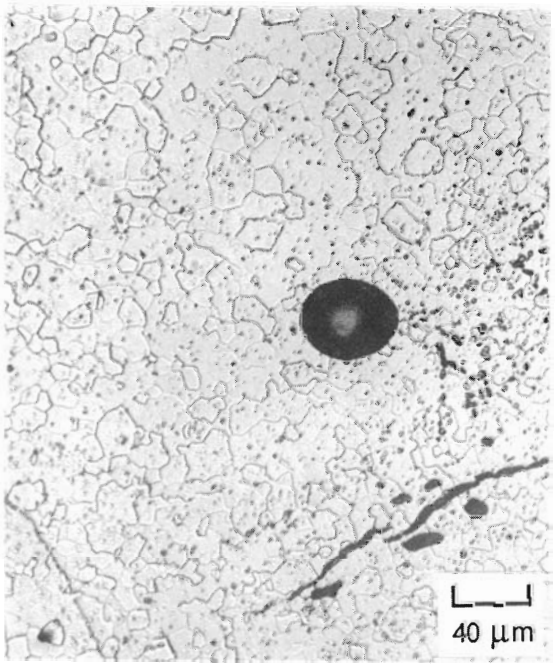
a) Center (Neg. No. P-3180)



b) 1/3 Radius (Neg. No. P-3179)

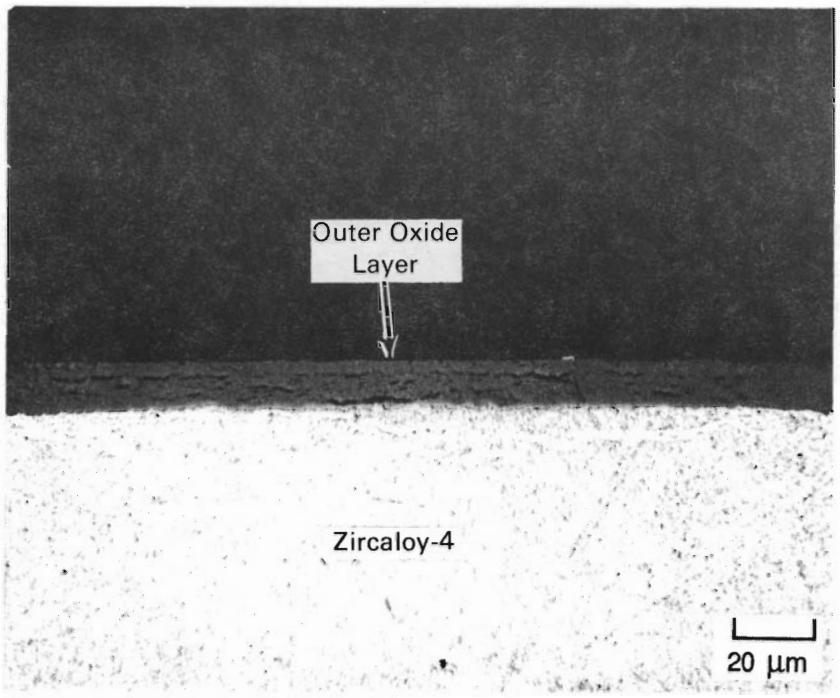


c) 2/3 Radius (Neg. No. P-3178)

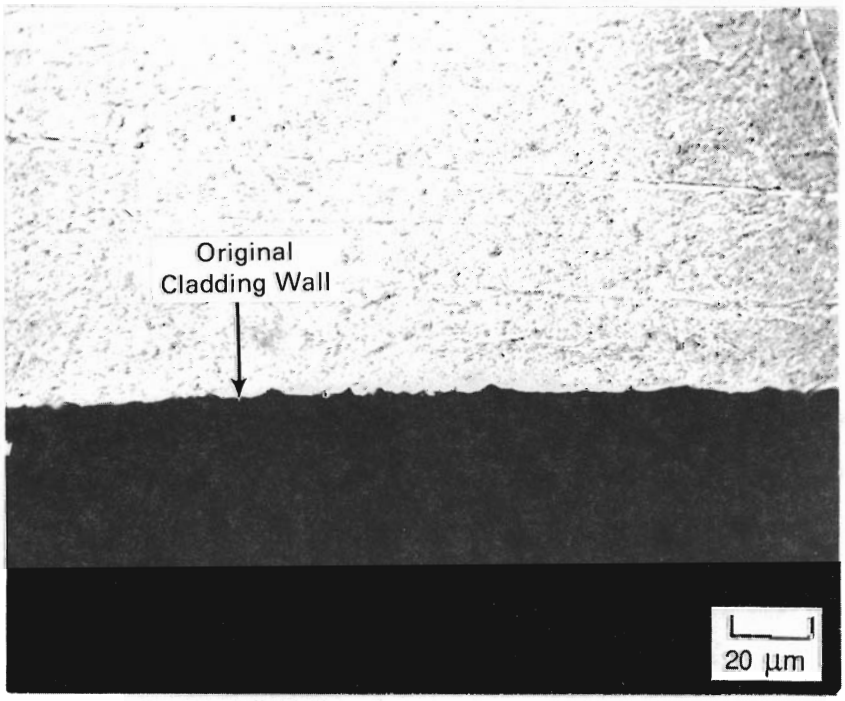


d) Edge (Neg. No. P-3177)

FIGURE E.3.h. Photomicrographs of Argon Ion-Etched Longitudinal Sample 103-MLA098-HH

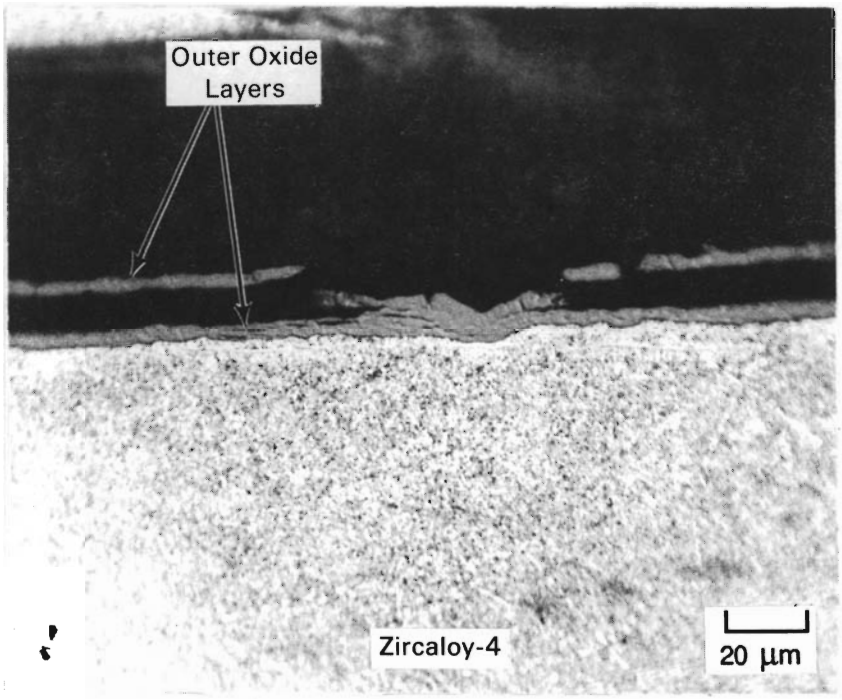


a) Exterior Surface (Neg. No. P-3024)



b) Interior Surface (Neg. No. P-3025)

FIGURE E.4.a. Exterior/Interior Cladding Surfaces of As-Polished Sample 103-MLA098-H



a) Exterior Surface (Neg. No. P-2676)

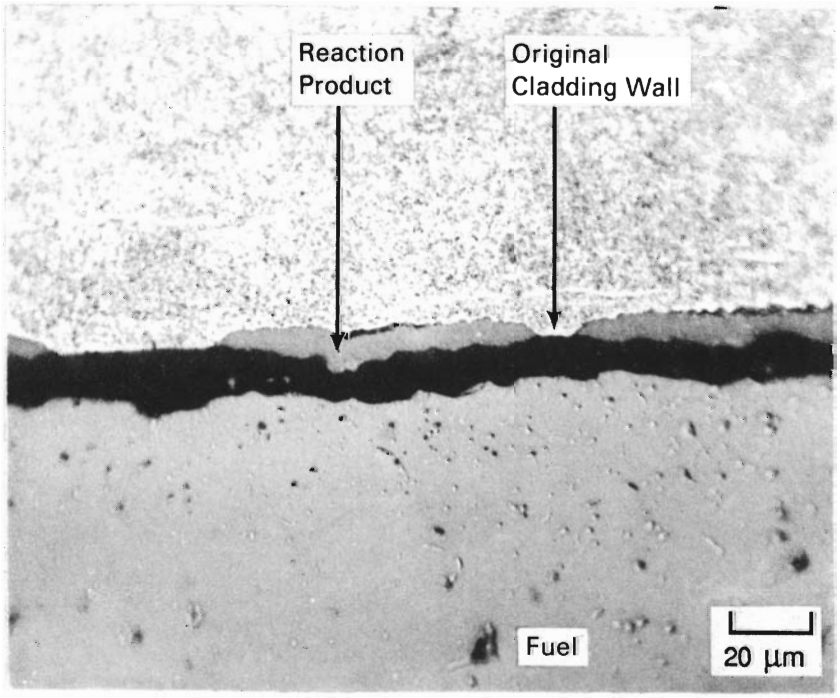
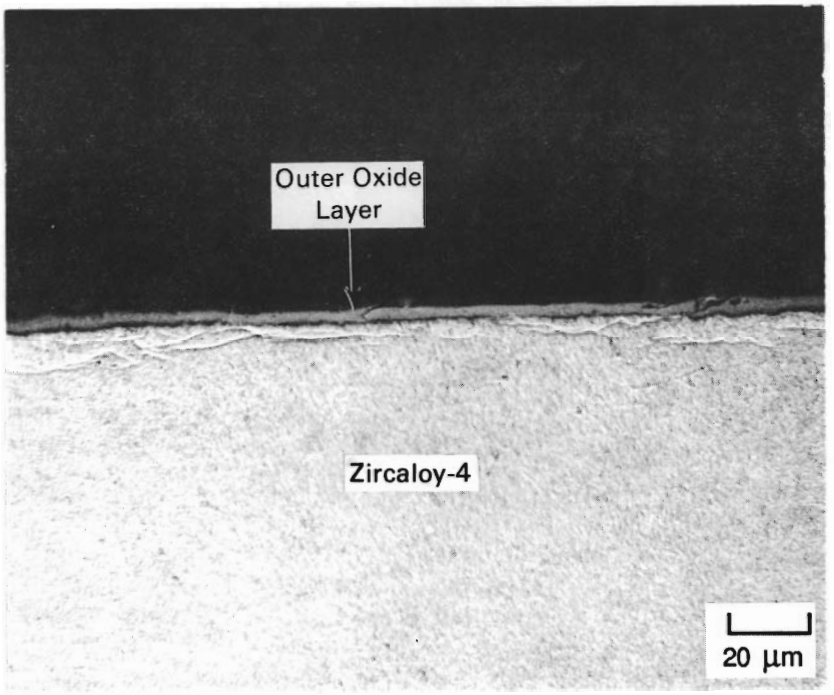
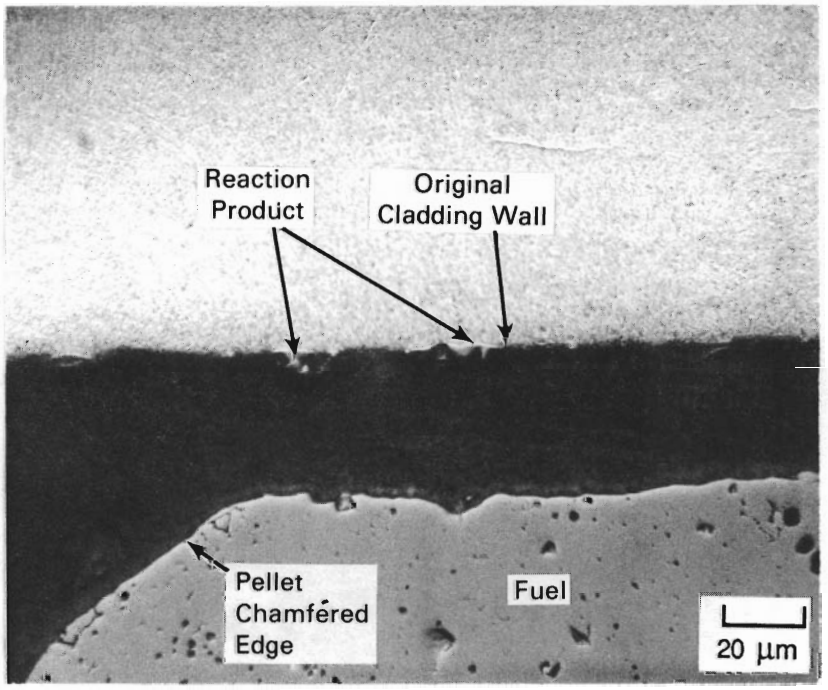


FIGURE E.4.b. Exterior/Interior Cladding Surfaces of As-Polished Sample 103-MLA098-N

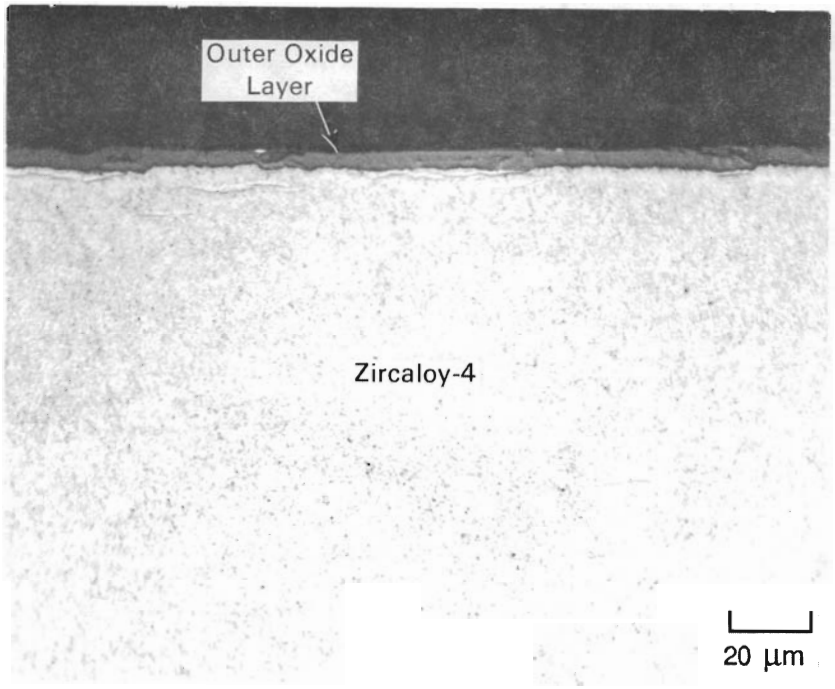


a) Exterior Surface (Neg. No. P-2987)

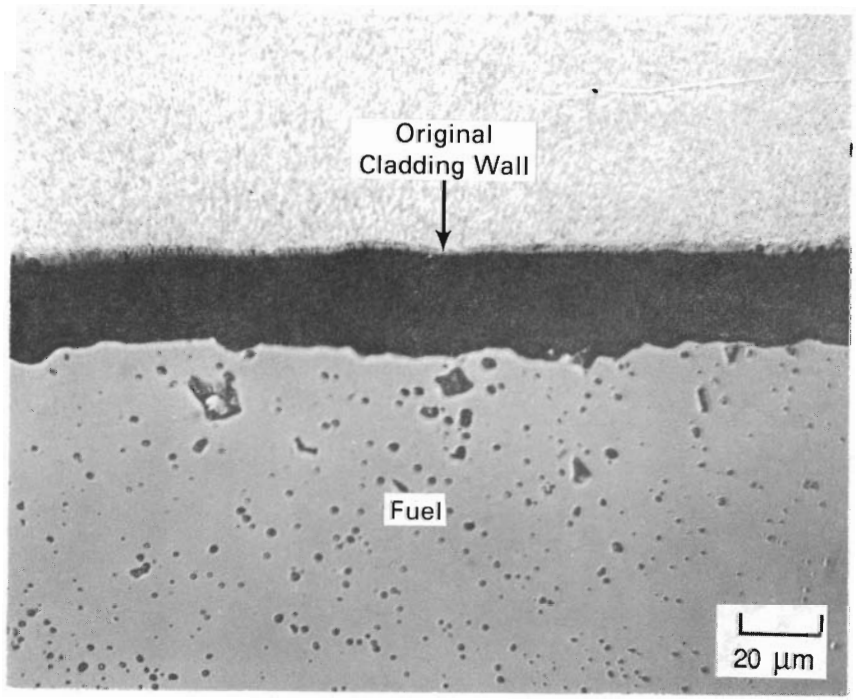


b) Interior Surface (Neg. No. P-2988)

FIGURE E.4.c. Exterior/Interior Cladding Surfaces of As-Polished Sample 103-MLA098-Z



a) Exterior Surface (Neg. No. P-2981)



b) Interior Surface (Neg. No. P-2982)

FIGURE E.4.d. Exterior/Interior Cladding Surfaces of As-Polished Sample 103-MLA098-HH

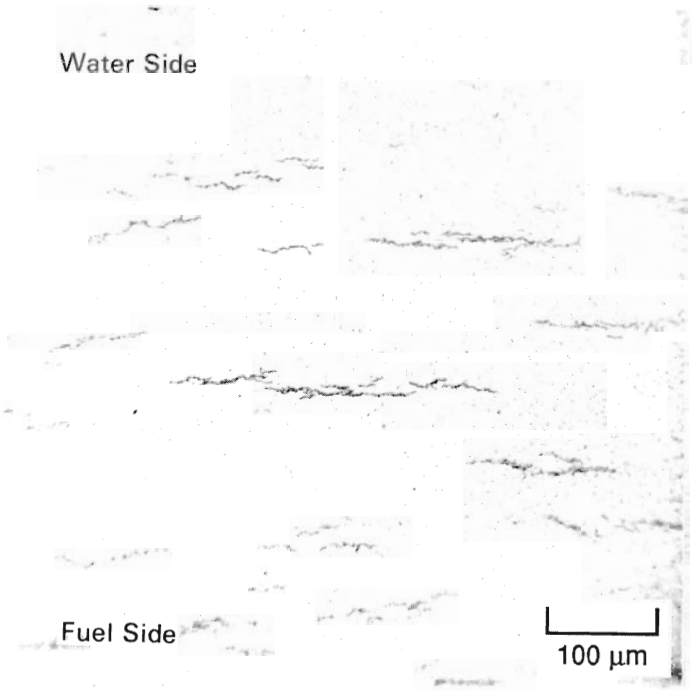


FIGURE E.5.a. Etched Cladding of Transverse Sample 103-MLA098-C (Neg. No. P-3298)

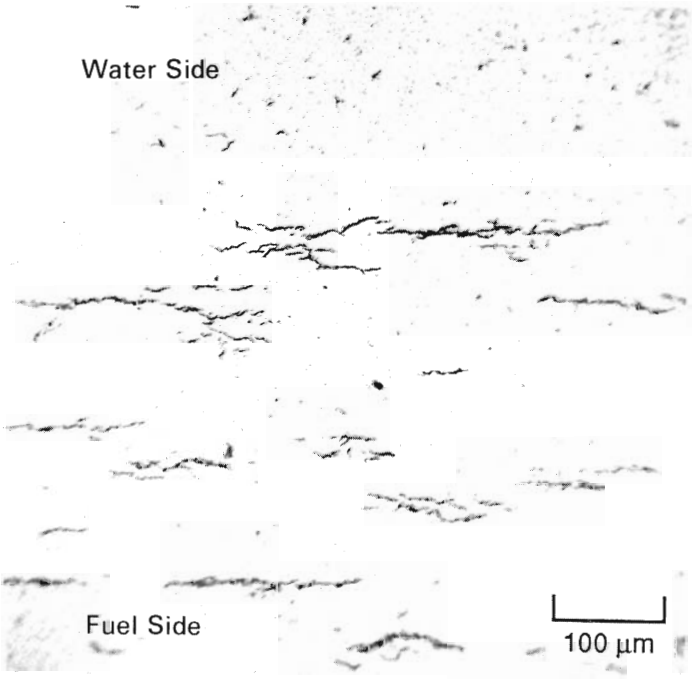


FIGURE E.5.b. Etched Cladding of Transverse Sample 103-MLA098-H (Neg. No. P-3277)

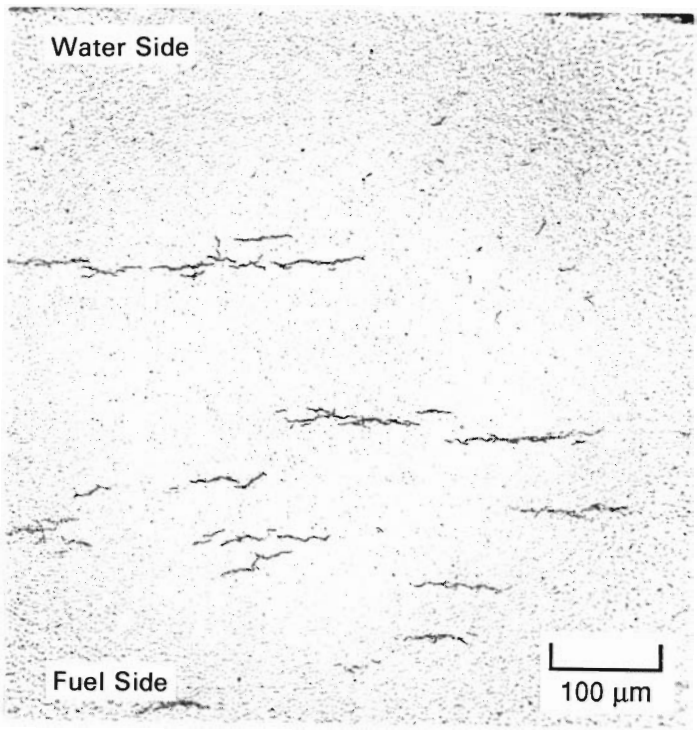


FIGURE E.5.c. Etched Cladding of Transverse Sample 103-MLA098-0 (Neg. No. P-3246)

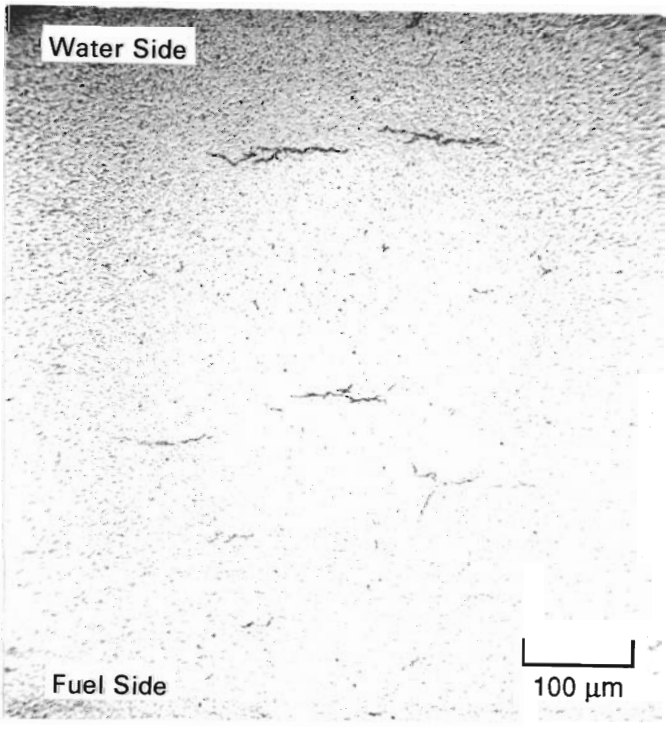


FIGURE E.5.d. Etched Cladding of Transverse Sample 103-MLA098-AA (Neg. No. P-3308)

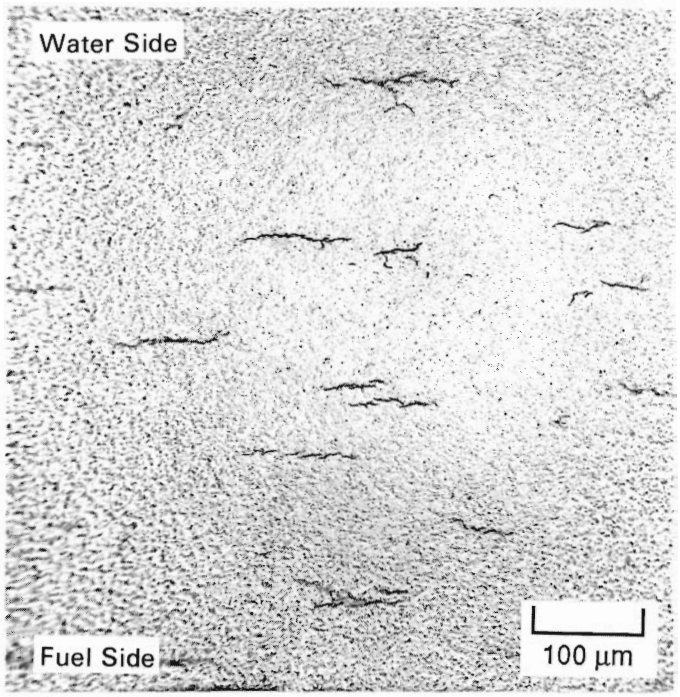


FIGURE E.5.e. Etched Cladding of Transverse Sample 103-MLA098-II (Neg. No. P-3271)

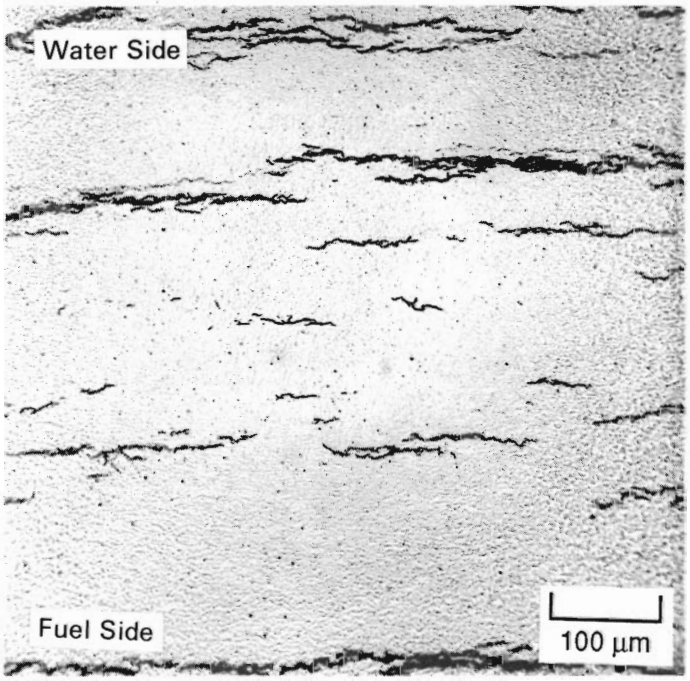


FIGURE E.5.f. Etched Cladding of Longitudinal Sample 103-MLA098-N (Neg. No. P-3245)

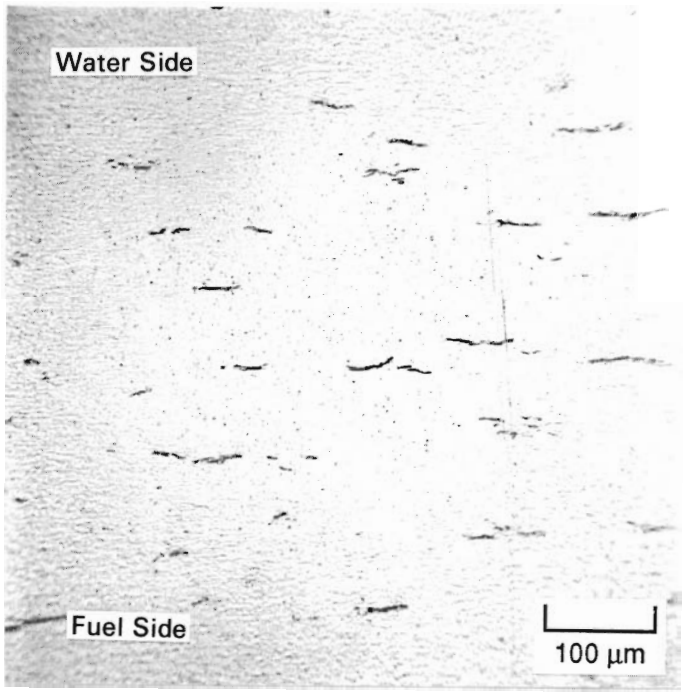


FIGURE E.5.g. Etched Cladding of Longitudinal Sample 103-MLA098-Z (Neg. No. P-3319)

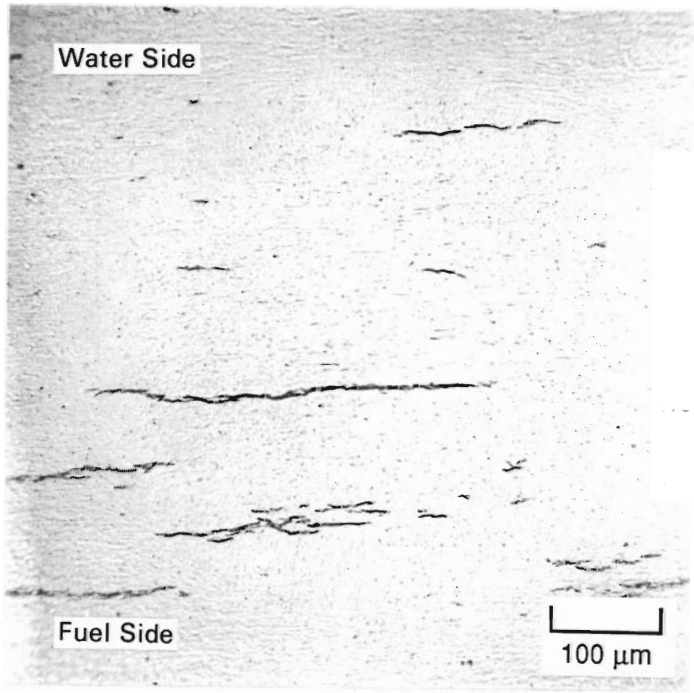


FIGURE E.5.h. Etched Cladding of Longitudinal Sample 103-MLA098-HH (Neg. No. P-3316)

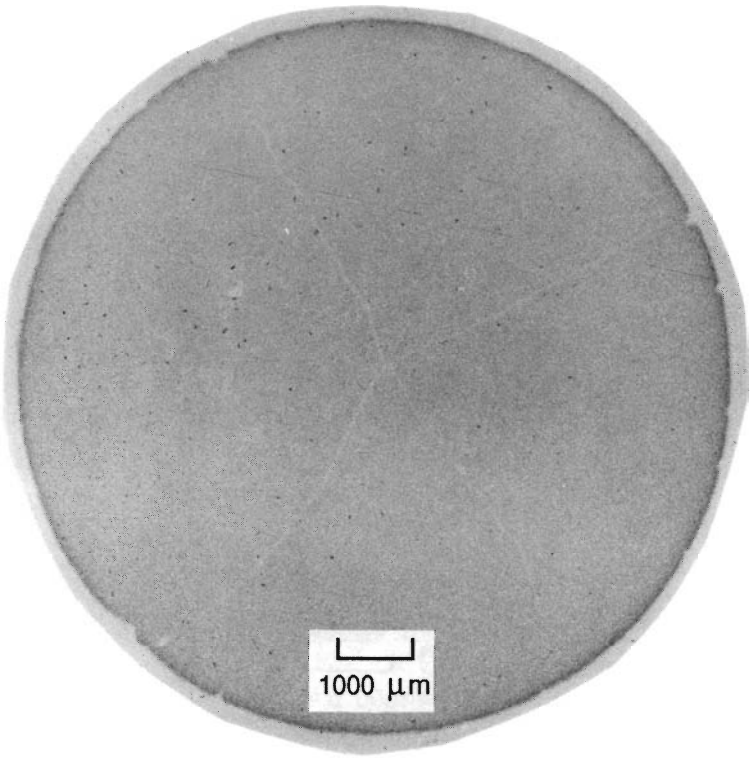


FIGURE E.6.a. Alpha Autoradiograph of Transverse Sample 103-MLA098-C (Neg. No. 5438)

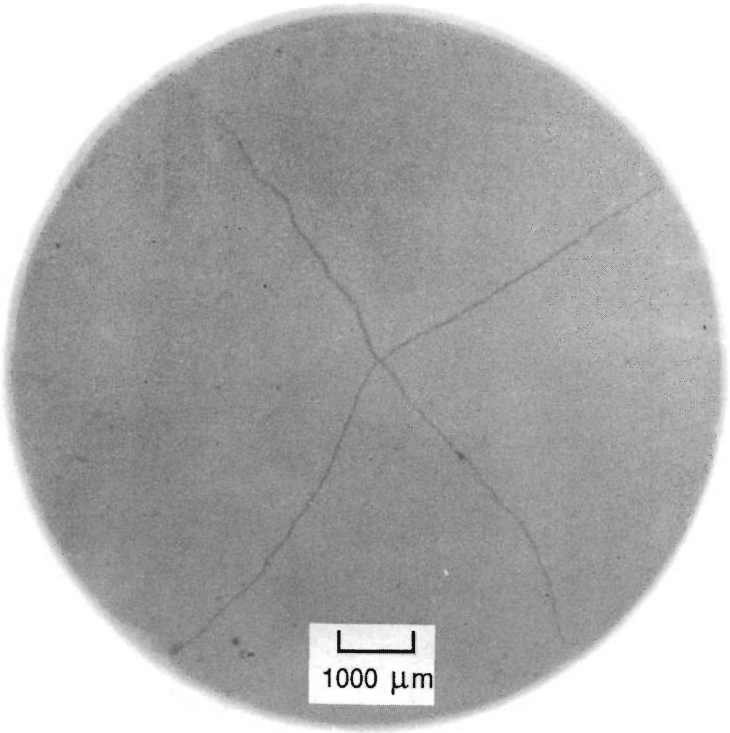


FIGURE E.6.b. Beta-Gamma Autoradiograph of Transverse Sample 103-MLA098-C (Neg. No. 5439)

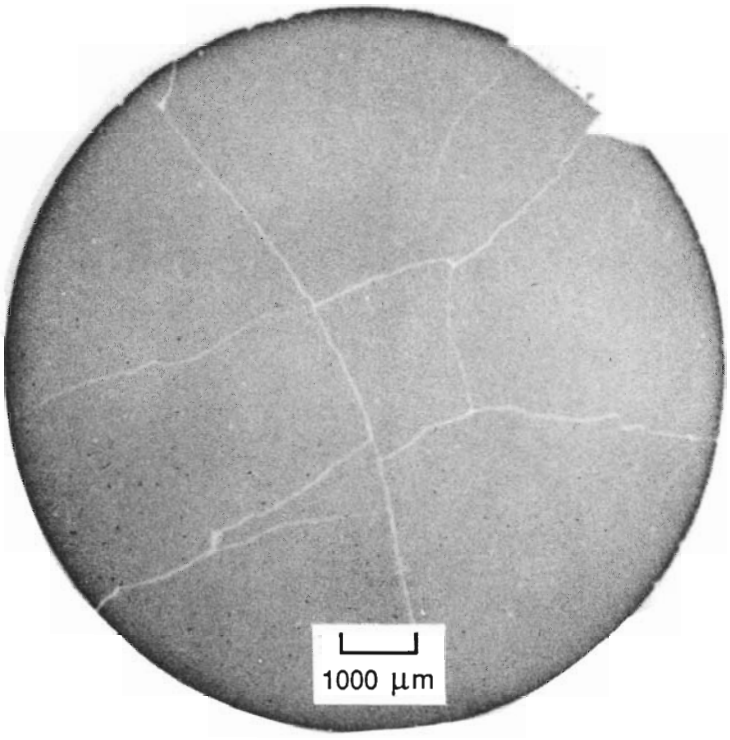


FIGURE E.6.c. Alpha Autoradiograph of Transverse Sample 103-MLA098-H (Neg. No. 5446)

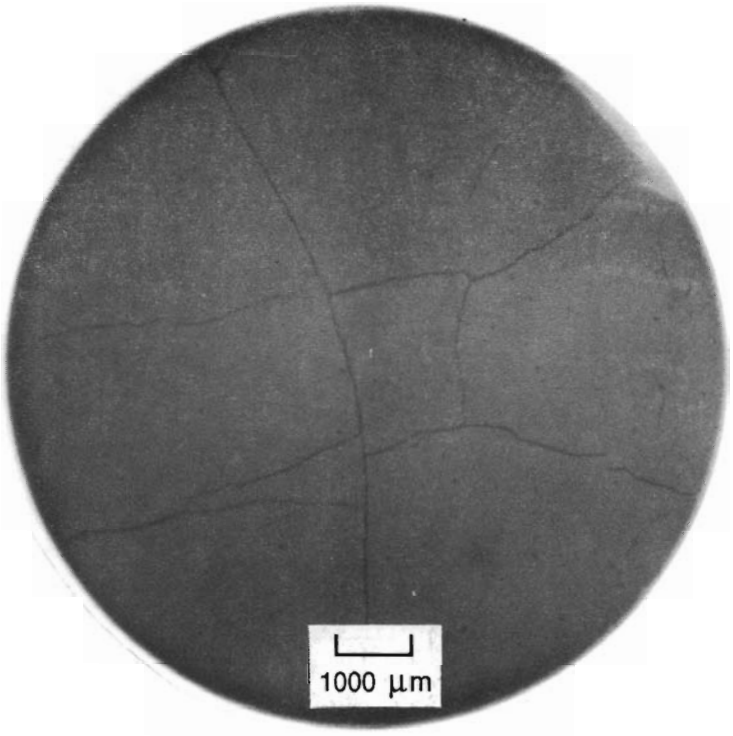


FIGURE E.6.d. Beta-Gamma Autoradiograph of Transverse Sample 103-MLA098-H (Neg. No. 5447)

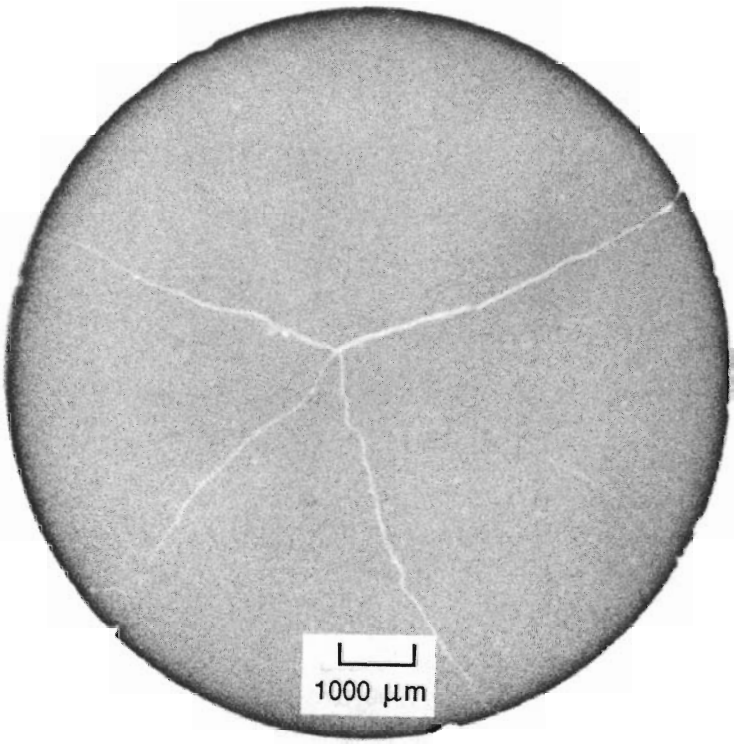


FIGURE E.6.e. Alpha Autoradiograph of Transverse Sample 103-MLA098-0 (Neg. No. 5424)

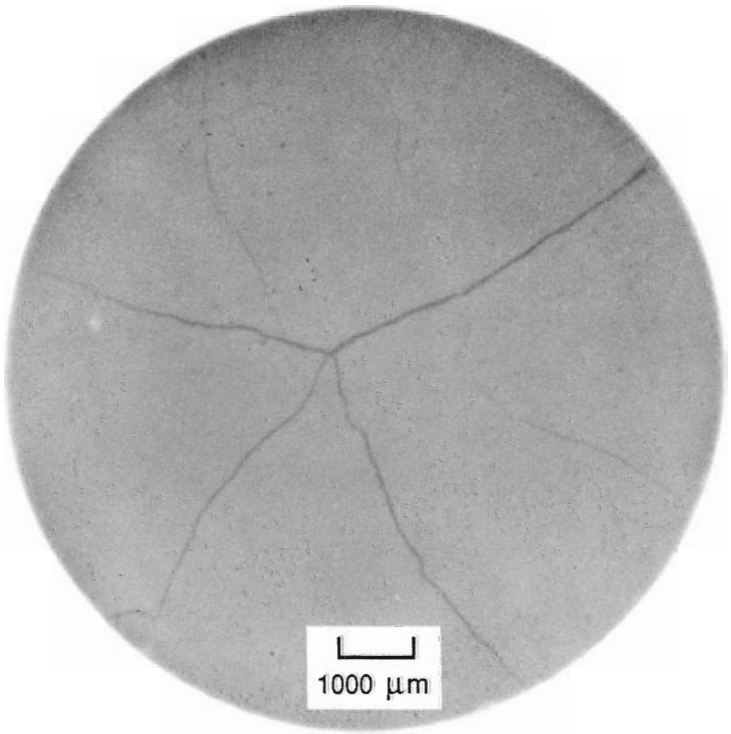


FIGURE E.6.f. Beta-Gamma Autoradiograph of Transverse Sample 103-MLA098-0 (Neg. No. 5425)

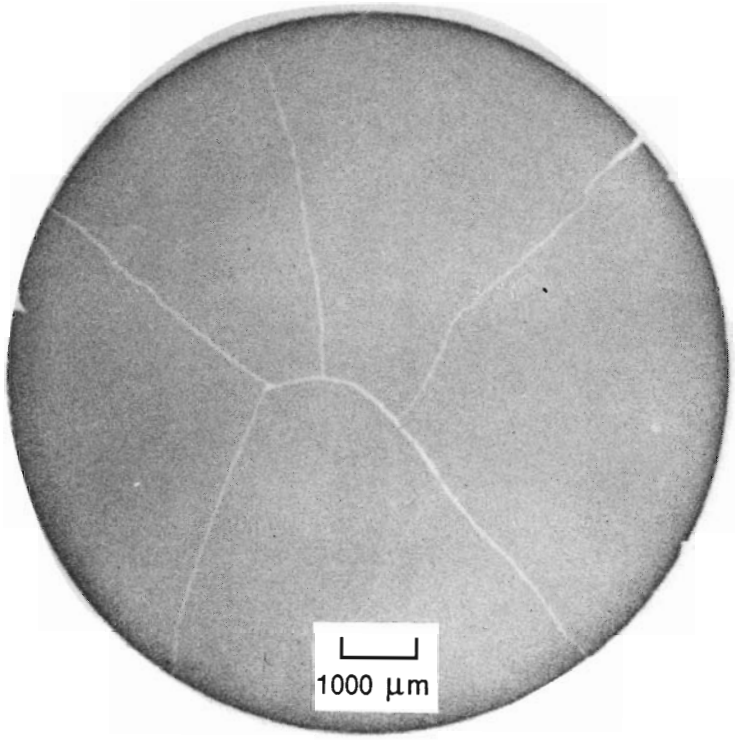


FIGURE E.6.g. Alpha Autoradiograph of Transverse Sample 103-MLA098-AA (Neg. No. 5448)

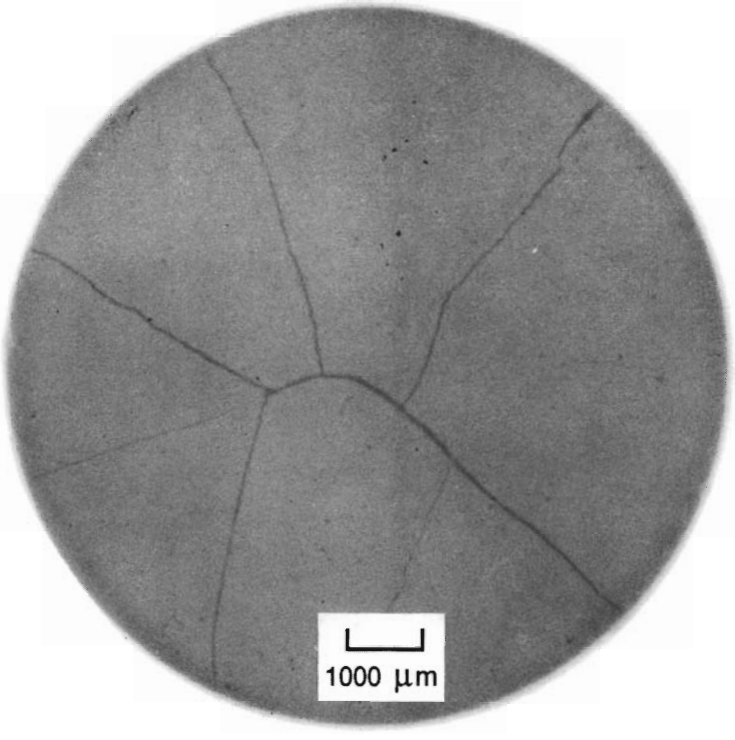


FIGURE E.6.h. Beta-Gamma Autoradiograph of Transverse Sample 103-MLA098-AA (Neg. No. 5449)

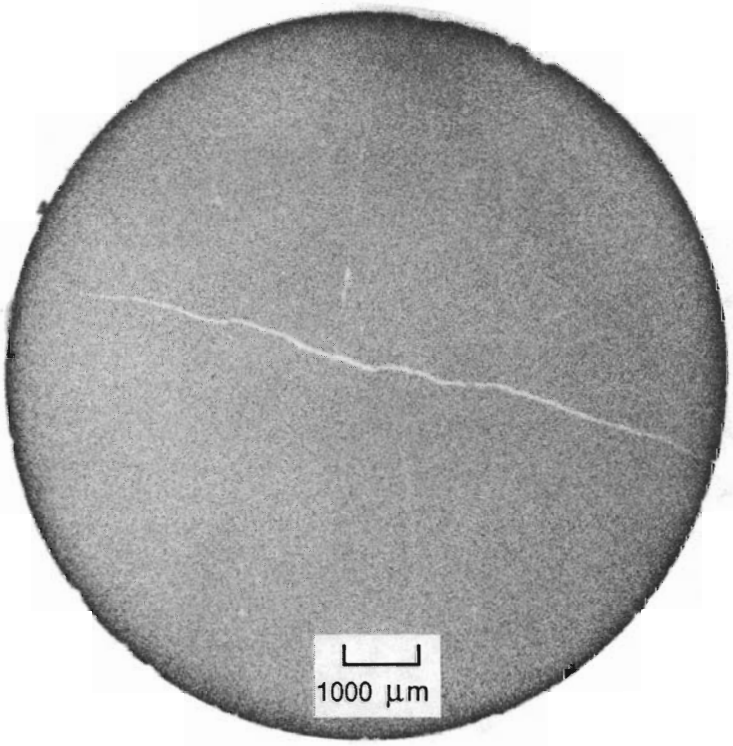


FIGURE E.6.i. Alpha Autoradiograph of Transverse Sample 103-MLA098-II (Neg. No. 5418)

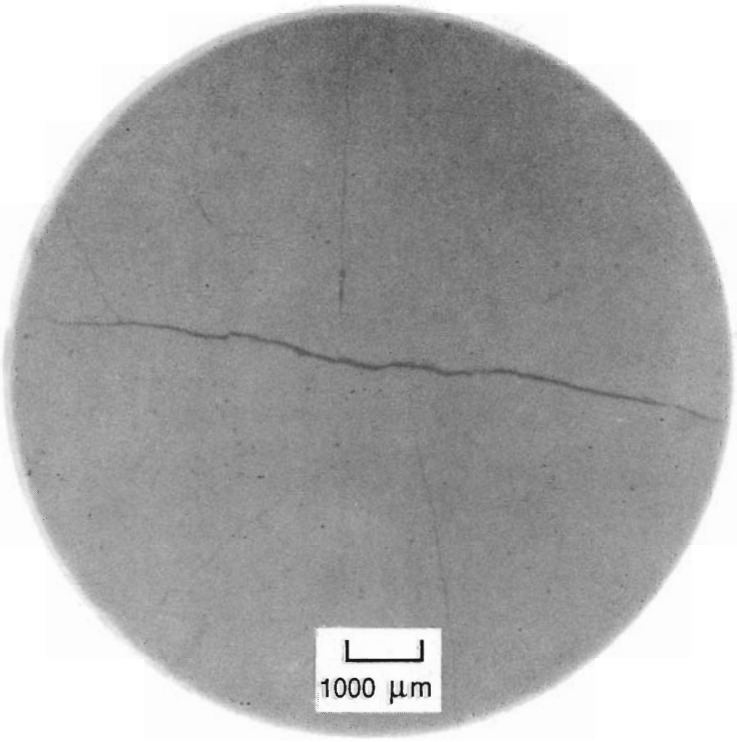


FIGURE E.6.j. Beta-Gamma Autoradiograph of Transverse Sample 103-MLA098-II (Neg. No. 5419)

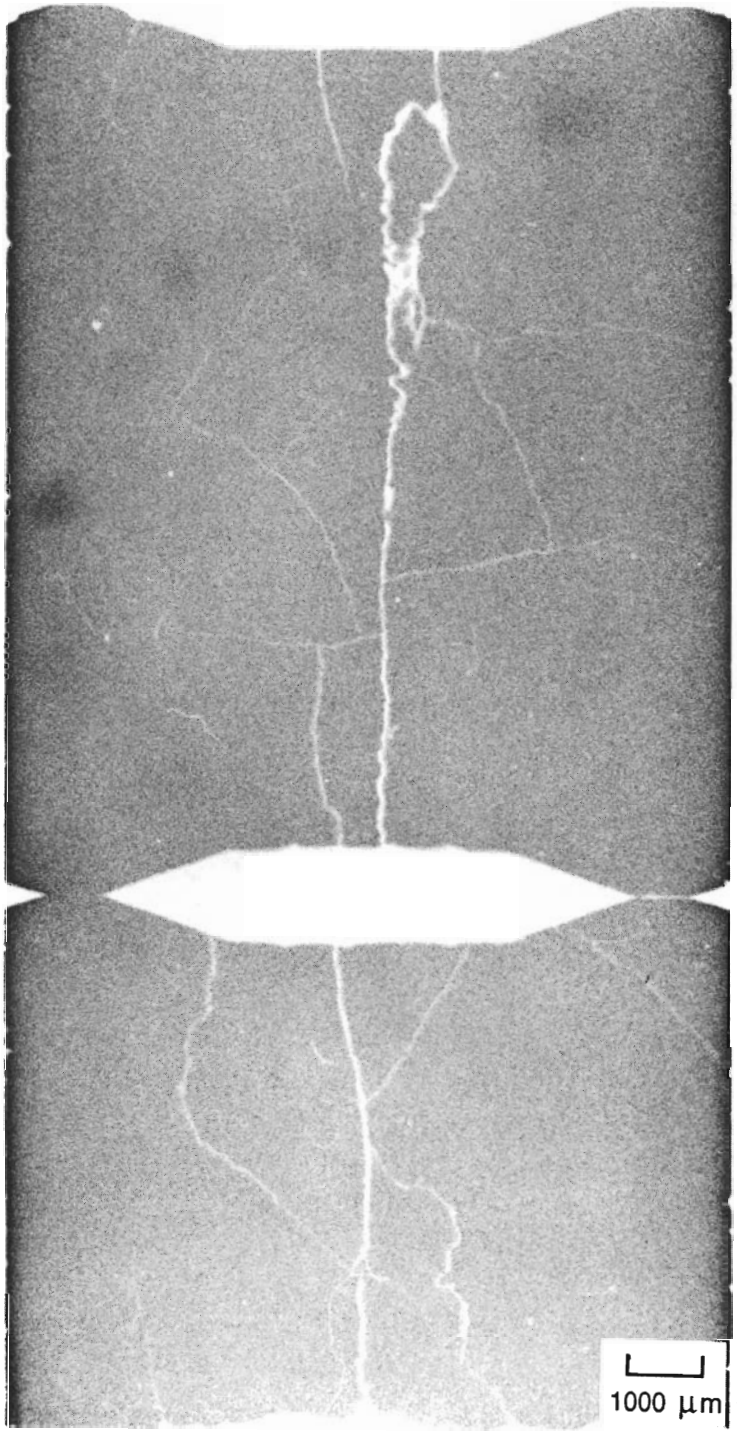


FIGURE E.6.k. Alpha Autoradiograph of Longitudinal Sample 103-MLA098-N (Neg. No. 5414)

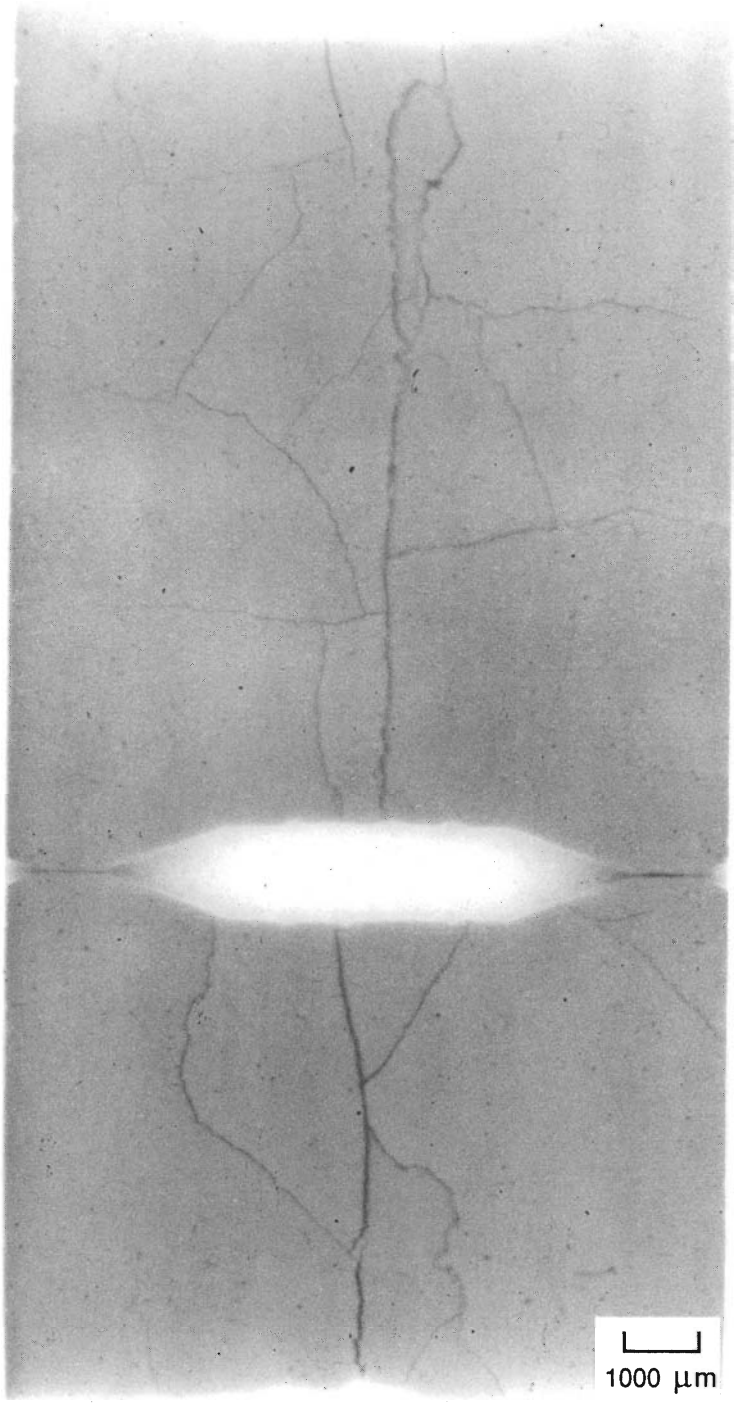


FIGURE E.6.1. Beta-Gamma Autoradiograph of Longitudinal Sample 103-MLA098-N (Neg. No. 5423)

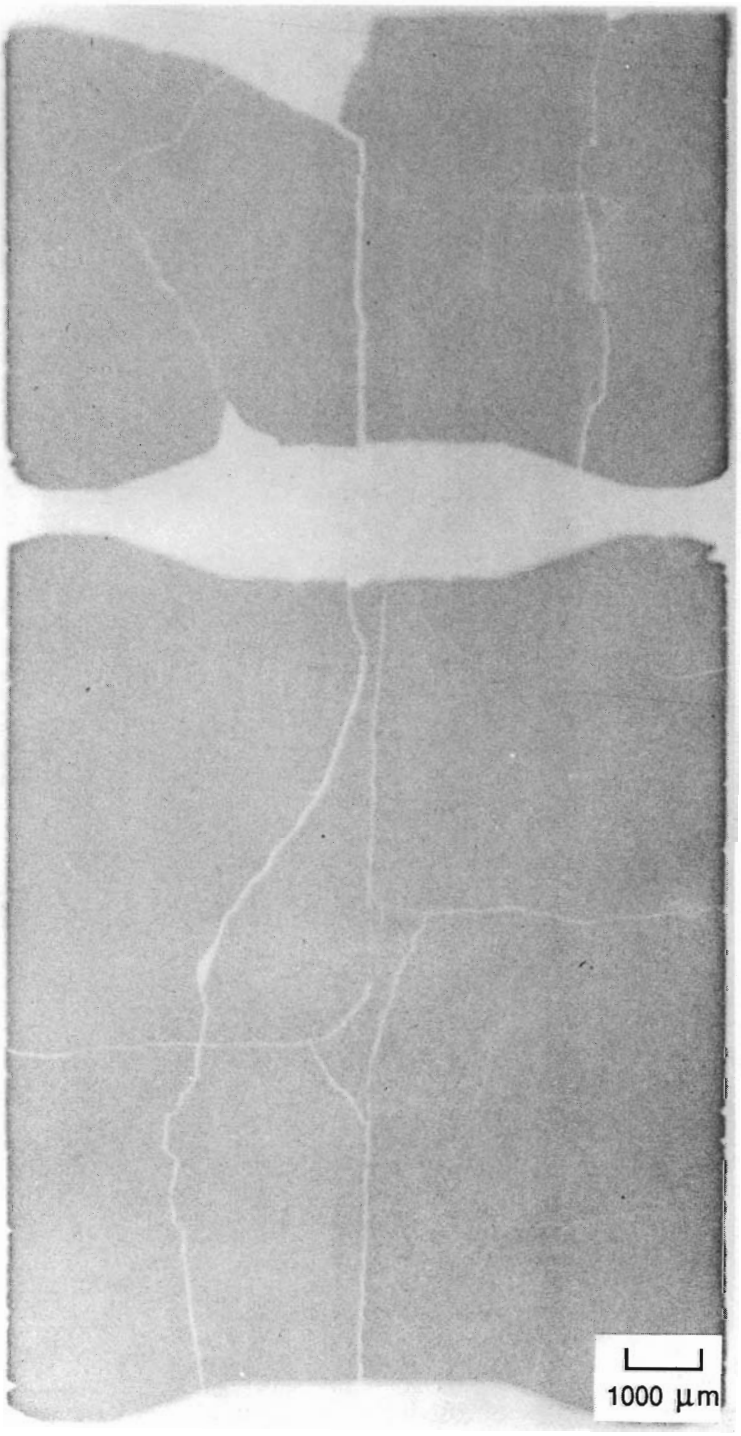


FIGURE E.6.m. Alpha Autoradiograph of Longitudinal Sample 103-MLA098-Z (Neg. No. 5456)

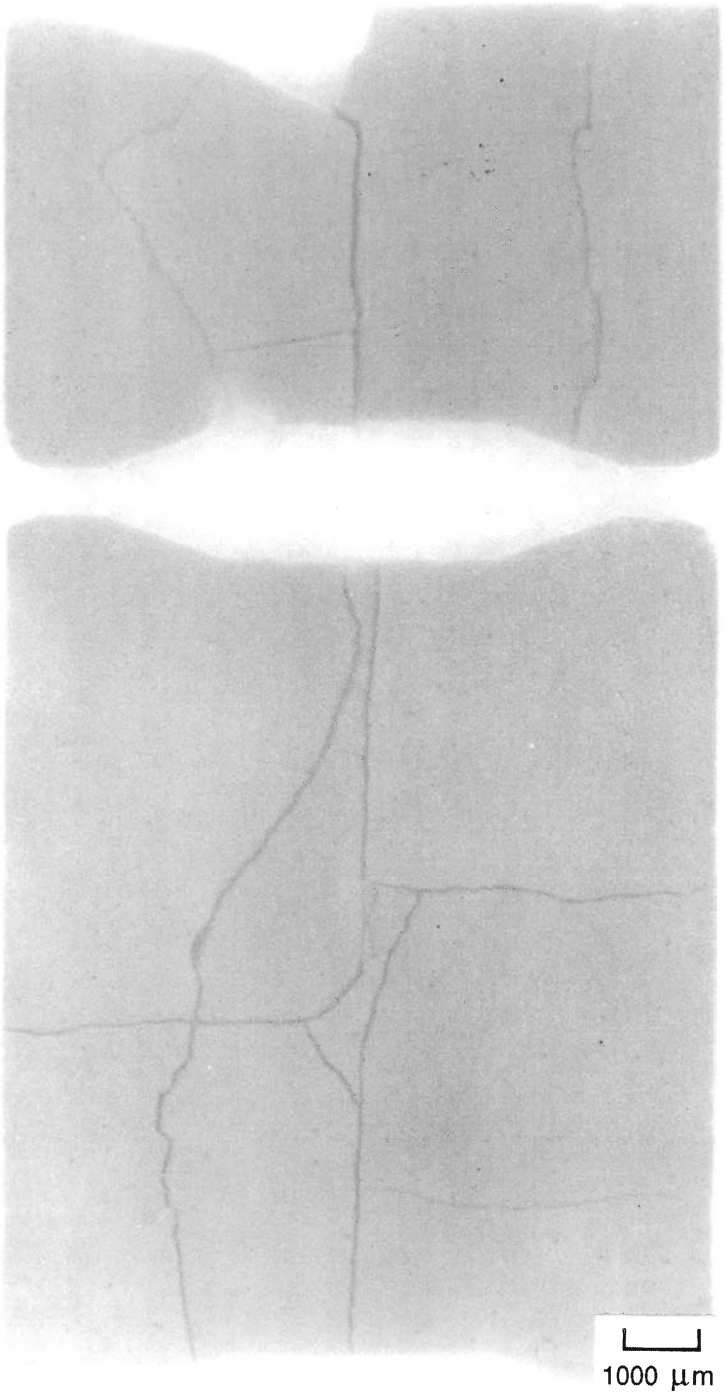


FIGURE E.6.n. Beta-Gamma Autoradiograph of Longitudinal Sample 103-MLA098-Z (Neg. No. 5457)

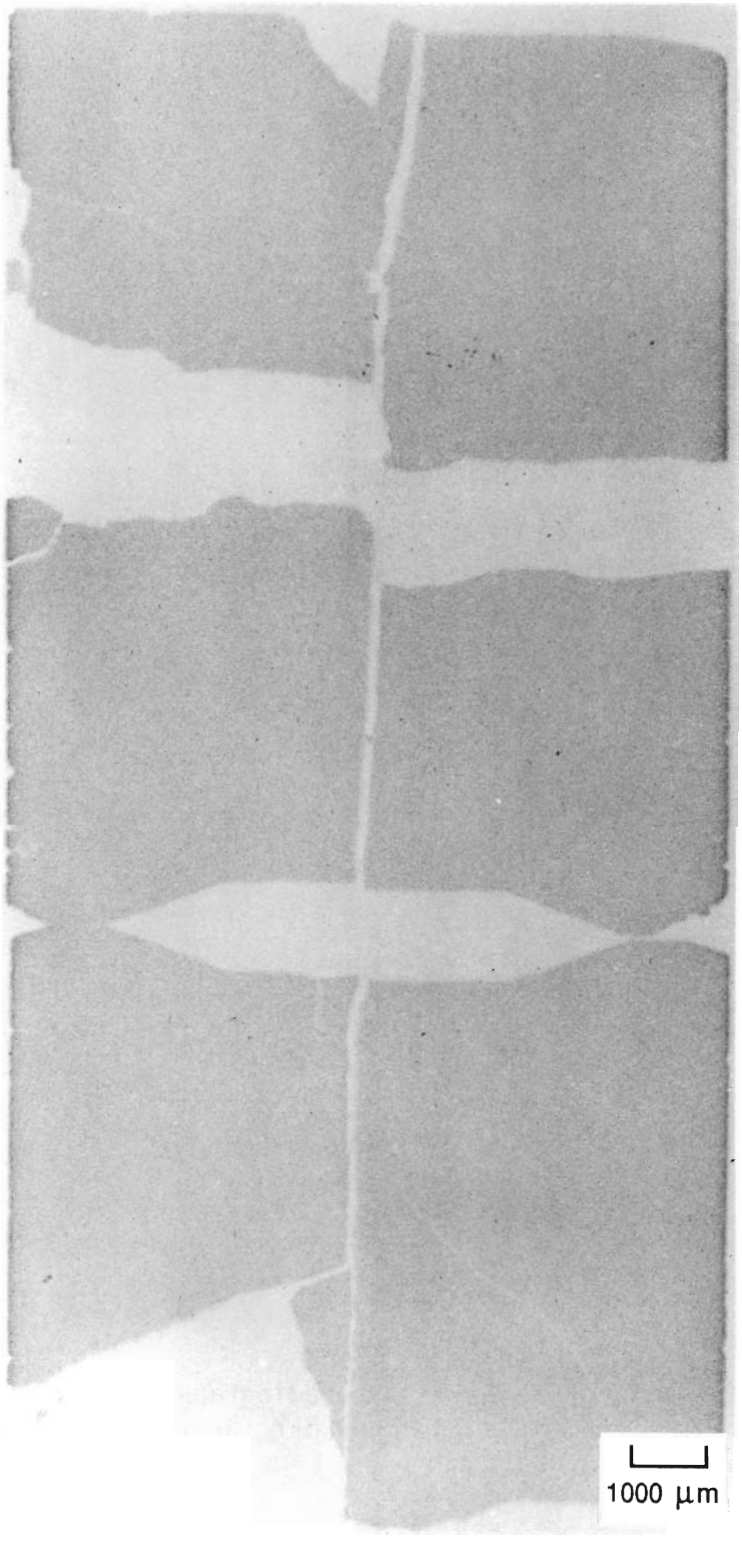


FIGURE E.6.o. Alpha Autoradiograph of Longitudinal Sample 103-MLA098-HH (Neg. No. 5452)

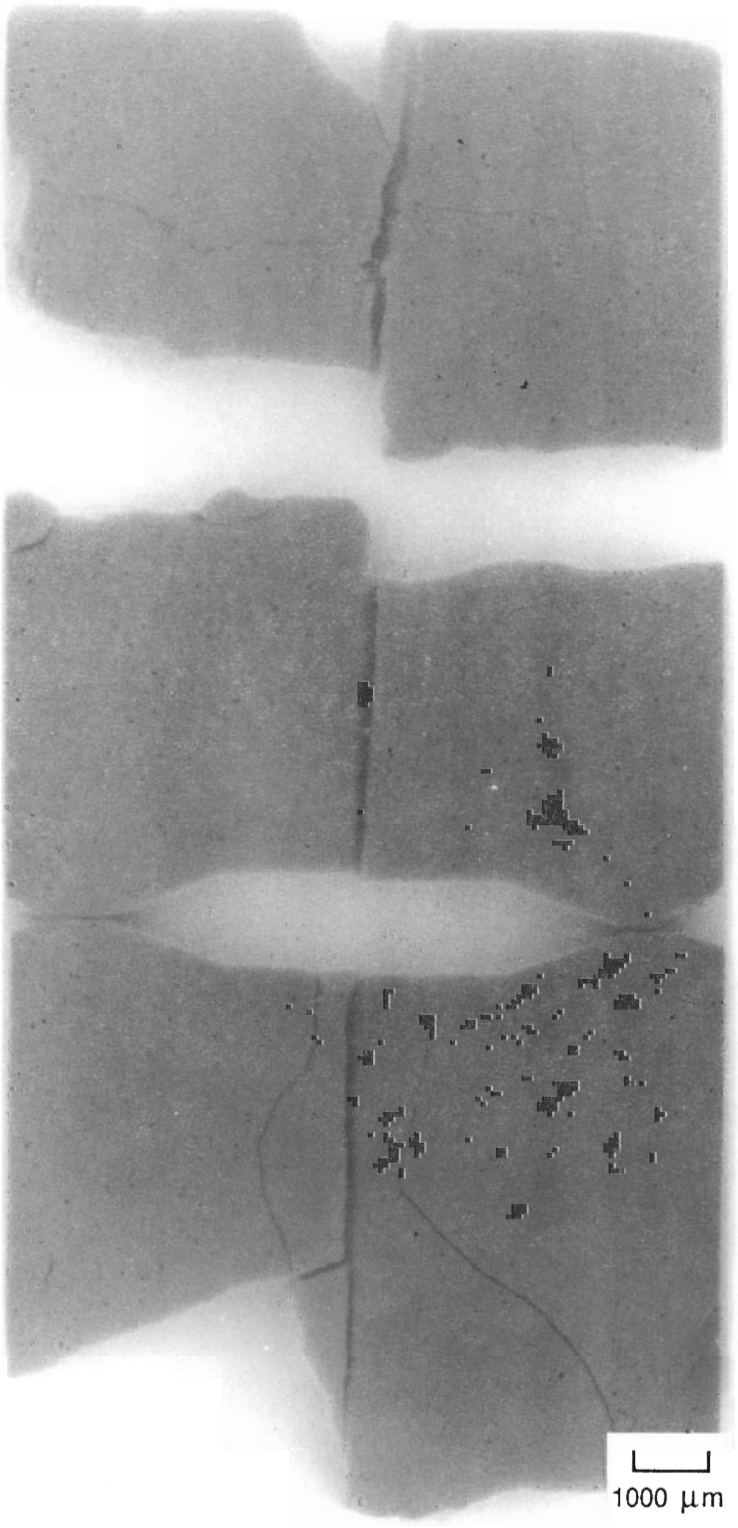


FIGURE E.6.p. Beta-Gamma Autoradiograph of Longitudinal Sample 103-MLA098-HH (Neg. No. 5453)

APPENDIX F

RESULTS OF ORIGEN2 RADIONUCLIDE INVENTORY CALCULATIONS

APPENDIX F

RESULTS OF ORIGEN2 RADIONUCLIDE INVENTORY CALCULATIONS

Appendix F contains input and output from the ORIGEN2 calculations for ATM-103 spent fuel based on data described in Section 4.7 and Appendix A. An example of the ORIGEN2 input for fuel irradiation/decay is shown in Figure F.1. An example of the ORIGEN2 input for cladding irradiation/decay is shown in Figure F.2. The power densities given in Appendix A were normalized to given burnup exposures of 15, 20, 25, 30, and 35 MWd/kgM. Eight tables of output at each of these exposures are given in Appendix F. Their contents are as follows:

Table F.1.a - F.1.e	Fission Product Radioactivity by Isotope, Ci/gU
Table F.2.a - F.2.e	Actinide Radioactivity by Isotope, Ci/gU
Table F.3.a - F.3.e	Fission Product Inventory by Isotope, g/gU
Table F.4.a - F.4.e	Actinide Inventory by Isotope, g/gU
Table F.5.a - F.5.e	Fission Product Inventory by Element, g/gU
Table F.6.a - F.6.e	Actinide Inventory by Element, g/gU
Table F.7.a - F.7.e	Fuel Activation Product Inventory by Isotope, g/gU
Table F.8.a - F.8.e	Cladding Activation Product Inventory by Isotope, g/gZr

Each table contains values for out-of-reactor decay times of 6, 8, 10, 12, 15, 20, and 1000 years.

```
-1
-1
-1
TIT   ATM-103 FUEL PWR E=2.72  15 GWD/MTU
BAS   GRAM
LIB   0 1 2 3 204 205 206 9 3 0 1 1
PHO   101 102 103 10
LIP   0 0 0
INP   1 1 -1 -1 1 1
RDA   BURNUP TO 15,000 MWD/MTU
BUP
IRP   100.   16.1520-6  1 2 4 2
IRP   200.   16.1520-6  2 3 4 0
IRP   306.   16.1520-6  3 4 4 0
DEC   377.              4 5 4 0
IRP   398.1  12.6890-6  5 6 4 0
IRP   417.6   8.8536-6  6 7 4 0
IRP   527.6  14.3500-6  7 8 4 0
IRP   646.   14.3500-6  8 9 4 0
DEC   671.              9 1 4 0
IRP   759.   14.3500-6  1 2 4 0
DEC   840.              2 3 4 0
IRP   959.1  12.3619-6  3 4 4 0
IRP   1080.9  6.1054-6  4 5 4 0
IRP   1190.9 12.7092-6  5 6 4 0
IRP   1306.  12.7092-6  6 7 4 0
DEC   1.      7  8 5 2
DEC   6       8  1 5 0
DEC   8.      1  2 5 0
DEC   10.     2  3 5 0
DEC   12.     3  4 5 0
DEC   15.     4  5 5 0
```

FIGURE F.1. Sample ORIGEN2 Input for the Fuel

```
DEC   20.    5  6 5 0
DEC   50.    6  7 5 0
DEC   100.   7  8 5 0
DEC   200.   8  9 5 0
DEC   500.   9 10 5 0
DEC   1000. 10  7 5 0
BUP
HED   1 ' 6 YEARS
HED   2 ' 8 YEARS
HED   3 10 YEARS
HED   4 12 YEARS
HED   5 15 YEARS
HED   6 20 YEARS
HED   7 1000 YEARS
OPTA  8 8 8 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTL  8 8 8 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
IPTF  8 8 8 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
CUT   5 1.0-15  7 1.0-15  -1
OUT   7 1  0  1
STP   4
2  922340 .000221 922350 .0272 922380 .97258 0 0.0
4  80000 .13443  60000 13.6-6  70000 27.2-6  90000 5.7-6
4  170000 5.7-6  260000 59.0-6   470000 1.1-6  200000 45.4-6
4  130000 45.4-6  140000 45.4-6  280000 28.4-6  0 0.0
0
END
```

FIGURE F.1. Sample ORIGEN2 Input for the Fuel (contd)

```
-1
-1
-1
TIT   ATM-103 CLAD PWR  E=2.72  15.0 GWD/MTU
BAS   GRAM
LIB   0 1 2 3 204 205 206 9 3 0 1 1
PHO   101 102 103 10
LIP   0 0 0
INP   1 1 -1 -1 1 1
RDA   BURNUP TO 15,000 MWD/MTU
BUP
IRP   100.    72.9155-6  1 2 4 2
IRP   200.    72.9155-6  2 3 4 0
IRP   306.    72.9155-6  3 4 4 0
DEC   377.               4 5 4 0
IRP   398.1   57.2827-6  5 6 4 0
IRP   417.6   39.9683-6  6 7 4 0
IRP   527.6   64.7810-6  7 8 4 0
IRP   646.    64.7810-6  8 9 4 0
DEC   671.               9 1 4 0
IRP   759.    64.7810-6  1 2 4 0
DEC   840.               2 3 4 0
IRP   959.1   55.8057-6  3 4 4 0
IRP   1080.9  27.5620-6  4 5 4 0
IRP   1190.9  57.3736-6  5 6 4 0
IRP   1306.   57.3736-6  6 7 4 0
DEC   1.      7  8 5 2
DEC   6       8  1 5 0
DEC   8.      1  2 5 0
DEC   10.     2  3 5 0
DEC   12.     3  4 5 0
DEC   15.     4  5 5 0
DEC   20.     5  6 5 0
```

FIGURE F.2. Sample ORIGEN2 Input for the Cladding

```
DEC   50.    6  7 5 0
DEC   100.   7  8 5 0
DEC   200.   8  9 5 0
DEC   500.   9 10 5 0
DEC   1000. 10  7 5 0
BUP
HED   1 ' 6 YEARS
HED   2 ' 8 YEARS
HED   3 10 YEARS
HED   4 12 YEARS
HED   5 15 YEARS
HED   6 20 YEARS
HED   7 1000 YEARS
OPTA  8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTL  8 8 8 8 7 8 7 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
OPTF  8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8 8
CUT   5 1.0-15  7 1.0-15  -1
OUT   7 1  0  1
STP   4
2  922340 .000998 922350 .12279 922380 4.3906 0 0.0
4  400000 .9804  50000  .015  260000 .002  240000 .001
4  130000 40.0-6  720000 55.0-6  140000 80.0-6  80000 1257.0-6
4  60000 137.0-6  70000 30.0-6 10000 14.0-6  0 0.0
0
END
```

FIGURE F.2. Sample ORIGEN2 Input for the Cladding (contd)

TABLE F.1.a. Fission Product Radioactivity by Isotope at 15 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	1.657E-04	1.481E-04	1.323E-04	1.183E-04	9.995E-05	7.549E-05	0.00
Be 10	1.325E-12	1.325E-12	1.325E-12	1.325E-12	1.325E-12	1.325E-12	1.324E-12
C 14	5.339E-11	5.337E-11	5.336E-11	5.335E-11	5.333E-11	5.330E-11	4.734E-11
Se 79	1.924E-07	1.924E-07	1.924E-07	1.924E-07	1.924E-07	1.924E-07	1.903E-07
Kr 81	1.239E-13	1.239E-13	1.239E-13	1.239E-13	1.239E-13	1.239E-13	1.235E-13
Kr 85	3.001E-03	2.637E-03	2.317E-03	2.036E-03	1.677E-03	1.214E-03	0.00
Rb 87	1.057E-11	1.057E-11	1.057E-11	1.057E-11	1.057E-11	1.057E-11	1.057E-11
Sr 89	3.010E-14	1.330E-18	5.877E-23	0.00	0.00	0.00	0.00
Sr 90	3.100E-02	2.956E-02	2.819E-02	2.688E-02	2.502E-02	2.222E-02	1.646E-12
Y 90	3.101E-02	2.957E-02	2.819E-02	2.688E-02	2.503E-02	2.222E-02	1.646E-12
Y 91	2.346E-12	4.091E-16	7.133E-20	1.244E-23	0.00	0.00	0.00
Zr 93	8.728E-07	8.728E-07	8.728E-07	8.728E-07	8.728E-07	8.728E-07	8.725E-07
Nb 93m	2.771E-07	3.306E-07	3.789E-07	4.226E-07	4.802E-07	5.587E-07	8.288E-07
Nb 94	5.250E-11	5.250E-11	5.249E-11	5.249E-11	5.248E-11	5.247E-11	5.075E-11
Zr 95	2.798E-11	1.023E-14	3.740E-18	1.367E-21	0.00	0.00	0.00
Nb 95	6.211E-11	2.271E-14	8.303E-18	3.036E-21	0.00	0.00	0.00
Nb 95m	2.075E-13	7.588E-17	2.774E-20	1.014E-23	0.00	0.00	0.00
Tc 98	1.154E-12	1.154E-12	1.154E-12	1.154E-12	1.154E-12	1.154E-12	1.154E-12
Tc 99	6.319E-06	6.319E-06	6.319E-06	6.319E-06	6.319E-06	6.319E-06	6.298E-06
Rh102	6.106E-08	3.786E-08	2.347E-08	1.455E-08	7.105E-09	2.151E-09	0.00
Ru106	2.488E-03	6.289E-04	1.590E-04	4.018E-05	5.106E-06	1.640E-07	0.00
Rh106	2.488E-03	6.289E-04	1.590E-04	4.018E-05	5.106E-06	1.640E-07	0.00
Pd107	3.845E-08	3.845E-08	3.845E-08	3.845E-08	3.845E-08	3.845E-08	3.844E-08
Ag108	8.375E-13	8.284E-13	8.194E-13	8.105E-13	7.974E-13	7.759E-13	3.690E-15
Ag108m	9.410E-12	9.308E-12	9.207E-12	9.107E-12	8.959E-12	8.718E-12	4.146E-14
Ag109m	3.455E-12	1.160E-12	3.896E-13	1.308E-13	2.546E-14	1.664E-15	0.00
Cd109	3.455E-12	1.160E-12	3.896E-13	1.308E-13	2.546E-14	1.664E-15	0.00
Ag110	1.801E-08	2.374E-09	3.129E-10	4.125E-11	1.974E-12	1.245E-14	0.00
Ag110m	1.354E-06	1.785E-07	2.353E-08	3.101E-09	1.484E-10	9.365E-13	0.00
Cd113m	1.477E-05	1.343E-05	1.222E-05	1.111E-05	9.633E-06	7.596E-06	0.00
Sn119m	1.390E-07	1.760E-08	2.228E-09	2.822E-10	1.271E-11	7.253E-14	0.00
Sn121m	7.433E-08	7.230E-08	7.032E-08	6.839E-08	6.561E-08	6.121E-08	7.644E-14
Sn123	9.016E-09	1.789E-10	3.549E-12	7.041E-14	1.968E-16	1.091E-20	0.00
Te123m	3.315E-12	4.820E-14	7.007E-16	1.026E-17	0.00	0.00	0.00
Sb124	2.316E-15	5.148E-19	1.144E-22	0.00	0.00	0.00	0.00
Sb125	1.235E-03	7.485E-04	4.537E-04	2.751E-04	1.298E-04	3.715E-05	0.00
Te125m	3.012E-04	1.827E-04	1.107E-04	6.713E-05	3.168E-05	9.065E-06	0.00
Sn126	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.318E-07
Sb126	4.677E-08	4.677E-08	4.677E-08	4.677E-08	4.677E-08	4.677E-08	4.645E-08
Sb126m	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.318E-07
Te127	3.918E-09	3.765E-11	3.618E-13	3.476E-15	3.273E-18	2.962E-23	0.00

TABLE F.1.a. Fission Product Radioactivity by Isotope at 15 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Te127m	4.000E-09	3.844E-11	3.693E-13	3.549E-15	3.342E-18	3.024E-23	0.00
I129	1.406E-08	1.406E-08	1.406E-08	1.406E-08	1.406E-08	1.406E-08	1.406E-08
Cs134	4.235E-03	2.162E-03	1.104E-03	5.635E-04	2.056E-04	3.828E-05	0.00
Cs135	2.880E-07	2.880E-07	2.880E-07	2.880E-07	2.880E-07	2.880E-07	2.879E-07
Cs137	4.042E-02	3.860E-02	3.685E-02	3.519E-02	3.283E-02	2.925E-02	4.287E-12
Ba137m	3.824E-02	3.651E-02	3.486E-02	3.329E-02	3.106E-02	2.767E-02	4.056E-12
Ce142	1.252E-11	1.252E-11	1.252E-11	1.252E-11	1.252E-11	1.252E-11	1.252E-11
Ce144	1.966E-03	3.311E-04	5.576E-05	9.392E-06	6.491E-07	7.557E-09	0.00
Pr144	1.966E-03	3.311E-04	5.576E-05	9.392E-06	6.492E-07	7.558E-09	0.00
Pr144m	2.359E-05	3.973E-06	6.692E-07	1.127E-07	7.790E-09	9.069E-11	0.00
Nd144	6.429E-16	6.435E-16	6.436E-16	6.436E-16	6.436E-16	6.436E-16	6.436E-16
Pm146	3.687E-07	2.866E-07	2.227E-07	1.731E-07	1.186E-07	6.316E-08	0.00
Sm146	7.600E-14	7.839E-14	8.025E-14	8.169E-14	8.328E-14	8.489E-14	8.672E-14
Pm147	1.741E-02	1.026E-02	6.050E-03	3.567E-03	1.614E-03	4.308E-04	0.00
Sm147	2.902E-12	3.077E-12	3.180E-12	3.241E-12	3.289E-12	3.318E-12	3.328E-12
Eu150	1.116E-11	1.073E-11	1.033E-11	9.938E-12	9.380E-12	8.519E-12	5.448E-20
Sm151	2.269E-04	2.234E-04	2.200E-04	2.166E-04	2.117E-04	2.037E-04	1.074E-07
Eu152	7.757E-06	7.005E-06	6.326E-06	5.713E-06	4.903E-06	3.800E-06	0.00
Gd153	4.979E-08	6.145E-09	7.583E-10	9.359E-11	4.058E-12	2.172E-14	0.00
Eu154	1.419E-03	1.208E-03	1.028E-03	8.752E-04	6.872E-04	4.593E-04	0.00
Eu155	7.700E-04	5.822E-04	4.402E-04	3.329E-04	2.189E-04	1.088E-04	0.00
Tb160	9.182E-14	8.348E-17	7.589E-20	6.899E-23	0.00	0.00	0.00
Ho166m	2.995E-10	2.991E-10	2.988E-10	2.984E-10	2.979E-10	2.971E-10	1.687E-10
Tm170	1.812E-14	3.532E-16	6.839E-18	1.801E-19	3.769E-20	1.999E-24	0.00
Tm171	1.889E-12	9.175E-13	4.457E-13	2.165E-13	7.330E-14	1.205E-14	0.00
TOTAL	1.784E-01	1.543E-01	1.404E-01	1.304E-01	1.189E-01	1.040E-01	9.348E-06

TABLE F.1.b. Fission Product Radioactivity by Isotope at 20 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	2.261E-04	2.021E-04	1.807E-04	1.615E-04	1.364E-04	1.031E-04	0.00
Be 10	1.762E-12	1.762E-12	1.762E-12	1.762E-12	1.762E-12	1.762E-12	1.762E-12
C 14	7.103E-11	7.101E-11	7.099E-11	7.097E-11	7.095E-11	7.091E-11	6.298E-11
Se 79	2.531E-07	2.531E-07	2.531E-07	2.531E-07	2.531E-07	2.530E-07	2.504E-07
Kr 81	2.099E-13	2.099E-13	2.099E-13	2.099E-13	2.099E-13	2.099E-13	2.092E-13
Kr 85	3.853E-03	3.385E-03	2.975E-03	2.614E-03	2.153E-03	1.558E-03	0.00
Rb 87	1.350E-11	1.350E-11	1.350E-11	1.350E-11	1.350E-11	1.350E-11	1.350E-11
Sr 89	3.692E-14	1.631E-18	7.209E-23	0.00	0.00	0.00	0.00
Sr 90	3.951E-02	3.768E-02	3.593E-02	3.426E-02	3.189E-02	2.832E-02	2.097E-12
Y 90	3.952E-02	3.769E-02	3.593E-02	3.426E-02	3.190E-02	2.832E-02	2.098E-12
Y 91	2.913E-12	5.079E-16	8.856E-20	1.544E-23	0.00	0.00	0.00
Zr 93	1.130E-06	1.130E-06	1.130E-06	1.130E-06	1.130E-06	1.130E-06	1.130E-06
Nb 93m	3.596E-07	4.288E-07	4.913E-07	5.478E-07	6.224E-07	7.239E-07	1.073E-06
Nb 94	7.896E-11	7.895E-11	7.895E-11	7.894E-11	7.893E-11	7.892E-11	7.632E-11
Zr 95	3.622E-11	1.324E-14	4.842E-18	1.770E-21	0.00	0.00	0.00
Nb 95	8.041E-11	2.940E-14	1.075E-17	3.930E-21	0.00	0.00	0.00
Nb 95m	2.687E-13	9.824E-17	3.592E-20	1.313E-23	0.00	0.00	0.00
Tc 98	2.083E-12	2.083E-12	2.083E-12	2.083E-12	2.083E-12	2.083E-12	2.082E-12
Tc 99	8.261E-06	8.260E-06	8.260E-06	8.260E-06	8.260E-06	8.260E-06	8.234E-06
Rh102	1.106E-07	6.860E-08	4.253E-08	2.637E-08	1.287E-08	3.897E-09	0.00
Ru106	3.799E-03	9.602E-04	2.427E-04	6.135E-05	7.796E-06	2.504E-07	0.00
Rh106	3.799E-03	9.602E-04	2.427E-04	6.135E-05	7.796E-06	2.504E-07	0.00
Pd107	5.936E-08	5.936E-08	5.936E-08	5.936E-08	5.936E-08	5.936E-08	5.935E-08
Ag108	1.333E-12	1.319E-12	1.305E-12	1.290E-12	1.269E-12	1.235E-12	5.875E-15
Ag108m	1.498E-11	1.482E-11	1.466E-11	1.450E-11	1.426E-11	1.388E-11	6.601E-14
Ag109m	9.541E-12	3.204E-12	1.076E-12	3.613E-13	7.030E-14	4.594E-15	0.00
Cd109	9.541E-12	3.204E-12	1.076E-12	3.613E-13	7.030E-14	4.594E-15	0.00
Ag110	3.739E-08	4.929E-09	6.497E-10	8.564E-11	4.099E-12	2.586E-14	0.00
Ag110m	2.811E-06	3.706E-07	4.885E-08	6.439E-09	3.082E-10	1.944E-12	0.00
Cd113m	2.187E-05	1.989E-05	1.808E-05	1.645E-05	1.426E-05	1.125E-05	6.759E-26
Sn119m	1.999E-07	2.532E-08	3.206E-09	4.060E-10	1.829E-11	1.044E-13	0.00
Sn121m	1.074E-07	1.045E-07	1.016E-07	9.884E-08	9.482E-08	8.846E-08	1.105E-13
Sn123	1.249E-08	2.478E-10	4.917E-12	9.755E-14	2.723E-16	1.510E-20	0.00
Te123m	8.496E-12	1.235E-13	1.796E-15	2.606E-17	7.371E-20	1.878E-24	0.00
Sb124	4.389E-15	9.758E-19	2.169E-22	4.822E-26	0.00	0.00	0.00
Sb125	1.722E-03	1.044E-03	6.329E-04	3.837E-04	1.811E-04	5.182E-05	0.00
Te125m	4.202E-04	2.548E-04	1.545E-04	9.364E-05	4.419E-05	1.264E-05	0.00
Sn126	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.603E-07
Sb126	6.488E-08	6.488E-08	6.488E-08	6.488E-08	6.488E-08	6.487E-08	6.444E-08
Sb126m	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.603E-07

TABLE F.1.b. Fission Product Radioactivity by Isotope at 20 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Te127	5.554E-09	5.337E-11	5.128E-13	4.927E-15	4.640E-18	4.199E-23	0.00
Te127m	5.670E-09	5.449E-11	5.235E-13	5.030E-15	4.737E-18	4.287E-23	0.00
I129	1.915E-08	1.915E-08	1.915E-08	1.915E-08	1.915E-08	1.915E-08	1.914E-08
Cs134	7.456E-03	3.807E-03	1.943E-03	9.921E-04	3.619E-04	6.739E-05	0.00
Cs135	3.223E-07	3.223E-07	3.223E-07	3.223E-07	3.223E-07	3.223E-07	3.222E-07
Cs137	5.396E-02	5.152E-02	4.919E-02	4.697E-02	4.383E-02	3.905E-02	5.723E-12
Ba137m	5.104E-02	4.874E-02	4.654E-02	4.444E-02	4.146E-02	3.694E-02	5.414E-12
Ce142	1.651E-11	1.651E-11	1.651E-11	1.651E-11	1.651E-11	1.651E-11	1.651E-11
Ce144	2.557E-03	4.306E-04	7.252E-05	1.221E-05	8.443E-07	9.829E-09	0.00
Pr144	2.557E-03	4.306E-04	7.253E-05	1.222E-05	8.443E-07	9.829E-09	0.00
Pr144m	3.068E-05	5.167E-06	8.703E-07	1.466E-07	1.013E-08	1.179E-10	0.00
Nd144	8.803E-16	8.811E-16	8.812E-16	8.812E-16	8.812E-16	8.812E-16	8.812E-16
Pn146	6.112E-07	4.750E-07	3.692E-07	2.869E-07	1.966E-07	1.047E-07	0.00
Sn146	1.263E-13	1.303E-13	1.333E-13	1.357E-13	1.384E-13	1.410E-13	1.441E-13
Pn147	2.024E-02	1.193E-02	7.034E-03	4.147E-03	1.877E-03	5.009E-04	0.00
Sn147	3.380E-12	3.584E-12	3.704E-12	3.775E-12	3.831E-12	3.864E-12	3.877E-12
Eu150	1.279E-11	1.231E-11	1.184E-11	1.139E-11	1.076E-11	9.768E-12	6.238E-20
Sm151	2.486E-04	2.448E-04	2.411E-04	2.374E-04	2.320E-04	2.232E-04	1.177E-07
Eu152	7.080E-06	6.394E-06	5.775E-06	5.215E-06	4.476E-06	3.469E-06	0.00
Gd153	6.830E-08	8.430E-09	1.040E-09	1.284E-10	5.567E-12	2.979E-14	0.00
Eu154	2.603E-03	2.215E-03	1.885E-03	1.605E-03	1.260E-03	8.422E-04	0.00
Eu155	1.223E-03	9.247E-04	6.992E-04	5.287E-04	3.476E-04	1.728E-04	0.00
Tb160	1.950E-13	1.773E-16	1.612E-19	1.465E-22	0.00	0.00	0.00
Ho166m	6.910E-10	6.902E-10	6.894E-10	6.886E-10	6.874E-10	6.854E-10	3.891E-10
Tm170	5.778E-14	1.126E-15	2.199E-17	3.857E-19	0.00	0.00	0.00
Tm171	8.257E-12	4.011E-12	1.948E-12	9.464E-13	3.204E-13	5.270E-14	0.00
TOTAL	2.348E-01	2.025E-01	1.840E-01	1.709E-01	1.557E-01	1.362E-01	1.219E-05

TABLE F.1.c. Fission Product Radioactivity by Isotope at 25 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	2.886E-04	2.579E-04	2.305E-04	2.061E-04	1.741E-04	1.315E-04	0.00
Be 10	2.199E-12	2.199E-12	2.199E-12	2.199E-12	2.199E-12	2.199E-12	2.198E-12
C 14	8.860E-11	8.858E-11	8.856E-11	8.853E-11	8.850E-11	8.845E-11	7.856E-11
Se 79	3.121E-07	3.121E-07	3.121E-07	3.121E-07	3.121E-07	3.121E-07	3.088E-07
Kr 81	3.188E-13	3.188E-13	3.188E-13	3.188E-13	3.188E-13	3.188E-13	3.178E-13
Kr 85	4.648E-03	4.084E-03	3.589E-03	3.154E-03	2.598E-03	1.880E-03	0.00
Rb 87	1.621E-11	1.621E-11	1.621E-11	1.621E-11	1.621E-11	1.621E-11	1.621E-11
Sr 89	4.270E-14	1.887E-18	8.337E-23	0.00	0.00	0.00	0.00
Sr 90	4.733E-02	4.513E-02	4.303E-02	4.103E-02	3.821E-02	3.392E-02	2.512E-12
Y 90	4.735E-02	4.514E-02	4.305E-02	4.104E-02	3.822E-02	3.393E-02	2.513E-12
Y 91	3.409E-12	5.944E-16	1.036E-19	1.807E-23	0.00	0.00	0.00
Zr 93	1.375E-06	1.375E-06	1.375E-06	1.375E-06	1.375E-06	1.375E-06	1.374E-06
Nb 93m	4.382E-07	5.222E-07	5.982E-07	6.668E-07	7.574E-07	8.808E-07	1.305E-06
Nb 94	1.075E-10	1.075E-10	1.075E-10	1.075E-10	1.075E-10	1.075E-10	1.039E-10
Zr 95	4.406E-11	1.611E-14	5.890E-18	2.153E-21	0.00	0.00	0.00
Nb 95	9.782E-11	3.576E-14	1.308E-17	4.781E-21	0.00	0.00	0.00
Nb 95m	3.268E-13	1.195E-16	4.369E-20	1.597E-23	0.00	0.00	0.00
Tc 98	3.304E-12	3.304E-12	3.304E-12	3.304E-12	3.304E-12	3.304E-12	3.304E-12
Tc 99	1.012E-05	1.012E-05	1.012E-05	1.012E-05	1.012E-05	1.012E-05	1.008E-05
Rh102	1.749E-07	1.084E-07	6.723E-08	4.168E-08	2.035E-08	6.159E-09	0.00
Ru106	5.304E-03	1.341E-03	3.389E-04	8.566E-05	1.089E-05	3.496E-07	0.00
Rh106	5.304E-03	1.341E-03	3.389E-04	8.566E-05	1.089E-05	3.496E-07	0.00
Pd107	8.342E-08	8.342E-08	8.342E-08	8.342E-08	8.342E-08	8.342E-08	8.342E-08
Ag108	1.907E-12	1.887E-12	1.866E-12	1.846E-12	1.816E-12	1.767E-12	8.403E-15
Ag108m	2.143E-11	2.120E-11	2.097E-11	2.074E-11	2.040E-11	1.985E-11	9.442E-14
Ag109m	2.096E-11	7.039E-12	2.364E-12	7.938E-13	1.545E-13	1.009E-14	0.00
Cd109	2.096E-11	7.039E-12	2.364E-12	7.938E-13	1.545E-13	1.009E-14	0.00
Ag110	6.557E-08	8.644E-09	1.139E-09	1.502E-10	7.188E-12	4.535E-14	0.00
Ag110m	4.930E-06	6.499E-07	8.567E-08	1.129E-08	5.405E-10	3.409E-12	0.00
Cd113m	3.024E-05	2.750E-05	2.500E-05	2.274E-05	1.972E-05	1.555E-05	9.345E-26
Sn119m	2.683E-07	3.397E-08	4.302E-09	5.447E-10	2.455E-11	1.401E-13	0.00
Sn121m	1.427E-07	1.388E-07	1.350E-07	1.313E-07	1.260E-07	1.175E-07	1.468E-13
Sn123	1.608E-08	3.190E-10	6.328E-12	1.255E-13	3.507E-16	1.944E-20	0.00
Te123m	1.778E-11	2.584E-13	3.758E-15	5.465E-17	1.545E-19	3.939E-24	0.00
Sb124	7.198E-15	1.600E-18	3.557E-22	7.907E-26	0.00	0.00	0.00
Sb125	2.235E-03	1.355E-03	8.212E-04	4.979E-04	2.350E-04	6.725E-05	0.00
Te125m	5.452E-04	3.306E-04	2.004E-04	1.215E-04	5.734E-05	1.641E-05	0.00
Sn126	5.987E-07	5.987E-07	5.987E-07	5.987E-07	5.987E-07	5.987E-07	5.946E-07
Sb126	8.382E-08	8.382E-08	8.382E-08	8.382E-08	8.382E-08	8.381E-08	8.325E-08
Sb126m	5.987E-07	5.987E-07	5.987E-07	5.987E-07	5.987E-07	5.987E-07	5.946E-07
Te127	7.269E-09	6.984E-11	6.710E-13	6.447E-15	6.072E-18	5.494E-23	0.00

TABLE F.1.c. Fission Product Radioactivity by Isotope at 25 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Te127m	7.421E-09	7.130E-11	6.851E-13	6.582E-15	6.199E-18	5.609E-23	0.00
I129	2.429E-08	2.429E-08	2.429E-08	2.429E-08	2.429E-08	2.429E-08	2.429E-08
Cs134	1.150E-02	5.870E-03	2.997E-03	1.530E-03	5.581E-04	1.039E-04	0.00
Cs135	3.481E-07	3.481E-07	3.481E-07	3.481E-07	3.481E-07	3.481E-07	3.480E-07
Cs137	6.751E-02	6.446E-02	6.155E-02	5.877E-02	5.483E-02	4.885E-02	7.160E-12
Ba137m	6.386E-02	6.098E-02	5.822E-02	5.559E-02	5.187E-02	4.621E-02	6.773E-12
Ce142	2.043E-11	2.043E-11	2.043E-11	2.043E-11	2.043E-11	2.043E-11	2.043E-11
Ce144	3.125E-03	5.263E-04	8.863E-05	1.493E-05	1.032E-06	1.201E-08	0.00
Pr144	3.125E-03	5.263E-04	8.864E-05	1.493E-05	1.032E-06	1.201E-08	0.00
Pr144m	3.750E-05	6.315E-06	1.064E-06	1.791E-07	1.238E-08	1.441E-10	0.00
Nd144	1.129E-15	1.130E-15	1.130E-15	1.130E-15	1.130E-15	1.130E-15	1.130E-15
Pm146	8.924E-07	6.936E-07	5.391E-07	4.190E-07	2.871E-07	1.529E-07	0.00
Sm146	1.844E-13	1.902E-13	1.947E-13	1.982E-13	2.020E-13	2.059E-13	2.104E-13
Pm147	2.216E-02	1.306E-02	7.700E-03	4.540E-03	2.055E-03	5.483E-04	0.00
Sm147	3.698E-12	3.921E-12	4.053E-12	4.130E-12	4.191E-12	4.228E-12	4.241E-12
Eu150	1.408E-11	1.355E-11	1.304E-11	1.255E-11	1.184E-11	1.076E-11	6.869E-20
Sm151	2.710E-04	2.668E-04	2.628E-04	2.587E-04	2.528E-04	2.433E-04	1.282E-07
Eu152	6.291E-06	5.681E-06	5.131E-06	4.633E-06	3.976E-06	3.082E-06	0.00
Gd153	8.356E-08	1.031E-08	1.273E-09	1.571E-10	6.810E-12	3.645E-14	0.00
Eu154	4.080E-03	3.473E-03	2.956E-03	2.516E-03	1.975E-03	1.320E-03	0.00
Eu155	1.812E-03	1.370E-03	1.036E-03	7.832E-04	5.150E-04	2.560E-04	0.00
Tb160	3.491E-13	3.174E-16	2.885E-19	2.623E-22	0.00	0.00	0.00
Ho166m	1.370E-09	1.368E-09	1.366E-09	1.365E-09	1.362E-09	1.358E-09	7.713E-10
Tm170	1.419E-13	2.767E-15	5.391E-17	1.079E-18	3.244E-20	1.721E-24	0.00
Tm171	2.621E-11	1.273E-11	6.184E-12	3.004E-12	1.017E-12	1.672E-13	0.00
TOTAL	2.905E-01	2.496E-01	2.265E-01	2.103E-01	1.916E-01	1.675E-01	1.493E-05

TABLE F.1.d. Fission Product Radioactivity by Isotope at 30 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	3.527E-04	3.152E-04	2.817E-04	2.518E-04	2.128E-04	1.607E-04	0.00
Be 10	2.633E-12	2.633E-12	2.633E-12	2.633E-12	2.633E-12	2.633E-12	2.632E-12
C 14	1.061E-10	1.061E-10	1.061E-10	1.060E-10	1.060E-10	1.059E-10	9.409E-11
Se 79	3.698E-07	3.698E-07	3.698E-07	3.698E-07	3.698E-07	3.698E-07	3.659E-07
Kr 81	4.529E-13	4.529E-13	4.529E-13	4.529E-13	4.529E-13	4.529E-13	4.515E-13
Kr 85	5.397E-03	4.742E-03	4.167E-03	3.662E-03	3.016E-03	2.183E-03	0.00
Rb 87	1.873E-11	1.873E-11	1.873E-11	1.873E-11	1.873E-11	1.873E-11	1.873E-11
Sr 89	4.759E-14	2.103E-18	9.291E-23	0.00	0.00	0.00	0.00
Sr 90	5.457E-02	5.203E-02	4.961E-02	4.731E-02	4.405E-02	3.911E-02	2.897E-12
Y 90	5.458E-02	5.205E-02	4.963E-02	4.732E-02	4.406E-02	3.912E-02	2.897E-12
Y 91	3.847E-12	6.707E-16	1.169E-19	2.039E-23	0.00	0.00	0.00
Zr 93	1.607E-06	1.607E-06	1.607E-06	1.607E-06	1.607E-06	1.607E-06	1.607E-06
Nb 93m	5.133E-07	6.115E-07	7.002E-07	7.803E-07	8.862E-07	1.030E-06	1.526E-06
Nb 94	1.375E-10	1.375E-10	1.375E-10	1.375E-10	1.375E-10	1.375E-10	1.330E-10
Zr 95	5.160E-11	1.887E-14	6.898E-18	2.522E-21	0.00	0.00	0.00
Nb 95	1.146E-10	4.188E-14	1.531E-17	5.599E-21	0.00	0.00	0.00
Nb 95m	3.828E-13	1.400E-16	5.117E-20	1.871E-23	0.00	0.00	0.00
Tc 98	4.841E-12	4.841E-12	4.841E-12	4.841E-12	4.841E-12	4.841E-12	4.840E-12
Tc 99	1.188E-05	1.188E-05	1.188E-05	1.188E-05	1.188E-05	1.188E-05	1.184E-05
Rh102	2.542E-07	1.576E-07	9.771E-08	6.058E-08	2.957E-08	8.951E-09	0.00
Ru106	6.957E-03	1.758E-03	4.445E-04	1.124E-04	1.428E-05	4.586E-07	0.00
Rh106	6.957E-03	1.758E-03	4.445E-04	1.124E-04	1.428E-05	4.586E-07	0.00
Pd107	1.100E-07	1.100E-07	1.100E-07	1.100E-07	1.100E-07	1.100E-07	1.100E-07
Ag108	2.555E-12	2.527E-12	2.499E-12	2.472E-12	2.432E-12	2.367E-12	1.125E-14
Ag108m	2.870E-11	2.839E-11	2.808E-11	2.778E-11	2.733E-11	2.659E-11	1.265E-13
Ag109m	4.009E-11	1.346E-11	4.520E-12	1.518E-12	2.953E-13	1.930E-14	0.00
Cd109	4.009E-11	1.346E-11	4.520E-12	1.518E-12	2.953E-13	1.930E-14	0.00
Ag110	1.040E-07	1.371E-08	1.807E-09	2.383E-10	1.140E-11	7.195E-14	0.00
Ag110m	7.821E-06	1.031E-06	1.359E-07	1.791E-08	8.574E-10	5.410E-12	0.00
Cd113m	3.999E-05	3.636E-05	3.307E-05	3.007E-05	2.608E-05	2.056E-05	1.236E-25
Sn119m	3.454E-07	4.373E-08	5.538E-09	7.013E-10	3.160E-11	1.803E-13	0.00
Sn121m	1.799E-07	1.750E-07	1.702E-07	1.655E-07	1.588E-07	1.481E-07	1.850E-13
Sn123	1.987E-08	3.942E-10	7.821E-12	1.552E-13	4.335E-16	2.403E-20	0.00
Te123m	3.324E-11	4.832E-13	7.025E-15	1.022E-16	1.466E-19	3.736E-24	0.00
Sb124	1.103E-14	2.452E-18	5.451E-22	1.212E-25	0.00	0.00	0.00
Sb125	2.771E-03	1.680E-03	1.018E-03	6.173E-04	2.914E-04	8.338E-05	0.00
Te125m	6.760E-04	4.099E-04	2.485E-04	1.507E-04	7.109E-05	2.034E-05	0.00
Sn126	7.394E-07	7.394E-07	7.393E-07	7.393E-07	7.393E-07	7.393E-07	7.343E-07
Sb126	1.035E-07	1.035E-07	1.035E-07	1.035E-07	1.035E-07	1.035E-07	1.028E-07
Sb126m	7.394E-07	7.394E-07	7.393E-07	7.393E-07	7.393E-07	7.393E-07	7.343E-07
Te127	9.079E-09	8.724E-11	8.383E-13	8.054E-15	7.584E-18	6.863E-23	0.00

TABLE F.1.d. Fission Product Radioactivity by Isotope at 30 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Te127m	9.269E-09	8.906E-11	8.558E-13	8.222E-15	7.743E-18	7.007E-23	0.00
I129	2.945E-08	2.945E-08	2.945E-08	2.945E-08	2.945E-08	2.945E-08	2.945E-08
Cs134	1.635E-02	8.349E-03	4.263E-03	2.176E-03	7.938E-04	1.478E-04	0.00
Cs135	3.699E-07	3.699E-07	3.699E-07	3.699E-07	3.699E-07	3.699E-07	3.698E-07
Cs137	8.106E-02	7.740E-02	7.391E-02	7.057E-02	6.584E-02	5.866E-02	8.598E-12
Ba137m	7.668E-02	7.322E-02	6.991E-02	6.676E-02	6.229E-02	5.549E-02	8.134E-12
Ce142	2.430E-11	2.430E-11	2.430E-11	2.430E-11	2.430E-11	2.430E-11	2.430E-11
Ce144	3.674E-03	6.188E-04	1.042E-04	1.755E-05	1.213E-06	1.412E-08	0.00
Pr144	3.674E-03	6.188E-04	1.042E-04	1.755E-05	1.213E-06	1.413E-08	0.00
Pr144m	4.409E-05	7.425E-06	1.251E-06	2.106E-07	1.456E-08	1.695E-10	0.00
Nd144	1.389E-15	1.391E-15	1.391E-15	1.391E-15	1.391E-15	1.391E-15	1.391E-15
Pm146	1.206E-06	9.371E-07	7.283E-07	5.660E-07	3.878E-07	2.065E-07	0.00
Sm146	2.488E-13	2.566E-13	2.626E-13	2.674E-13	2.725E-13	2.778E-13	2.838E-13
Pm147	2.332E-02	1.375E-02	8.105E-03	4.778E-03	2.163E-03	5.772E-04	0.00
Sm147	3.885E-12	4.119E-12	4.258E-12	4.339E-12	4.403E-12	4.442E-12	4.456E-12
Eu150	1.524E-11	1.466E-11	1.411E-11	1.358E-11	1.282E-11	1.164E-11	7.440E-20
Sm151	2.898E-04	2.854E-04	2.810E-04	2.767E-04	2.704E-04	2.602E-04	1.372E-07
Eu152	5.566E-06	5.026E-06	4.539E-06	4.099E-06	3.518E-06	2.727E-06	0.00
Gd153	9.711E-08	1.198E-08	1.479E-09	1.825E-10	7.914E-12	4.235E-14	0.00
Eu154	5.781E-03	4.921E-03	4.188E-03	3.565E-03	2.799E-03	1.871E-03	0.00
Eu155	2.510E-03	1.898E-03	1.435E-03	1.085E-03	7.133E-04	3.546E-04	0.00
Tb160	5.714E-13	5.195E-16	4.722E-19	4.293E-22	0.00	0.00	0.00
Ho166m	2.474E-09	2.471E-09	2.469E-09	2.466E-09	2.462E-09	2.454E-09	1.394E-09
Tm170	3.013E-13	5.874E-15	1.145E-16	2.291E-18	6.888E-20	3.654E-24	0.00
Tm171	6.857E-11	3.331E-11	1.618E-11	7.860E-12	2.661E-12	4.376E-13	0.00
TOTAL	3.457E-01	2.959E-01	2.682E-01	2.488E-01	2.266E-01	1.981E-01	1.756E-05

TABLE F.1.e. Fission Product Radioactivity by Isotope at 35 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	4.184E-04	3.740E-04	3.342E-04	2.988E-04	2.525E-04	1.907E-04	0.00
Be 10	3.067E-12	3.067E-12	3.067E-12	3.067E-12	3.067E-12	3.067E-12	3.065E-12
C 14	1.236E-10	1.236E-10	1.235E-10	1.235E-10	1.235E-10	1.234E-10	1.096E-10
Se 79	4.261E-07	4.261E-07	4.261E-07	4.261E-07	4.261E-07	4.261E-07	4.216E-07
Kr 81	6.152E-13	6.152E-13	6.152E-13	6.152E-13	6.152E-13	6.152E-13	6.132E-13
Kr 85	6.101E-03	5.361E-03	4.710E-03	4.139E-03	3.409E-03	2.467E-03	0.00
Rb 87	2.107E-11	2.107E-11	2.107E-11	2.107E-11	2.107E-11	2.107E-11	2.107E-11
Sr 89	5.150E-14	2.276E-18	1.006E-22	0.00	0.00	0.00	0.00
Sr 90	6.124E-02	5.840E-02	5.568E-02	5.309E-02	4.944E-02	4.389E-02	3.251E-12
Y 90	6.126E-02	5.841E-02	5.570E-02	5.311E-02	4.945E-02	4.390E-02	3.252E-12
Y 91	4.217E-12	7.352E-16	1.282E-19	2.235E-23	0.00	0.00	0.00
Zr 93	1.829E-06	1.829E-06	1.829E-06	1.829E-06	1.829E-06	1.829E-06	1.828E-06
Nb 93m	5.851E-07	6.968E-07	7.976E-07	8.887E-07	1.009E-06	1.173E-06	1.737E-06
Nb 94	1.688E-10	1.688E-10	1.688E-10	1.688E-10	1.688E-10	1.688E-10	1.632E-10
Zr 95	5.879E-11	2.149E-14	7.858E-18	2.873E-21	0.00	0.00	0.00
Nb 95	1.305E-10	4.772E-14	1.745E-17	6.379E-21	0.00	0.00	0.00
Nb 95m	4.361E-13	1.594E-16	5.830E-20	2.131E-23	0.00	0.00	0.00
Tc 98	6.709E-12	6.709E-12	6.709E-12	6.709E-12	6.709E-12	6.709E-12	6.707E-12
Tc 99	1.355E-05	1.355E-05	1.355E-05	1.355E-05	1.355E-05	1.355E-05	1.350E-05
Rh102	3.480E-07	2.158E-07	1.338E-07	8.294E-08	4.049E-08	1.226E-08	0.00
Ru106	8.766E-03	2.216E-03	5.601E-04	1.416E-04	1.799E-05	5.779E-07	0.00
Rh106	8.766E-03	2.216E-03	5.601E-04	1.416E-04	1.799E-05	5.779E-07	0.00
Pd107	1.391E-07	1.391E-07	1.391E-07	1.391E-07	1.391E-07	1.391E-07	1.391E-07
Ag108	3.278E-12	3.242E-12	3.207E-12	3.172E-12	3.121E-12	3.037E-12	1.444E-14
Ag108m	3.683E-11	3.643E-11	3.603E-11	3.564E-11	3.506E-11	3.412E-11	1.623E-13
Ag109m	6.942E-11	2.331E-11	7.828E-12	2.629E-12	5.115E-13	3.342E-14	0.00
Cd109	6.942E-11	2.331E-11	7.828E-12	2.629E-12	5.115E-13	3.342E-14	0.00
Ag110	1.533E-07	2.021E-08	2.665E-09	3.513E-10	1.681E-11	1.061E-13	0.00
Ag110m	1.153E-05	1.520E-06	2.003E-07	2.641E-08	1.264E-09	7.973E-12	0.00
Cd113m	5.131E-05	4.666E-05	4.243E-05	3.858E-05	3.346E-05	2.638E-05	1.586E-25
Sn119m	4.319E-07	5.469E-08	6.926E-09	8.770E-10	3.952E-11	2.255E-13	0.00
Sn121m	2.188E-07	2.128E-07	2.070E-07	2.013E-07	1.931E-07	1.802E-07	2.250E-13
Sn123	2.384E-08	4.729E-10	9.382E-12	1.861E-13	5.197E-16	2.881E-20	0.00
Te123m	5.705E-11	8.294E-13	1.206E-14	1.754E-16	2.527E-19	6.441E-24	0.00
Sb124	1.588E-14	3.530E-18	7.847E-22	1.744E-25	0.00	0.00	0.00
Sb125	3.330E-03	2.019E-03	1.224E-03	7.420E-04	3.502E-04	1.002E-04	0.00
Te125m	8.126E-04	4.927E-04	2.987E-04	1.811E-04	8.545E-05	2.445E-05	0.00
Sn126	8.852E-07	8.852E-07	8.852E-07	8.852E-07	8.852E-07	8.851E-07	8.792E-07
Sb126	1.239E-07	1.239E-07	1.239E-07	1.239E-07	1.239E-07	1.239E-07	1.231E-07
Sb126m	8.852E-07	8.852E-07	8.852E-07	8.852E-07	8.852E-07	8.851E-07	8.792E-07
Te127	1.098E-08	1.055E-10	1.014E-12	9.739E-15	9.172E-18	8.299E-23	0.00

TABLE F.1 e. Fission Product Radioactivity by Isotope at 35 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Te127m	1.121E-08	1.077E-10	1.035E-12	9.943E-15	9.364E-18	8.473E-23	0.00
I129	3.461E-08	3.461E-08	3.461E-08	3.461E-08	3.461E-08	3.461E-08	3.460E-08
Cs134	2.196E-02	1.121E-02	5.723E-03	2.922E-03	1.066E-03	1.985E-04	0.00
Cs135	3.909E-07	3.909E-07	3.909E-07	3.909E-07	3.909E-07	3.909E-07	3.908E-07
Cs137	9.463E-02	9.036E-02	8.628E-02	8.238E-02	7.686E-02	6.848E-02	1.004E-11
Ba137m	8.952E-02	8.548E-02	8.162E-02	7.793E-02	7.271E-02	6.478E-02	9.495E-12
Ce142	2.811E-11	2.811E-11	2.811E-11	2.811E-11	2.811E-11	2.811E-11	2.811E-11
Ce144	4.204E-03	7.080E-04	1.193E-04	2.008E-05	1.388E-06	1.616E-08	0.00
Pr144	4.204E-03	7.081E-04	1.193E-04	2.009E-05	1.388E-06	1.616E-08	0.00
Pr144m	5.045E-05	8.497E-06	1.431E-06	2.410E-07	1.666E-08	1.939E-10	0.00
Nd144	1.660E-15	1.662E-15	1.662E-15	1.662E-15	1.662E-15	1.662E-15	1.662E-15
Pm146	1.543E-06	1.200E-06	9.323E-07	7.246E-07	4.965E-07	2.644E-07	0.00
Sm146	3.174E-13	3.274E-13	3.352E-13	3.412E-13	3.479E-13	3.546E-13	3.623E-13
Pm147	2.394E-02	1.411E-02	8.321E-03	4.906E-03	2.221E-03	5.926E-04	0.00
Sm147	3.971E-12	4.212E-12	4.354E-12	4.437E-12	4.503E-12	4.543E-12	4.558E-12
Eu150	1.628E-11	1.567E-11	1.508E-11	1.451E-11	1.369E-11	1.244E-11	7.951E-20
Sm151	3.095E-04	3.047E-04	3.001E-04	2.955E-04	2.888E-04	2.778E-04	1.465E-07
Eu152	4.909E-06	4.434E-06	4.004E-06	3.616E-06	3.103E-06	2.405E-06	0.00
Gd153	1.089E-07	1.344E-08	1.659E-09	2.047E-10	8.876E-12	4.749E-14	0.00
Eu154	7.615E-03	6.482E-03	5.517E-03	4.695E-03	3.687E-03	2.464E-03	0.00
Eu155	3.291E-03	2.488E-03	1.881E-03	1.423E-03	9.354E-04	4.650E-04	0.00
Tb160	8.667E-13	7.879E-16	7.163E-19	6.512E-22	0.00	0.00	0.00
Ho166m	4.193E-09	4.188E-09	4.183E-09	4.178E-09	4.171E-09	4.159E-09	2.361E-09
Tm170	5.772E-13	1.125E-14	2.192E-16	4.245E-18	0.00	0.00	0.00
Tm171	1.576E-10	7.658E-11	3.720E-11	1.807E-11	6.118E-12	1.006E-12	0.00
TOTAL	4.005E-01	3.414E-01	3.090E-01	2.865E-01	2.608E-01	2.279E-01	2.009E-05

TABLE F.2.a. Actinide Radioactivity by Isotope at 15 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Tl207	2.627E-12	3.430E-12	4.262E-12	5.124E-12	6.467E-12	8.828E-12	6.607E-10
Tl208	1.694E-09	1.927E-09	2.068E-09	2.146E-09	2.185E-09	2.151E-09	2.209E-13
Tl209	8.667E-16	9.156E-16	9.684E-16	1.025E-15	1.118E-15	1.292E-15	1.065E-12
Pb209	4.013E-14	4.239E-14	4.483E-14	4.747E-14	5.176E-14	5.983E-14	4.933E-11
Pb210	1.847E-14	3.183E-14	5.036E-14	7.479E-14	1.240E-13	2.447E-13	2.115E-09
Pb211	2.634E-12	3.440E-12	4.274E-12	5.138E-12	6.485E-12	8.853E-12	6.626E-10
Pb212	4.715E-09	5.363E-09	5.755E-09	5.972E-09	6.082E-09	5.987E-09	6.148E-13
Pb214	1.963E-13	2.867E-13	3.945E-13	5.197E-13	7.399E-13	1.194E-12	2.115E-09
Bi210	1.847E-14	3.184E-14	5.038E-14	7.482E-14	1.240E-13	2.448E-13	2.115E-09
Bi211	2.634E-12	3.440E-12	4.274E-12	5.138E-12	6.485E-12	8.853E-12	6.626E-10
Bi212	4.715E-09	5.363E-09	5.755E-09	5.972E-09	6.082E-09	5.987E-09	6.148E-13
Bi213	4.013E-14	4.239E-14	4.483E-14	4.747E-14	5.176E-14	5.983E-14	4.933E-11
Bi214	1.963E-13	2.867E-13	3.945E-13	5.197E-13	7.399E-13	1.194E-12	2.115E-09
Po210	1.847E-14	2.773E-14	4.458E-14	6.717E-14	1.134E-13	2.448E-13	2.115E-09
Po211	7.376E-15	9.631E-15	1.197E-14	1.439E-14	1.816E-14	2.479E-14	1.855E-12
Po212	3.021E-09	3.436E-09	3.687E-09	3.826E-09	3.897E-09	3.836E-09	3.939E-13
Po213	3.926E-14	4.147E-14	4.386E-14	4.644E-14	5.064E-14	5.854E-14	4.826E-11
Po214	1.962E-13	2.867E-13	3.945E-13	5.196E-13	7.398E-13	1.194E-12	2.115E-09
Po215	2.634E-12	3.440E-12	4.274E-12	5.138E-12	6.485E-12	8.853E-12	6.626E-10
Po216	4.715E-09	5.363E-09	5.755E-09	5.972E-09	6.082E-09	5.987E-09	6.148E-13
Po218	1.963E-13	2.868E-13	3.946E-13	5.198E-13	7.401E-13	1.194E-12	2.116E-09
At217	4.013E-14	4.239E-14	4.483E-14	4.747E-14	5.176E-14	5.983E-14	4.933E-11
Rn219	2.634E-12	3.440E-12	4.274E-12	5.138E-12	6.485E-12	8.853E-12	6.626E-10
Rn220	4.715E-09	5.363E-09	5.755E-09	5.972E-09	6.082E-09	5.987E-09	6.148E-13
Rn222	1.963E-13	2.868E-13	3.946E-13	5.198E-13	7.401E-13	1.194E-12	2.116E-09
Fr221	4.013E-14	4.239E-14	4.483E-14	4.747E-14	5.176E-14	5.983E-14	4.933E-11
Fr223	3.633E-14	4.739E-14	5.888E-14	7.078E-14	8.935E-14	1.220E-13	9.143E-12
Ra223	2.634E-12	3.440E-12	4.274E-12	5.138E-12	6.485E-12	8.853E-12	6.626E-10
Ra224	4.715E-09	5.363E-09	5.755E-09	5.972E-09	6.082E-09	5.987E-09	6.148E-13
Ra225	4.013E-14	4.239E-14	4.483E-14	4.747E-14	5.176E-14	5.983E-14	4.933E-11
Ra226	1.963E-13	2.868E-13	3.946E-13	5.198E-13	7.401E-13	1.194E-12	2.116E-09
Ac225	4.013E-14	4.239E-14	4.483E-14	4.747E-14	5.176E-14	5.983E-14	4.933E-11
Ac227	2.633E-12	3.434E-12	4.267E-12	5.129E-12	6.474E-12	8.840E-12	6.626E-10
Th227	2.598E-12	3.392E-12	4.215E-12	5.068E-12	6.396E-12	8.731E-12	6.534E-10
Th228	4.713E-09	5.351E-09	5.741E-09	5.957E-09	6.071E-09	5.981E-09	6.148E-13
Th229	4.013E-14	4.239E-14	4.483E-14	4.746E-14	5.176E-14	5.983E-14	4.933E-11
Th230	9.466E-11	1.147E-10	1.348E-10	1.550E-10	1.853E-10	2.360E-10	1.131E-08
Th231	3.100E-08	3.100E-08	3.100E-08	3.100E-08	3.100E-08	3.100E-08	3.125E-08
Th232	5.868E-17	7.315E-17	8.762E-17	1.021E-16	1.238E-16	1.600E-16	7.429E-15
Th234	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07
Pa231	1.496E-11	1.627E-11	1.758E-11	1.890E-11	2.087E-11	2.414E-11	6.623E-10

TABLE F.2.a. Actinide Radioactivity by Isotope at 15 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Pa233	1.066E-07	1.070E-07	1.075E-07	1.080E-07	1.089E-07	1.107E-07	4.088E-07
Pa234m	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07
Pa234	4.204E-10	4.204E-10	4.204E-10	4.204E-10	4.204E-10	4.204E-10	4.204E-10
U232	5.799E-09	6.042E-09	6.145E-09	6.162E-09	6.096E-09	5.881E-09	5.944E-13
U233	1.149E-11	1.247E-11	1.346E-11	1.445E-11	1.593E-11	1.833E-11	1.283E-09
U234	1.113E-06	1.116E-06	1.118E-06	1.121E-06	1.124E-06	1.130E-06	1.280E-06
U235	3.100E-08	3.100E-08	3.100E-08	3.100E-08	3.100E-08	3.100E-08	3.125E-08
U236	1.466E-07	1.466E-07	1.467E-07	1.467E-07	1.467E-07	1.467E-07	1.539E-07
U237	9.951E-07	9.038E-07	8.208E-07	7.455E-07	6.452E-07	5.072E-07	5.910E-14
U238	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07	3.234E-07
U240	1.114E-14	1.114E-14	1.114E-14	1.114E-14	1.114E-14	1.114E-14	1.114E-14
Np235	2.547E-11	7.094E-12	1.975E-12	5.501E-13	8.083E-14	3.308E-15	0.00
Np236	1.376E-12	1.376E-12	1.376E-12	1.376E-12	1.375E-12	1.375E-12	1.367E-12
Np237	1.066E-07	1.070E-07	1.075E-07	1.080E-07	1.089E-07	1.107E-07	4.088E-07
Np238	2.252E-08	2.231E-08	2.211E-08	2.191E-08	2.161E-08	2.113E-08	2.421E-10
Np239	1.418E-06	1.417E-06	1.417E-06	1.417E-06	1.417E-06	1.416E-06	1.291E-06
Np240m	1.114E-14	1.114E-14	1.114E-14	1.114E-14	1.114E-14	1.114E-14	1.114E-14
Pu236	2.347E-08	1.443E-08	8.875E-09	5.457E-09	2.632E-09	7.805E-10	1.231E-13
Pu238	4.677E-04	4.604E-04	4.532E-04	4.462E-04	4.358E-04	4.191E-04	2.733E-07
Pu239	2.655E-04	2.655E-04	2.654E-04	2.654E-04	2.654E-04	2.654E-04	2.580E-04
Pu240	2.593E-04	2.592E-04	2.592E-04	2.591E-04	2.591E-04	2.589E-04	2.335E-04
Pu241	4.057E-02	3.684E-02	3.346E-02	3.039E-02	2.630E-02	2.068E-02	2.412E-09
Pu242	3.222E-07	3.222E-07	3.222E-07	3.222E-07	3.222E-07	3.222E-07	3.219E-07
Pu243	2.630E-16	2.630E-16	2.630E-16	2.630E-16	2.630E-16	2.630E-16	2.630E-16
Pu244	1.116E-14	1.116E-14	1.116E-14	1.116E-14	1.116E-14	1.116E-14	1.115E-14
Am241	5.385E-04	6.606E-04	7.710E-04	8.706E-04	1.002E-03	1.181E-03	3.933E-04
Am242m	4.503E-06	4.463E-06	4.422E-06	4.382E-06	4.322E-06	4.225E-06	4.843E-08
Am242	4.481E-06	4.440E-06	4.400E-06	4.360E-06	4.301E-06	4.204E-06	4.818E-08
Am243	1.418E-06	1.417E-06	1.417E-06	1.417E-06	1.417E-06	1.416E-06	1.291E-06
Cm242	4.791E-06	3.727E-06	3.648E-06	3.612E-06	3.564E-06	3.478E-06	3.985E-08
Cm243	1.833E-06	1.746E-06	1.663E-06	1.584E-06	1.473E-06	1.304E-06	5.811E-17
Cm244	5.068E-05	4.695E-05	4.349E-05	4.028E-05	3.591E-05	2.966E-05	1.521E-21
Cm245	2.611E-09	2.611E-09	2.611E-09	2.610E-09	2.610E-09	2.608E-09	2.408E-09
Cm246	2.216E-10	2.215E-10	2.214E-10	2.214E-10	2.213E-10	2.211E-10	1.915E-10
Cm247	2.630E-16	2.630E-16	2.630E-16	2.630E-16	2.630E-16	2.630E-16	2.630E-16
Cm248	2.496E-16	2.496E-16	2.496E-16	2.496E-16	2.496E-16	2.496E-16	2.491E-16
Bk249	3.966E-15	8.150E-16	1.675E-16	3.445E-17	3.219E-18	8.495E-20	0.00
Cf249	1.342E-15	1.345E-15	1.341E-15	1.336E-15	1.328E-15	1.315E-15	1.894E-16
Cf250	3.193E-15	2.872E-15	2.583E-15	2.324E-15	1.982E-15	1.521E-15	0.00
Cf252	2.605E-16	1.540E-16	9.106E-17	5.383E-17	2.448E-17	6.575E-18	0.00
TOTAL	4.217E-02	3.856E-02	3.527E-02	3.229E-02	2.832E-02	2.285E-02	8.914E-04

TABLE F.2.b. Actinide Radioactivity by Isotope at 20 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Tl207	2.780E-12	3.589E-12	4.410E-12	5.244E-12	6.519E-12	8.698E-12	5.288E-10
Tl208	2.972E-09	3.424E-09	3.702E-09	3.860E-09	3.948E-09	3.897E-09	3.949E-13
Tl209	1.434E-15	1.495E-15	1.562E-15	1.634E-15	1.754E-15	1.984E-15	1.591E-12
Pb209	6.640E-14	6.921E-14	7.229E-14	7.566E-14	8.122E-14	9.186E-14	7.368E-11
Pb210	1.742E-14	2.973E-14	4.683E-14	6.940E-14	1.149E-13	2.269E-13	2.205E-09
Pb211	2.788E-12	3.599E-12	4.422E-12	5.259E-12	6.537E-12	8.723E-12	5.302E-10
Pb212	8.273E-09	9.529E-09	1.030E-08	1.074E-08	1.099E-08	1.085E-08	1.099E-12
Pb214	1.812E-13	2.648E-13	3.647E-13	4.807E-13	6.854E-13	1.109E-12	2.206E-09
Bi210	1.742E-14	2.974E-14	4.684E-14	6.943E-14	1.150E-13	2.270E-13	2.205E-09
Bi211	2.788E-12	3.599E-12	4.422E-12	5.259E-12	6.537E-12	8.723E-12	5.302E-10
Bi212	8.273E-09	9.529E-09	1.030E-08	1.074E-08	1.099E-08	1.085E-08	1.099E-12
Bi213	6.640E-14	6.921E-14	7.229E-14	7.566E-14	8.122E-14	9.186E-14	7.368E-11
Bi214	1.812E-13	2.648E-13	3.647E-13	4.807E-13	6.854E-13	1.109E-12	2.206E-09
Po210	1.742E-14	2.594E-14	4.149E-14	6.235E-14	1.052E-13	2.270E-13	2.205E-09
Po211	7.806E-15	1.008E-14	1.238E-14	1.473E-14	1.830E-14	2.442E-14	1.485E-12
Po212	5.300E-09	6.105E-09	6.602E-09	6.883E-09	7.039E-09	6.949E-09	7.041E-13
Po213	6.497E-14	6.771E-14	7.073E-14	7.402E-14	7.947E-14	8.988E-14	7.209E-11
Po214	1.811E-13	2.648E-13	3.646E-13	4.806E-13	6.853E-13	1.109E-12	2.205E-09
Po215	2.788E-12	3.599E-12	4.422E-12	5.259E-12	6.537E-12	8.723E-12	5.302E-10
Po216	8.273E-09	9.529E-09	1.030E-08	1.074E-08	1.099E-08	1.085E-08	1.099E-12
Po218	1.812E-13	2.649E-13	3.647E-13	4.808E-13	6.856E-13	1.109E-12	2.206E-09
At217	6.640E-14	6.921E-14	7.229E-14	7.566E-14	8.122E-14	9.186E-14	7.368E-11
Rn219	2.788E-12	3.599E-12	4.422E-12	5.259E-12	6.537E-12	8.723E-12	5.302E-10
Rn220	8.273E-09	9.529E-09	1.030E-08	1.074E-08	1.099E-08	1.085E-08	1.099E-12
Rn222	1.812E-13	2.649E-13	3.647E-13	4.808E-13	6.856E-13	1.109E-12	2.206E-09
Fr221	6.640E-14	6.921E-14	7.229E-14	7.566E-14	8.122E-14	9.186E-14	7.368E-11
Fr223	3.845E-14	4.959E-14	6.092E-14	7.244E-14	9.006E-14	1.202E-13	7.317E-12
Ra223	2.788E-12	3.599E-12	4.422E-12	5.259E-12	6.537E-12	8.723E-12	5.302E-10
Ra224	8.273E-09	9.529E-09	1.030E-08	1.074E-08	1.099E-08	1.085E-08	1.099E-12
Ra225	6.640E-14	6.921E-14	7.229E-14	7.566E-14	8.122E-14	9.186E-14	7.368E-11
Ra226	1.812E-13	2.649E-13	3.647E-13	4.808E-13	6.856E-13	1.109E-12	2.206E-09
Ac225	6.640E-14	6.921E-14	7.229E-14	7.566E-14	8.122E-14	9.186E-14	7.368E-11
Ac227	2.786E-12	3.593E-12	4.415E-12	5.250E-12	6.526E-12	8.710E-12	5.303E-10
Th227	2.750E-12	3.550E-12	4.361E-12	5.187E-12	6.447E-12	8.602E-12	5.229E-10
Th228	8.270E-09	9.508E-09	1.028E-08	1.072E-08	1.097E-08	1.084E-08	1.099E-12
Th229	6.640E-14	6.921E-14	7.229E-14	7.566E-14	8.122E-14	9.186E-14	7.368E-11
Th230	8.743E-11	1.062E-10	1.250E-10	1.439E-10	1.724E-10	2.204E-10	1.193E-08
Th231	2.461E-08	2.461E-08	2.461E-08	2.461E-08	2.461E-08	2.461E-08	2.489E-08
Th232	7.124E-17	8.868E-17	1.061E-16	1.236E-16	1.497E-16	1.934E-16	8.986E-15
Th234	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07
Pa231	1.534E-11	1.638E-11	1.742E-11	1.847E-11	2.003E-11	2.263E-11	5.301E-10

TABLE F.2.b. Actinide Radioactivity by Isotope at 20 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Pa233	1.596E-07	1.601E-07	1.608E-07	1.616E-07	1.630E-07	1.657E-07	6.133E-07
Pa234m	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07
Pa234	4.187E-10	4.187E-10	4.187E-10	4.187E-10	4.187E-10	4.187E-10	4.187E-10
U232	1.036E-08	1.086E-08	1.109E-08	1.114E-08	1.104E-08	1.066E-08	1.067E-12
U233	1.415E-11	1.562E-11	1.710E-11	1.858E-11	2.079E-11	2.438E-11	1.921E-09
U234	1.037E-06	1.042E-06	1.048E-06	1.053E-06	1.060E-06	1.072E-06	1.371E-06
U235	2.461E-08	2.461E-08	2.461E-08	2.461E-08	2.461E-08	2.461E-08	2.489E-08
U236	1.768E-07	1.768E-07	1.768E-07	1.768E-07	1.769E-07	1.769E-07	1.867E-07
U237	1.500E-06	1.363E-06	1.238E-06	1.124E-06	9.728E-07	7.647E-07	3.334E-13
U238	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07	3.221E-07
U240	4.830E-14	4.830E-14	4.830E-14	4.830E-14	4.830E-14	4.830E-14	4.830E-14
Np235	4.756E-11	1.325E-11	3.688E-12	1.027E-12	1.509E-13	6.177E-15	0.00
Np236	2.363E-12	2.363E-12	2.363E-12	2.363E-12	2.363E-12	2.363E-12	2.349E-12
Np237	1.596E-07	1.601E-07	1.608E-07	1.616E-07	1.630E-07	1.657E-07	6.133E-07
Np238	3.496E-08	3.464E-08	3.433E-08	3.401E-08	3.355E-08	3.280E-08	3.759E-10
Np239	4.208E-06	4.207E-06	4.207E-06	4.206E-06	4.205E-06	4.203E-06	3.833E-06
Np240m	4.830E-14	4.830E-14	4.830E-14	4.830E-14	4.830E-14	4.830E-14	4.830E-14
Pu236	4.644E-08	2.856E-08	1.756E-08	1.080E-08	5.208E-09	1.544E-09	2.114E-13
Pu238	9.290E-04	9.146E-04	9.003E-04	8.863E-04	8.657E-04	8.324E-04	5.032E-07
Pu239	2.903E-04	2.903E-04	2.903E-04	2.903E-04	2.902E-04	2.902E-04	2.822E-04
Pu240	3.541E-04	3.540E-04	3.540E-04	3.540E-04	3.539E-04	3.538E-04	3.192E-04
Pu241	6.116E-02	5.554E-02	5.045E-02	4.582E-02	3.965E-02	3.117E-02	1.361E-08
Pu242	6.732E-07	6.732E-07	6.732E-07	6.732E-07	6.732E-07	6.732E-07	6.725E-07
Pu243	2.952E-15	2.952E-15	2.952E-15	2.952E-15	2.952E-15	2.952E-15	2.951E-15
Pu244	4.836E-14	4.836E-14	4.836E-14	4.836E-14	4.836E-14	4.836E-14	4.836E-14
Am241	8.002E-04	9.844E-04	1.151E-03	1.301E-03	1.500E-03	1.769E-03	5.906E-04
Am242m	6.991E-06	6.928E-06	6.865E-06	6.802E-06	6.710E-06	6.559E-06	7.517E-08
Am242	6.956E-06	6.893E-06	6.831E-06	6.768E-06	6.677E-06	6.526E-06	7.480E-08
Am243	4.208E-06	4.207E-06	4.207E-06	4.206E-06	4.205E-06	4.203E-06	3.833E-06
Cm242	7.913E-06	5.808E-06	5.663E-06	5.608E-06	5.533E-06	5.399E-06	6.186E-08
Cm243	5.150E-06	4.906E-06	4.673E-06	4.451E-06	4.138E-06	3.664E-06	1.633E-16
Cm244	2.181E-04	2.021E-04	1.872E-04	1.734E-04	1.546E-04	1.277E-04	6.546E-21
Cm245	1.473E-08	1.473E-08	1.473E-08	1.472E-08	1.472E-08	1.471E-08	1.358E-08
Cm246	1.797E-09	1.796E-09	1.796E-09	1.795E-09	1.794E-09	1.793E-09	1.553E-09
Cm247	2.952E-15	2.952E-15	2.952E-15	2.952E-15	2.952E-15	2.952E-15	2.951E-15
Cm248	3.905E-15	3.905E-15	3.905E-15	3.905E-15	3.905E-15	3.905E-15	3.897E-15
Bk249	8.060E-14	1.656E-14	3.404E-15	6.997E-16	6.519E-17	1.239E-18	0.00
Cf249	2.695E-14	2.700E-14	2.693E-14	2.683E-14	2.667E-14	2.641E-14	3.802E-15
Cf250	7.719E-14	6.943E-14	6.245E-14	5.617E-14	4.791E-14	3.676E-14	1.197E-23
Cf251	4.663E-16	4.656E-16	4.649E-16	4.642E-16	4.631E-16	4.613E-16	2.165E-16
Cf252	1.050E-14	6.209E-15	3.671E-15	2.170E-15	9.868E-16	2.652E-16	0.00
TOTAL	6.379E-02	5.833E-02	5.337E-02	4.886E-02	4.285E-02	3.458E-02	1.205E-03

TABLE F.2.c. Actinide Radioactivity by Isotope at 25 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Tl207	2.861E-12	3.664E-12	4.465E-12	5.268E-12	6.471E-12	8.481E-12	4.187E-10
Tl208	4.646E-09	5.399E-09	5.869E-09	6.139E-09	6.296E-09	6.227E-09	6.216E-13
Tl209	2.198E-15	2.269E-15	2.348E-15	2.435E-15	2.580E-15	2.863E-15	2.095E-12
Pb209	1.018E-13	1.050E-13	1.087E-13	1.127E-13	1.195E-13	1.325E-13	9.699E-11
Pb210	1.659E-14	2.790E-14	4.363E-14	6.444E-14	1.065E-13	2.104E-13	2.379E-09
Pb211	2.869E-12	3.674E-12	4.478E-12	5.282E-12	6.490E-12	8.505E-12	4.199E-10
Pb212	1.293E-08	1.503E-08	1.633E-08	1.709E-08	1.752E-08	1.733E-08	1.730E-12
Pb214	1.668E-13	2.440E-13	3.364E-13	4.440E-13	6.343E-13	1.030E-12	2.379E-09
Bi210	1.659E-14	2.790E-14	4.365E-14	6.447E-14	1.066E-13	2.104E-13	2.379E-09
Bi211	2.869E-12	3.674E-12	4.478E-12	5.282E-12	6.490E-12	8.505E-12	4.199E-10
Bi212	1.293E-08	1.503E-08	1.633E-08	1.709E-08	1.752E-08	1.733E-08	1.730E-12
Bi213	1.018E-13	1.050E-13	1.087E-13	1.127E-13	1.195E-13	1.325E-13	9.699E-11
Bi214	1.668E-13	2.440E-13	3.364E-13	4.440E-13	6.343E-13	1.030E-12	2.379E-09
Po210	1.659E-14	2.441E-14	3.871E-14	5.794E-14	9.748E-14	2.104E-13	2.379E-09
Po211	8.034E-15	1.029E-14	1.254E-14	1.479E-14	1.817E-14	2.381E-14	1.176E-12
Po212	8.284E-09	9.627E-09	1.047E-08	1.095E-08	1.123E-08	1.110E-08	1.108E-12
Po213	9.957E-14	1.028E-13	1.063E-13	1.103E-13	1.169E-13	1.297E-13	9.489E-11
Po214	1.668E-13	2.440E-13	3.363E-13	4.439E-13	6.342E-13	1.029E-12	2.379E-09
Po215	2.869E-12	3.674E-12	4.478E-12	5.282E-12	6.490E-12	8.505E-12	4.199E-10
Po216	1.293E-08	1.503E-08	1.633E-08	1.709E-08	1.752E-08	1.733E-08	1.730E-12
Po218	1.668E-13	2.441E-13	3.364E-13	4.441E-13	6.345E-13	1.030E-12	2.380E-09
At217	1.018E-13	1.050E-13	1.087E-13	1.127E-13	1.195E-13	1.325E-13	9.699E-11
Rn219	2.869E-12	3.674E-12	4.478E-12	5.282E-12	6.490E-12	8.505E-12	4.199E-10
Rn220	1.293E-08	1.503E-08	1.633E-08	1.709E-08	1.752E-08	1.733E-08	1.730E-12
Rn222	1.668E-13	2.441E-13	3.364E-13	4.441E-13	6.345E-13	1.030E-12	2.380E-09
Fr221	1.018E-13	1.050E-13	1.087E-13	1.127E-13	1.195E-13	1.325E-13	9.699E-11
Fr223	3.957E-14	5.062E-14	6.169E-14	7.276E-14	8.940E-14	1.172E-13	5.794E-12
Ra223	2.869E-12	3.674E-12	4.478E-12	5.282E-12	6.490E-12	8.505E-12	4.199E-10
Ra224	1.293E-08	1.503E-08	1.633E-08	1.709E-08	1.752E-08	1.733E-08	1.730E-12
Ra225	1.018E-13	1.050E-13	1.087E-13	1.127E-13	1.195E-13	1.325E-13	9.699E-11
Ra226	1.668E-13	2.441E-13	3.364E-13	4.441E-13	6.345E-13	1.030E-12	2.380E-09
Ac225	1.018E-13	1.050E-13	1.087E-13	1.127E-13	1.195E-13	1.325E-13	9.699E-11
Ac227	2.867E-12	3.668E-12	4.470E-12	5.273E-12	6.478E-12	8.492E-12	4.199E-10
Th227	2.830E-12	3.624E-12	4.416E-12	5.210E-12	6.400E-12	8.387E-12	4.141E-10
Th228	1.293E-08	1.499E-08	1.630E-08	1.704E-08	1.749E-08	1.731E-08	1.730E-12
Th229	1.018E-13	1.050E-13	1.087E-13	1.127E-13	1.195E-13	1.325E-13	9.699E-11
Th230	8.060E-11	9.809E-11	1.157E-10	1.335E-10	1.605E-10	2.062E-10	1.303E-08
Th231	1.930E-08	1.930E-08	1.930E-08	1.930E-08	1.930E-08	1.930E-08	1.959E-08
Th234	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07
Pa231	1.543E-11	1.625E-11	1.707E-11	1.789E-11	1.911E-11	2.115E-11	4.197E-10
Pa233	2.159E-07	2.167E-07	2.175E-07	2.186E-07	2.203E-07	2.238E-07	8.025E-07
Pa234m	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07

TABLE F.2.c. Actinide Radioactivity by Isotope at 25 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Pa234	4.169E-10	4.169E-10	4.169E-10	4.169E-10	4.169E-10	4.169E-10	4.169E-10
U232	1.640E-08	1.727E-08	1.767E-08	1.778E-08	1.764E-08	1.705E-08	1.682E-12
U233	1.638E-11	1.837E-11	2.037E-11	2.238E-11	2.536E-11	3.021E-11	2.523E-09
U234	9.676E-07	9.763E-07	9.848E-07	9.932E-07	1.006E-06	1.026E-06	1.524E-06
U235	1.930E-08	1.930E-08	1.930E-08	1.930E-08	1.930E-08	1.930E-08	1.959E-08
U236	1.999E-07	1.999E-07	1.999E-07	1.999E-07	2.000E-07	2.001E-07	2.121E-07
U237	1.945E-06	1.767E-06	1.605E-06	1.457E-06	1.261E-06	9.915E-07	1.186E-12
U238	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07	3.207E-07
U240	1.442E-13	1.442E-13	1.442E-13	1.442E-13	1.442E-13	1.442E-13	1.442E-13
Np235	7.572E-11	2.109E-11	5.872E-12	1.635E-12	2.403E-13	9.834E-15	0.00
Np236	3.516E-12	3.516E-12	3.516E-12	3.516E-12	3.515E-12	3.515E-12	3.495E-12
Np237	2.159E-07	2.167E-07	2.175E-07	2.186E-07	2.203E-07	2.238E-07	8.025E-07
Np238	4.499E-08	4.458E-08	4.418E-08	4.378E-08	4.318E-08	4.221E-08	4.838E-10
Np239	9.250E-06	9.248E-06	9.246E-06	9.244E-06	9.242E-06	9.237E-06	8.425E-06
Np240m	1.442E-13	1.442E-13	1.442E-13	1.442E-13	1.442E-13	1.442E-13	1.442E-13
Pu236	7.847E-08	4.825E-08	2.967E-08	1.825E-08	8.799E-09	2.609E-09	3.145E-13
Pu238	1.547E-03	1.523E-03	1.499E-03	1.475E-03	1.441E-03	1.385E-03	7.841E-07
Pu239	3.036E-04	3.036E-04	3.036E-04	3.036E-04	3.035E-04	3.035E-04	2.953E-04
Pu240	4.371E-04	4.372E-04	4.372E-04	4.372E-04	4.372E-04	4.372E-04	3.950E-04
Pu241	7.930E-02	7.202E-02	6.541E-02	5.940E-02	5.142E-02	4.042E-02	4.841E-08
Pu242	1.160E-06	1.160E-06	1.160E-06	1.160E-06	1.160E-06	1.160E-06	1.158E-06
Pu243	1.841E-14	1.841E-14	1.841E-14	1.841E-14	1.841E-14	1.841E-14	1.841E-14
Pu244	1.443E-13	1.443E-13	1.443E-13	1.443E-13	1.443E-13	1.443E-13	1.443E-13
Am241	1.027E-03	1.266E-03	1.481E-03	1.676E-03	1.934E-03	2.283E-03	7.636E-04
Am242m	8.998E-06	8.916E-06	8.835E-06	8.755E-06	8.636E-06	8.441E-06	9.675E-08
Am242	8.953E-06	8.871E-06	8.791E-06	8.711E-06	8.593E-06	8.399E-06	9.627E-08
Am243	9.250E-06	9.248E-06	9.246E-06	9.244E-06	9.242E-06	9.237E-06	8.425E-06
Cm242	1.088E-05	7.506E-06	7.290E-06	7.217E-06	7.121E-06	6.949E-06	7.961E-08
Cm243	1.066E-05	1.015E-05	9.668E-06	9.209E-06	8.561E-06	7.581E-06	3.378E-16
Cm244	6.423E-04	5.950E-04	5.512E-04	5.105E-04	4.552E-04	3.759E-04	1.927E-20
Cm245	5.241E-08	5.240E-08	5.239E-08	5.239E-08	5.237E-08	5.235E-08	4.833E-08
Cm246	8.590E-09	8.587E-09	8.585E-09	8.582E-09	8.578E-09	8.572E-09	7.425E-09
Cm247	1.841E-14	1.841E-14	1.841E-14	1.841E-14	1.841E-14	1.841E-14	1.841E-14
Cm248	3.217E-14	3.217E-14	3.217E-14	3.217E-14	3.217E-14	3.217E-14	3.211E-14
Bk249	8.108E-13	1.666E-13	3.425E-14	7.038E-15	6.557E-16	1.258E-17	0.00
Cf249	2.689E-13	2.694E-13	2.687E-13	2.677E-13	2.661E-13	2.635E-13	3.794E-14
Cf250	8.787E-13	7.904E-13	7.109E-13	6.394E-13	5.454E-13	4.185E-13	1.857E-22
Cf251	6.006E-15	5.996E-15	5.987E-15	5.978E-15	5.964E-15	5.941E-15	2.789E-15
Cf252	1.784E-13	1.055E-13	6.236E-14	3.687E-14	1.676E-14	4.506E-15	0.00
TOTAL	8.332E-02	7.620E-02	6.974E-02	6.386E-02	5.604E-02	4.526E-02	1.477E-03

TABLE F.2.d. Actinide Radioactivity by Isotope at 30 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Tl207	2.880E-12	3.667E-12	4.442E-12	5.208E-12	6.341E-12	8.190E-12	3.271E-10
Tl208	6.698E-09	7.836E-09	8.553E-09	8.968E-09	9.215E-09	9.128E-09	8.980E-13
Tl209	3.194E-15	3.273E-15	3.363E-15	3.462E-15	3.631E-15	3.963E-15	2.536E-12
Pb209	1.479E-13	1.515E-13	1.557E-13	1.603E-13	1.681E-13	1.835E-13	1.174E-10
Pb210	1.604E-14	2.637E-14	4.079E-14	5.992E-14	9.873E-14	1.950E-13	2.627E-09
Pb211	2.888E-12	3.678E-12	4.455E-12	5.223E-12	6.358E-12	8.213E-12	3.281E-10
Pb212	1.864E-08	2.181E-08	2.380E-08	2.496E-08	2.565E-08	2.540E-08	2.499E-12
Pb214	1.531E-13	2.242E-13	3.095E-13	4.093E-13	5.863E-13	9.560E-13	2.628E-09
Bi210	1.604E-14	2.638E-14	4.081E-14	5.995E-14	9.876E-14	1.950E-13	2.627E-09
Bi211	2.888E-12	3.678E-12	4.455E-12	5.223E-12	6.358E-12	8.213E-12	3.281E-10
Bi212	1.864E-08	2.181E-08	2.380E-08	2.496E-08	2.565E-08	2.540E-08	2.499E-12
Bi213	1.479E-13	1.515E-13	1.557E-13	1.603E-13	1.681E-13	1.835E-13	1.174E-10
Bi214	1.531E-13	2.242E-13	3.095E-13	4.093E-13	5.863E-13	9.560E-13	2.628E-09
Po210	1.604E-14	2.317E-14	3.628E-14	5.394E-14	9.038E-14	1.950E-13	2.627E-09
Po211	8.087E-15	1.030E-14	1.247E-14	1.462E-14	1.780E-14	2.300E-14	9.185E-13
Po212	1.194E-08	1.397E-08	1.525E-08	1.599E-08	1.643E-08	1.628E-08	1.601E-12
Po213	1.447E-13	1.483E-13	1.523E-13	1.568E-13	1.645E-13	1.795E-13	1.149E-10
Po214	1.530E-13	2.241E-13	3.095E-13	4.092E-13	5.862E-13	9.558E-13	2.627E-09
Po215	2.888E-12	3.678E-12	4.455E-12	5.223E-12	6.358E-12	8.213E-12	3.281E-10
Po216	1.864E-08	2.181E-08	2.380E-08	2.496E-08	2.565E-08	2.540E-08	2.499E-12
Po218	1.531E-13	2.242E-13	3.096E-13	4.094E-13	5.864E-13	9.562E-13	2.628E-09
At217	1.479E-13	1.515E-13	1.557E-13	1.603E-13	1.681E-13	1.835E-13	1.174E-10
Rn219	2.888E-12	3.678E-12	4.455E-12	5.223E-12	6.358E-12	8.213E-12	3.281E-10
Rn220	1.864E-08	2.181E-08	2.380E-08	2.496E-08	2.565E-08	2.540E-08	2.499E-12
Rn222	1.531E-13	2.242E-13	3.096E-13	4.094E-13	5.864E-13	9.562E-13	2.628E-09
Fr221	1.479E-13	1.515E-13	1.557E-13	1.603E-13	1.681E-13	1.835E-13	1.174E-10
Fr223	3.983E-14	5.066E-14	6.137E-14	7.194E-14	8.759E-14	1.132E-13	4.527E-12
Ra223	2.888E-12	3.678E-12	4.455E-12	5.223E-12	6.358E-12	8.213E-12	3.281E-10
Ra224	1.864E-08	2.181E-08	2.380E-08	2.496E-08	2.565E-08	2.540E-08	2.499E-12
Ra225	1.479E-13	1.515E-13	1.557E-13	1.603E-13	1.681E-13	1.835E-13	1.174E-10
Ra226	1.531E-13	2.242E-13	3.096E-13	4.094E-13	5.864E-13	9.562E-13	2.628E-09
Ac225	1.479E-13	1.515E-13	1.557E-13	1.603E-13	1.681E-13	1.835E-13	1.174E-10
Ac227	2.886E-12	3.671E-12	4.447E-12	5.213E-12	6.347E-12	8.200E-12	3.281E-10
Th227	2.848E-12	3.627E-12	4.393E-12	5.151E-12	6.271E-12	8.099E-12	3.235E-10
Th228	1.864E-08	2.176E-08	2.375E-08	2.490E-08	2.560E-08	2.538E-08	2.499E-12
Th229	1.479E-13	1.515E-13	1.557E-13	1.603E-13	1.681E-13	1.835E-13	1.174E-10
Th230	7.411E-11	9.049E-11	1.071E-10	1.239E-10	1.496E-10	1.935E-10	1.456E-08
Th231	1.489E-08	1.489E-08	1.489E-08	1.489E-08	1.489E-08	1.489E-08	1.519E-08
Th234	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07
Pa231	1.529E-11	1.592E-11	1.655E-11	1.718E-11	1.813E-11	1.970E-11	3.279E-10
Pa233	2.732E-07	2.740E-07	2.751E-07	2.763E-07	2.783E-07	2.823E-07	9.585E-07

TABLE F.2.d. Actinide Radioactivity by Isotope at 30 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Pa234m	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07
Pa234	4.150E-10	4.150E-10	4.150E-10	4.150E-10	4.150E-10	4.150E-10	4.150E-10
U232	2.387E-08	2.522E-08	2.585E-08	2.604E-08	2.586E-08	2.500E-08	2.433E-12
U233	1.823E-11	2.075E-11	2.328E-11	2.582E-11	2.959E-11	3.571E-11	3.037E-09
U234	9.034E-07	9.164E-07	9.291E-07	9.417E-07	9.601E-07	9.899E-07	1.731E-06
U235	1.489E-08	1.489E-08	1.489E-08	1.489E-08	1.489E-08	1.489E-08	1.519E-08
U236	2.170E-07	2.170E-07	2.170E-07	2.170E-07	2.171E-07	2.172E-07	2.315E-07
U237	2.279E-06	2.070E-06	1.880E-06	1.708E-06	1.478E-06	1.162E-06	3.231E-12
U238	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07	3.192E-07
U240	3.460E-13	3.460E-13	3.460E-13	3.460E-13	3.460E-13	3.460E-13	3.460E-13
Np235	1.089E-10	3.032E-11	8.443E-12	2.351E-12	3.455E-13	1.414E-14	0.00
Np236	4.762E-12	4.762E-12	4.762E-12	4.762E-12	4.762E-12	4.762E-12	4.734E-12
Np237	2.732E-07	2.740E-07	2.751E-07	2.763E-07	2.783E-07	2.823E-07	9.585E-07
Np238	5.096E-08	5.050E-08	5.004E-08	4.959E-08	4.892E-08	4.781E-08	5.480E-10
Np239	1.697E-05	1.697E-05	1.697E-05	1.696E-05	1.696E-05	1.695E-05	1.546E-05
Np240m	3.460E-13	3.460E-13	3.460E-13	3.460E-13	3.460E-13	3.460E-13	3.460E-13
Pu236	1.196E-07	7.356E-08	4.523E-08	2.781E-08	1.341E-08	3.977E-09	4.260E-13
Pu238	2.303E-03	2.267E-03	2.232E-03	2.197E-03	2.146E-03	2.063E-03	1.103E-06
Pu239	3.121E-04	3.121E-04	3.121E-04	3.121E-04	3.121E-04	3.120E-04	3.038E-04
Pu240	5.156E-04	5.158E-04	5.160E-04	5.162E-04	5.164E-04	5.166E-04	4.678E-04
Pu241	9.292E-02	8.439E-02	7.665E-02	6.961E-02	6.025E-02	4.736E-02	1.319E-07
Pu242	1.731E-06	1.731E-06	1.731E-06	1.731E-06	1.731E-06	1.731E-06	1.728E-06
Pu243	8.006E-14	8.006E-14	8.006E-14	8.006E-14	8.006E-14	8.006E-14	8.006E-14
Pu244	3.465E-13	3.465E-13	3.465E-13	3.465E-13	3.465E-13	3.465E-13	3.465E-13
Am241	1.190E-03	1.470E-03	1.723E-03	1.952E-03	2.253E-03	2.663E-03	8.923E-04
Am242m	1.019E-05	1.010E-05	1.001E-05	9.918E-06	9.783E-06	9.562E-06	1.096E-07
Am242	1.014E-05	1.005E-05	9.958E-06	9.868E-06	9.734E-06	9.515E-06	1.091E-07
Am243	1.697E-05	1.697E-05	1.697E-05	1.696E-05	1.696E-05	1.695E-05	1.546E-05
Cm242	1.330E-05	8.546E-06	8.260E-06	8.176E-06	8.067E-06	7.872E-06	9.019E-08
Cm243	1.857E-05	1.769E-05	1.685E-05	1.605E-05	1.492E-05	1.321E-05	5.886E-16
Cm244	1.511E-03	1.400E-03	1.296E-03	1.201E-03	1.071E-03	8.841E-04	4.533E-20
Cm245	1.428E-07	1.427E-07	1.427E-07	1.427E-07	1.427E-07	1.426E-07	1.316E-07
Cm246	3.002E-08	3.001E-08	3.000E-08	3.000E-08	2.998E-08	2.996E-08	2.595E-08
Cm247	8.006E-14	8.006E-14	8.006E-14	8.006E-14	8.006E-14	8.006E-14	8.006E-14
Cm248	1.771E-13	1.771E-13	1.771E-13	1.771E-13	1.771E-13	1.771E-13	1.768E-13
Bk249	5.239E-12	1.077E-12	2.213E-13	4.548E-14	4.238E-15	8.111E-17	0.00
Cf249	1.720E-12	1.724E-12	1.719E-12	1.713E-12	1.703E-12	1.686E-12	2.427E-13
Cf250	6.213E-12	5.588E-12	5.027E-12	4.521E-12	3.857E-12	2.959E-12	1.658E-21
Cf251	4.648E-14	4.641E-14	4.633E-14	4.626E-14	4.616E-14	4.598E-14	2.158E-14
Cf252	1.756E-12	1.038E-12	6.138E-13	3.629E-13	1.650E-13	4.435E-14	0.00
TOTAL	9.885E-02	9.044E-02	8.281E-02	7.587E-02	6.663E-02	5.388E-02	1.703E-03

TABLE F.2.e. Actinide Radioactivity by Isotope at 35 MWd/kgM, Ci/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Tl207	2.845E-12	3.608E-12	4.351E-12	5.078E-12	6.139E-12	7.838E-12	2.533E-10
Tl208	9.091E-09	1.069E-08	1.171E-08	1.230E-08	1.266E-08	1.255E-08	1.218E-12
Tl209	4.431E-15	4.518E-15	4.616E-15	4.728E-15	4.918E-15	5.295E-15	2.979E-12
Pb209	2.052E-13	2.091E-13	2.137E-13	2.189E-13	2.277E-13	2.452E-13	1.379E-10
Pb210	1.580E-14	2.519E-14	3.836E-14	5.589E-14	9.159E-14	1.807E-13	2.936E-09
Pb211	2.853E-12	3.618E-12	4.363E-12	5.092E-12	6.156E-12	7.860E-12	2.540E-10
Pb212	2.530E-08	2.976E-08	3.258E-08	3.423E-08	3.523E-08	3.493E-08	3.390E-12
Pb214	1.400E-13	2.053E-13	2.841E-13	3.765E-13	5.413E-13	8.876E-13	2.936E-09
Bi210	1.581E-14	2.520E-14	3.837E-14	5.591E-14	9.162E-14	1.807E-13	2.936E-09
Bi211	2.853E-12	3.618E-12	4.363E-12	5.092E-12	6.156E-12	7.860E-12	2.540E-10
Bi212	2.530E-08	2.976E-08	3.258E-08	3.423E-08	3.523E-08	3.493E-08	3.390E-12
Bi213	2.052E-13	2.091E-13	2.137E-13	2.189E-13	2.277E-13	2.452E-13	1.379E-10
Bi214	1.400E-13	2.053E-13	2.841E-13	3.765E-13	5.413E-13	8.876E-13	2.936E-09
Po210	1.581E-14	2.228E-14	3.422E-14	5.039E-14	8.389E-14	1.807E-13	2.936E-09
Po211	7.988E-15	1.013E-14	1.222E-14	1.426E-14	1.724E-14	2.201E-14	7.113E-13
Po212	1.621E-08	1.907E-08	2.087E-08	2.193E-08	2.257E-08	2.238E-08	2.172E-12
Po213	2.007E-13	2.046E-13	2.091E-13	2.141E-13	2.228E-13	2.399E-13	1.349E-10
Po214	1.399E-13	2.053E-13	2.840E-13	3.764E-13	5.411E-13	8.875E-13	2.936E-09
Po215	2.853E-12	3.618E-12	4.363E-12	5.092E-12	6.156E-12	7.860E-12	2.540E-10
Po216	2.530E-08	2.976E-08	3.258E-08	3.423E-08	3.523E-08	3.493E-08	3.390E-12
Po218	1.400E-13	2.054E-13	2.842E-13	3.766E-13	5.414E-13	8.878E-13	2.937E-09
At217	2.052E-13	2.091E-13	2.137E-13	2.189E-13	2.277E-13	2.452E-13	1.379E-10
Rn219	2.853E-12	3.618E-12	4.363E-12	5.092E-12	6.156E-12	7.860E-12	2.540E-10
Rn220	2.530E-08	2.976E-08	3.258E-08	3.423E-08	3.523E-08	3.493E-08	3.390E-12
Rn222	1.400E-13	2.054E-13	2.842E-13	3.766E-13	5.414E-13	8.878E-13	2.937E-09
Fr221	2.052E-13	2.091E-13	2.137E-13	2.189E-13	2.277E-13	2.452E-13	1.379E-10
Fr223	3.935E-14	4.984E-14	6.010E-14	7.014E-14	8.480E-14	1.083E-13	3.506E-12
Ra223	2.853E-12	3.618E-12	4.363E-12	5.092E-12	6.156E-12	7.860E-12	2.540E-10
Ra224	2.530E-08	2.976E-08	3.258E-08	3.423E-08	3.523E-08	3.493E-08	3.390E-12
Ra225	2.052E-13	2.091E-13	2.137E-13	2.189E-13	2.277E-13	2.452E-13	1.379E-10
Ra226	1.400E-13	2.054E-13	2.842E-13	3.766E-13	5.414E-13	8.878E-13	2.937E-09
Ac225	2.052E-13	2.091E-13	2.137E-13	2.189E-13	2.277E-13	2.452E-13	1.379E-10
Ac227	2.851E-12	3.612E-12	4.355E-12	5.082E-12	6.145E-12	7.848E-12	2.540E-10
Th227	2.814E-12	3.568E-12	4.303E-12	5.022E-12	6.071E-12	7.752E-12	2.505E-10
Th228	2.530E-08	2.969E-08	3.250E-08	3.414E-08	3.517E-08	3.490E-08	3.390E-12
Th229	2.051E-13	2.091E-13	2.137E-13	2.189E-13	2.277E-13	2.452E-13	1.379E-10
Th230	6.798E-11	8.334E-11	9.902E-11	1.150E-10	1.396E-10	1.820E-10	1.645E-08
Th231	1.135E-08	1.135E-08	1.135E-08	1.135E-08	1.135E-08	1.135E-08	1.165E-08
Th234	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07
Pa231	1.494E-11	1.542E-11	1.590E-11	1.638E-11	1.710E-11	1.830E-11	2.540E-10
Pa233	3.300E-07	3.310E-07	3.322E-07	3.336E-07	3.359E-07	3.405E-07	1.116E-06

TABLE F.2.e. Actinide Radioactivity by Isotope at 35 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Pa234m	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07
Pa234	4.130E-10	4.130E-10	4.130E-10	4.130E-10	4.130E-10	4.130E-10	4.130E-10
U232	3.264E-08	3.457E-08	3.548E-08	3.577E-08	3.555E-08	3.439E-08	3.303E-12
U233	1.977E-11	2.282E-11	2.587E-11	2.894E-11	3.348E-11	4.087E-11	3.556E-09
U234	8.444E-07	8.622E-07	8.798E-07	8.970E-07	9.224E-07	9.634E-07	1.982E-06
U235	1.135E-08	1.135E-08	1.135E-08	1.135E-08	1.135E-08	1.135E-08	1.165E-08
U236	2.284E-07	2.284E-07	2.284E-07	2.285E-07	2.285E-07	2.286E-07	2.446E-07
U237	2.627E-06	2.386E-06	2.167E-06	1.968E-06	1.703E-06	1.339E-06	7.260E-12
U238	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07	3.177E-07
U240	7.118E-13	7.118E-13	7.118E-13	7.118E-13	7.118E-13	7.118E-13	7.118E-13
Np235	1.455E-10	4.052E-11	1.128E-11	3.142E-12	4.617E-13	1.890E-14	0.00
Np236	6.048E-12	6.048E-12	6.047E-12	6.047E-12	6.047E-12	6.047E-12	6.012E-12
Np237	3.300E-07	3.310E-07	3.322E-07	3.336E-07	3.359E-07	3.405E-07	1.116E-06
Np238	5.329E-08	5.281E-08	5.233E-08	5.185E-08	5.115E-08	5.000E-08	5.730E-10
Np239	2.767E-05	2.767E-05	2.766E-05	2.766E-05	2.765E-05	2.764E-05	2.521E-05
Np240m	7.118E-13	7.118E-13	7.118E-13	7.118E-13	7.118E-13	7.118E-13	7.118E-13
Pu236	1.694E-07	1.042E-07	6.405E-08	3.938E-08	1.899E-08	5.632E-09	5.410E-13
Pu238	3.168E-03	3.119E-03	3.070E-03	3.022E-03	2.951E-03	2.837E-03	1.448E-06
Pu239	3.168E-04	3.168E-04	3.168E-04	3.168E-04	3.168E-04	3.167E-04	3.087E-04
Pu240	5.746E-04	5.751E-04	5.756E-04	5.760E-04	5.765E-04	5.772E-04	5.247E-04
Pu241	1.071E-01	9.725E-02	8.832E-02	8.022E-02	6.943E-02	5.458E-02	2.963E-07
Pu242	2.366E-06	2.366E-06	2.366E-06	2.366E-06	2.366E-06	2.366E-06	2.363E-06
Pu243	2.731E-13	2.731E-13	2.731E-13	2.731E-13	2.731E-13	2.731E-13	2.731E-13
Pu244	7.128E-13	7.128E-13	7.128E-13	7.128E-13	7.128E-13	7.128E-13	7.128E-13
Am241	1.351E-03	1.674E-03	1.965E-03	2.229E-03	2.576E-03	3.049E-03	1.024E-03
Am242m	1.066E-05	1.056E-05	1.047E-05	1.037E-05	1.023E-05	9.999E-06	1.146E-07
Am242	1.060E-05	1.051E-05	1.041E-05	1.032E-05	1.018E-05	9.949E-06	1.140E-07
Am243	2.767E-05	2.767E-05	2.766E-05	2.766E-05	2.765E-05	2.764E-05	2.521E-05
Am245	3.635E-16	7.470E-17	1.535E-17	3.155E-18	2.940E-19	5.629E-21	0.00
Cm242	1.507E-05	8.989E-06	8.640E-06	8.550E-06	8.435E-06	8.231E-06	9.430E-08
Cm243	2.837E-05	2.703E-05	2.574E-05	2.452E-05	2.280E-05	2.019E-05	8.994E-16
Cm244	3.022E-03	2.799E-03	2.593E-03	2.402E-03	2.141E-03	1.768E-03	9.066E-20
Cm245	3.208E-07	3.208E-07	3.207E-07	3.207E-07	3.206E-07	3.205E-07	2.958E-07
Cm246	8.458E-08	8.456E-08	8.454E-08	8.451E-08	8.447E-08	8.441E-08	7.312E-08
Cm247	2.731E-13	2.731E-13	2.731E-13	2.731E-13	2.731E-13	2.731E-13	2.731E-13
Cm248	7.440E-13	7.440E-13	7.441E-13	7.441E-13	7.441E-13	7.441E-13	7.426E-13
Bk249	2.506E-11	5.150E-12	1.058E-12	2.175E-13	2.027E-14	3.881E-16	0.00
Bk250	1.577E-16	2.515E-17	4.028E-18	6.512E-19	6.347E-20	2.962E-20	1.063E-20
Cf249	8.157E-12	8.174E-12	8.152E-12	8.122E-12	8.075E-12	7.995E-12	1.151E-12
Cf250	3.182E-11	2.862E-11	2.575E-11	2.316E-11	1.975E-11	1.516E-11	1.063E-20

TABLE F.2.e. Actinide Radioactivity by Isotope at 35 MWd/kgM, Ci/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cf251	2.549E-13	2.545E-13	2.542E-13	2.538E-13	2.532E-13	2.522E-13	1.184E-13
Cf252	1.191E-11	7.041E-12	4.163E-12	2.462E-12	1.119E-12	3.008E-13	0.00
Es254	1.576E-16	2.511E-17	4.015E-18	6.291E-19	5.239E-20	1.856E-20	0.00
TOTAL	1.156E-01	1.059E-01	9.696E-02	8.888E-02	7.811E-02	6.324E-02	1.918E-03

TABLE F.3.a. Fission Product Inventory by Isotope at 15 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	1.716E-08	1.534E-08	1.371E-08	1.225E-08	1.035E-08	7.820E-09	1.008E-32
Li 6	1.267E-10	1.267E-10	1.267E-10	1.267E-10	1.267E-10	1.267E-10	1.267E-10
Li 7	4.612E-12	4.612E-12	4.612E-12	4.612E-12	4.612E-12	4.612E-12	4.612E-12
Be 9	8.884E-12	8.884E-12	8.884E-12	8.884E-12	8.884E-12	8.884E-12	8.884E-12
Be 10	5.926E-11	5.926E-11	5.926E-11	5.926E-11	5.926E-11	5.926E-11	5.924E-11
C 14	1.197E-11	1.197E-11	1.197E-11	1.196E-11	1.196E-11	1.195E-11	1.062E-11
Zn 66	1.853E-14	1.853E-14	1.853E-14	1.853E-14	1.853E-14	1.853E-14	1.853E-14
Zn 67	7.777E-16	7.777E-16	7.777E-16	7.777E-16	7.777E-16	7.777E-16	7.777E-16
Ga 71	3.774E-13	3.774E-13	3.774E-13	3.774E-13	3.774E-13	3.774E-13	3.774E-13
Ge 72	9.562E-09	9.562E-09	9.562E-09	9.562E-09	9.562E-09	9.562E-09	9.562E-09
Ge 73	2.085E-08	2.085E-08	2.085E-08	2.085E-08	2.085E-08	2.085E-08	2.085E-08
Ge 74	4.432E-08	4.432E-08	4.432E-08	4.432E-08	4.432E-08	4.432E-08	4.432E-08
As 75	9.486E-08	9.486E-08	9.486E-08	9.486E-08	9.486E-08	9.486E-08	9.486E-08
Ge 76	2.371E-07	2.371E-07	2.371E-07	2.371E-07	2.371E-07	2.371E-07	2.371E-07
Se 76	1.208E-09	1.208E-09	1.208E-09	1.208E-09	1.208E-09	1.208E-09	1.208E-09
Se 77	5.004E-07	5.004E-07	5.004E-07	5.004E-07	5.004E-07	5.004E-07	5.004E-07
Se 78	1.105E-06	1.105E-06	1.105E-06	1.105E-06	1.105E-06	1.105E-06	1.105E-06
Se 79	2.760E-06	2.760E-06	2.760E-06	2.760E-06	2.760E-06	2.760E-06	2.731E-06
Br 79	2.365E-10	2.954E-10	3.543E-10	4.132E-10	5.015E-10	6.488E-10	2.936E-08
Se 80	6.293E-06	6.293E-06	6.293E-06	6.293E-06	6.293E-06	6.293E-06	6.293E-06
Kr 80	8.728E-11	8.728E-11	8.728E-11	8.728E-11	8.728E-11	8.728E-11	8.728E-11
Br 81	1.053E-05	1.053E-05	1.053E-05	1.053E-05	1.053E-05	1.053E-05	1.053E-05
Kr 81	5.888E-12	5.888E-12	5.888E-12	5.888E-12	5.888E-12	5.888E-12	5.869E-12
Se 82	1.620E-05	1.620E-05	1.620E-05	1.620E-05	1.620E-05	1.620E-05	1.620E-05
Kr 82	2.375E-07	2.375E-07	2.375E-07	2.375E-07	2.375E-07	2.375E-07	2.375E-07
Kr 83	2.304E-05	2.304E-05	2.304E-05	2.304E-05	2.304E-05	2.304E-05	2.304E-05
Kr 84	5.201E-05	5.201E-05	5.201E-05	5.201E-05	5.201E-05	5.201E-05	5.201E-05
Kr 85	7.645E-06	6.717E-06	5.902E-06	5.186E-06	4.272E-06	3.092E-06	9.358E-34
Rb 85	5.206E-05	5.299E-05	5.380E-05	5.452E-05	5.543E-05	5.661E-05	5.970E-05
Kr 86	9.383E-05	9.383E-05	9.383E-05	9.383E-05	9.383E-05	9.383E-05	.383E-05
Sr 86	9.209E-08	9.209E-08	9.209E-08	9.209E-08	9.209E-08	9.209E-08	9.209E-08
Rb 87	1.208E-04	1.208E-04	1.208E-04	1.208E-04	1.208E-04	1.208E-04	1.208E-04
Sr 87	7.233E-10	7.233E-10	7.233E-10	7.233E-10	7.233E-10	7.233E-10	7.251E-10
Sr 88	1.735E-04	1.735E-04	1.735E-04	1.735E-04	1.735E-04	1.735E-04	1.735E-04
Y 89	2.273E-04	2.273E-04	2.273E-04	2.273E-04	2.273E-04	2.273E-04	2.273E-04
Sr 90	2.272E-04	2.166E-04	2.066E-04	1.970E-04	1.834E-04	1.628E-04	1.206E-14
Y 90	5.697E-08	5.433E-08	5.180E-08	4.939E-08	4.599E-08	4.083E-08	3.024E-18
Zr 90	4.819E-05	5.875E-05	6.883E-05	7.843E-05	9.201E-05	1.126E-04	2.754E-04
Y 91	9.563E-17	1.667E-20	2.907E-24	5.068E-28	1.167E-33	0.00	0.00
Zr 91	2.909E-04	2.909E-04	2.909E-04	2.909E-04	2.909E-04	2.909E-04	2.909E-04
Zr 92	3.107E-04	3.107E-04	3.107E-04	3.107E-04	3.107E-04	3.107E-04	3.107E-04
Zr 93	3.472E-04	3.472E-04	3.472E-04	3.472E-04	3.472E-04	3.472E-04	3.471E-04

TABLE F.3.a. Fission Product Inventory by Isotope at 15 MWd/kgM, g/gU (contd)

Nb 93	2.839E-10	4.093E-10	5.531E-10	7.134E-10	9.815E-10	1.490E-09	1.547E-07
Nb 93m	9.800E-10	1.169E-09	1.340E-09	1.494E-09	1.698E-09	1.976E-09	2.931E-09
Zr 94	3.491E-04	3.491E-04	3.491E-04	3.491E-04	3.491E-04	3.491E-04	3.491E-04
Nb 94	2.801E-10	2.801E-10	2.801E-10	2.800E-10	2.800E-10	2.800E-10	2.708E-10
Zr 95	1.302E-15	4.760E-19	1.740E-22	6.363E-26	4.448E-31	0.00	0.00
Nb 95	1.588E-15	5.805E-19	2.123E-22	7.760E-26	4.055E-33	0.00	0.00
Mo 95	3.643E-04	3.643E-04	3.643E-04	3.643E-04	3.643E-04	3.643E-04	3.643E-04
Zr 96	3.735E-04	3.735E-04	3.735E-04	3.735E-04	3.735E-04	3.735E-04	3.735E-04
Mo 96	7.601E-06	7.601E-06	7.601E-06	7.601E-06	7.601E-06	7.601E-06	7.601E-06
Mo 97	3.656E-04	3.656E-04	3.656E-04	3.656E-04	3.656E-04	3.656E-04	3.656E-04
Mo 98	3.761E-04	3.761E-04	3.761E-04	3.761E-04	3.761E-04	3.761E-04	3.761E-04
Tc 98	1.328E-09	1.328E-09	1.328E-09	1.328E-09	1.328E-09	1.328E-09	1.328E-09
Tc 99	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.714E-04
Ru 99	9.601E-09	1.203E-08	1.445E-08	1.687E-08	2.051E-08	2.657E-08	1.213E-06
Mo100	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04	4.214E-04
Ru100	2.014E-05	2.014E-05	2.014E-05	2.014E-05	2.014E-05	2.014E-05	2.014E-05
Ru101	3.524E-04	3.524E-04	3.524E-04	3.524E-04	3.524E-04	3.524E-04	3.524E-04
Ru102	3.309E-04	3.309E-04	3.309E-04	3.309E-04	3.309E-04	3.309E-04	3.309E-04
Rh102	5.051E-11	3.131E-11	1.941E-11	1.204E-11	5.876E-12	1.779E-12	0.00
Rh103	2.381E-04	2.381E-04	2.381E-04	2.381E-04	2.381E-04	2.381E-04	2.381E-04
Ru104	2.158E-04	2.158E-04	2.158E-04	2.158E-04	2.158E-04	2.158E-04	2.158E-04
Pd104	4.977E-05	4.977E-05	4.977E-05	4.977E-05	4.977E-05	4.977E-05	4.977E-05
Pd105	1.533E-04	1.533E-04	1.533E-04	1.533E-04	1.533E-04	1.533E-04	1.533E-04
Ru106	7.433E-07	1.879E-07	4.749E-08	1.200E-08	1.525E-09	4.900E-11	0.00
Rh106	6.987E-13	1.766E-13	4.464E-14	1.128E-14	1.434E-15	4.606E-17	0.00
Pd106	1.168E-04	1.174E-04	1.175E-04	1.176E-04	1.176E-04	1.176E-04	1.176E-04
Pd107	7.472E-05	7.472E-05	7.472E-05	7.472E-05	7.472E-05	7.472E-05	7.471E-05
Ag107	6.001E-11	7.596E-11	9.190E-11	1.078E-10	1.318E-10	1.716E-10	7.985E-09
Pd108	5.035E-05	5.035E-05	5.035E-05	5.035E-05	5.035E-05	5.035E-05	5.035E-05
Ag108m	3.609E-13	3.570E-13	3.531E-13	3.493E-13	3.436E-13	3.344E-13	1.590E-15
Cd108	6.544E-11	6.544E-11	6.544E-11	6.544E-11	6.544E-11	6.544E-11	6.547E-11
Ag109	2.895E-05	2.895E-05	2.895E-05	2.895E-05	2.895E-05	2.895E-05	2.895E-05
Cd109	1.338E-15	4.492E-16	1.509E-16	5.066E-17	9.857E-18	6.441E-19	0.00
Pd110	1.675E-05	1.675E-05	1.675E-05	1.675E-05	1.675E-05	1.675E-05	1.675E-05
Ag110m	2.849E-10	3.755E-11	4.950E-12	6.526E-13	3.123E-14	1.971E-16	0.00
Cd110	5.589E-06	5.589E-06	5.589E-06	5.589E-06	5.589E-06	5.589E-06	5.589E-06
Cd111	9.819E-06	9.819E-06	9.819E-06	9.819E-06	9.819E-06	9.819E-06	9.819E-06
Cd112	6.207E-06	6.207E-06	6.207E-06	6.207E-06	6.207E-06	6.207E-06	6.207E-06
Cd113	1.294E-07	1.294E-07	1.294E-07	1.294E-07	1.294E-07	1.294E-07	1.294E-07
Cd113m	6.809E-08	6.192E-08	5.631E-08	5.120E-08	4.440E-08	3.501E-08	2.104E-28
In113	2.973E-08	3.589E-08	4.150E-08	4.660E-08	5.339E-08	6.277E-08	9.775E-08
Cd114	9.039E-06	9.039E-06	9.039E-06	9.039E-06	9.039E-06	9.039E-06	9.039E-06

TABLE F.3.a. Fission Product Inventory by Isotope at 15 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Sn114	3.155E-10	3.155E-10	3.155E-10	3.155E-10	3.155E-10	3.155E-10	3.155E-10
In115	1.868E-06	1.868E-06	1.868E-06	1.868E-06	1.868E-06	1.868E-06	1.868E-06
Sn115	1.403E-07	1.403E-07	1.403E-07	1.403E-07	1.403E-07	1.403E-07	1.403E-07
Cd116	3.599E-06	3.599E-06	3.599E-06	3.599E-06	3.599E-06	3.599E-06	3.599E-06
Sn116	2.272E-06	2.272E-06	2.272E-06	2.272E-06	2.272E-06	2.272E-06	2.272E-06
Sn117	3.655E-06	3.655E-06	3.655E-06	3.655E-06	3.655E-06	3.655E-06	3.655E-06
Sn118	3.693E-06	3.693E-06	3.693E-06	3.693E-06	3.693E-06	3.693E-06	3.693E-06
Sn119	3.669E-06	3.669E-06	3.669E-06	3.669E-06	3.669E-06	3.669E-06	3.669E-06
Sn119m	3.102E-11	3.928E-12	4.974E-13	6.298E-14	2.838E-15	1.619E-17	0.00
Sn120	3.750E-06	3.750E-06	3.750E-06	3.750E-06	3.750E-06	3.750E-06	3.750E-06
Sn121m	1.257E-09	1.222E-09	1.189E-09	1.156E-09	1.109E-09	1.035E-09	1.292E-15
Sb121	3.796E-06	3.796E-06	3.796E-06	3.796E-06	3.796E-06	3.796E-06	3.798E-06
Sn122	4.145E-06	4.145E-06	4.145E-06	4.145E-06	4.145E-06	4.145E-06	4.145E-06
Te122	1.153E-07	1.153E-07	1.153E-07	1.153E-07	1.153E-07	1.153E-07	1.153E-07
Sn123	1.097E-12	2.175E-14	4.316E-16	8.563E-18	2.394E-20	1.327E-24	0.00
Sn123	4.625E-06	4.625E-06	4.625E-06	4.625E-06	4.625E-06	4.625E-06	4.625E-06
Te123	9.873E-10	9.873E-10	9.873E-10	9.873E-10	9.873E-10	9.873E-10	9.873E-10
Te123m	3.736E-16	5.432E-18	7.896E-20	1.156E-21	0.00	0.00	0.00
Sn124	5.632E-06	5.632E-06	5.632E-06	5.632E-06	5.632E-06	5.632E-06	5.632E-06
Te124	8.685E-08	8.685E-08	8.685E-08	8.685E-08	8.685E-08	8.685E-08	8.685E-08
Sb125	1.195E-06	7.246E-07	4.393E-07	2.663E-07	1.257E-07	3.597E-08	0.00
Te125	6.916E-06	7.393E-06	7.683E-06	7.858E-06	8.001E-06	8.092E-06	8.128E-06
Te125m	1.672E-08	1.014E-08	6.146E-09	3.726E-09	1.758E-09	5.031E-10	0.00
Sn126	1.177E-05	1.177E-05	1.177E-05	1.177E-05	1.177E-05	1.177E-05	1.169E-05
Sb126	5.592E-13	5.592E-13	5.592E-13	5.592E-13	5.592E-13	5.592E-13	5.554E-13
Sb126m	4.252E-15	4.252E-15	4.252E-15	4.252E-15	4.252E-15	4.251E-15	4.223E-15
Te126	2.725E-07	2.727E-07	2.729E-07	2.730E-07	2.733E-07	2.737E-07	3.533E-07
Te127	1.484E-15	1.426E-17	1.370E-19	1.317E-21	1.240E-24	1.122E-29	0.00
Te127m	4.239E-13	4.073E-15	3.914E-17	3.761E-19	3.542E-22	3.205E-27	0.00
I127	2.389E-05	2.389E-05	2.389E-05	2.389E-05	2.389E-05	2.389E-05	2.389E-05
Te128	4.773E-05	4.773E-05	4.773E-05	4.773E-05	4.773E-05	4.773E-05	4.773E-05
Xe128	5.773E-07	5.773E-07	5.773E-07	5.773E-07	5.773E-07	5.773E-07	5.773E-07
I129	7.959E-05	7.959E-05	7.959E-05	7.959E-05	7.959E-05	7.959E-05	7.959E-05
Xe129	1.550E-09	1.557E-09	1.564E-09	1.571E-09	1.581E-09	1.599E-09	5.043E-09
Te130	1.552E-04	1.552E-04	1.552E-04	1.552E-04	1.552E-04	1.552E-04	1.552E-04
Xe130	2.464E-06	2.464E-06	2.464E-06	2.464E-06	2.464E-06	2.464E-06	2.464E-06
Xe131	2.313E-04	2.313E-04	2.313E-04	2.313E-04	2.313E-04	2.313E-04	2.313E-04
Xe132	4.412E-04	4.412E-04	4.412E-04	4.412E-04	4.412E-04	4.412E-04	4.412E-04
Ba132	3.999E-10	3.999E-10	3.999E-10	3.999E-10	3.999E-10	3.999E-10	3.999E-10
Cs133	5.550E-04	5.550E-04	5.550E-04	5.550E-04	5.550E-04	5.550E-04	5.550E-04
Xe134	6.685E-04	6.685E-04	6.685E-04	6.685E-04	6.685E-04	6.685E-04	6.685E-04
Cs134	3.272E-06	1.670E-06	8.528E-07	4.354E-07	1.588E-07	2.957E-08	0.00

TABLE F.3.a. Fission Product Inventory by Isotope at 15 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ba134	3.306E-05	3.466E-05	3.548E-05	3.590E-05	3.617E-05	3.630E-05	3.633E-05
Cs135	2.500E-04	2.500E-04	2.500E-04	2.500E-04	2.500E-04	2.500E-04	2.500E-04
Ba135	3.486E-08	3.501E-08	3.516E-08	3.531E-08	3.554E-08	3.592E-08	1.098E-07
Xe136	9.318E-04	9.318E-04	9.318E-04	9.318E-04	9.318E-04	9.318E-04	9.318E-04
Ba136	6.171E-06	6.171E-06	6.171E-06	6.171E-06	6.171E-06	6.171E-06	6.171E-06
Cs137	4.645E-04	4.435E-04	4.235E-04	4.044E-04	3.773E-04	3.361E-04	4.927E-14
Ba137	9.311E-05	1.141E-04	1.341E-04	1.532E-04	1.803E-04	2.215E-04	5.576E-04
Ba137m	7.106E-11	6.786E-11	6.479E-11	6.186E-11	5.772E-11	5.142E-11	7.538E-21
Ba138	5.883E-04	5.883E-04	5.883E-04	5.883E-04	5.883E-04	5.883E-04	5.883E-04
La138	3.429E-09	3.429E-09	3.429E-09	3.429E-09	3.429E-09	3.429E-09	3.429E-09
La139	5.643E-04	5.643E-04	5.643E-04	5.643E-04	5.643E-04	5.643E-04	5.643E-04
Ce140	5.661E-04	5.661E-04	5.661E-04	5.661E-04	5.661E-04	5.661E-04	5.661E-04
Pr141	5.218E-04	5.218E-04	5.218E-04	5.218E-04	5.218E-04	5.218E-04	5.218E-04
Ce142	5.214E-04	5.214E-04	5.214E-04	5.214E-04	5.214E-04	5.214E-04	5.214E-04
Nd142	5.454E-06	5.454E-06	5.454E-06	5.454E-06	5.454E-06	5.454E-06	5.454E-06
Nd143	4.390E-04	4.390E-04	4.390E-04	4.390E-04	4.390E-04	4.390E-04	4.390E-04
Ce144	6.160E-07	1.037E-07	1.747E-08	2.943E-09	2.034E-10	2.368E-12	0.00
Pr144	2.601E-11	4.381E-12	7.378E-13	1.243E-13	8.589E-15	9.999E-17	0.00
Pr144m	1.300E-13	2.190E-14	3.688E-15	6.212E-16	4.294E-17	4.999E-19	0.00
Nd144	5.432E-04	5.438E-04	5.438E-04	5.439E-04	5.439E-04	5.439E-04	5.439E-04
Nd145	3.337E-04	3.337E-04	3.337E-04	3.337E-04	3.337E-04	3.337E-04	3.337E-04
Nd146	2.955E-04	2.955E-04	2.955E-04	2.955E-04	2.955E-04	2.955E-04	2.955E-04
Pm146	8.278E-10	6.434E-10	5.000E-10	3.886E-10	2.663E-10	1.418E-10	0.00
Sm146	2.172E-09	2.240E-09	2.293E-09	2.334E-09	2.380E-09	2.426E-09	2.478E-09
Pm147	1.877E-05	1.107E-05	6.523E-06	3.846E-06	1.741E-06	4.645E-07	0.00
Sm147	1.276E-04	1.353E-04	1.399E-04	1.426E-04	1.447E-04	1.459E-04	1.464E-04
Nd148	1.677E-04	1.677E-04	1.677E-04	1.677E-04	1.677E-04	1.677E-04	1.677E-04
Sm148	5.484E-05	5.484E-05	5.484E-05	5.484E-05	5.484E-05	5.484E-05	5.484E-05
Sm149	1.785E-06	1.785E-06	1.785E-06	1.785E-06	1.785E-06	1.785E-06	1.785E-06
Nd150	7.686E-05	7.686E-05	7.686E-05	7.686E-05	7.686E-05	7.686E-05	7.686E-05
Sm150	1.096E-04	1.096E-04	1.096E-04	1.096E-04	1.096E-04	1.096E-04	1.096E-04
Eu150	1.684E-13	1.621E-13	1.559E-13	1.501E-13	1.416E-13	1.286E-13	8.226E-22
Sm151	8.619E-06	8.488E-06	8.358E-06	8.230E-06	8.042E-06	7.738E-06	4.079E-09
Eu151	4.267E-07	5.585E-07	6.882E-07	8.160E-07	1.004E-06	1.308E-06	9.042E-06
Sm152	6.548E-05	6.548E-05	6.549E-05	6.549E-05	6.549E-05	6.550E-05	6.551E-05
Eu152	4.484E-08	4.049E-08	3.657E-08	3.302E-08	2.834E-08	2.197E-08	4.474E-30
Gd152	2.546E-08	2.667E-08	2.776E-08	2.875E-08	3.006E-08	3.183E-08	3.795E-08
Eu153	3.865E-05	3.865E-05	3.865E-05	3.865E-05	3.865E-05	3.865E-05	3.865E-05
Gd153	1.411E-11	1.742E-12	2.149E-13	2.653E-14	1.150E-15	6.156E-18	0.00
Sm154	1.426E-05	1.426E-05	1.426E-05	1.426E-05	1.426E-05	1.426E-05	1.426E-05
Eu154	5.256E-06	4.474E-06	3.808E-06	3.241E-06	2.545E-06	1.701E-06	0.00
Gd154	4.101E-06	4.883E-06	5.549E-06	6.116E-06	6.812E-06	7.656E-06	9.357E-06

TABLE F.3.a. Fission Product Inventory by Isotope at 15 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Eu155	1.655E-06	1.251E-06	9.462E-07	7.154E-07	4.704E-07	2.339E-07	0.00
Gd155	2.228E-06	2.631E-06	2.936E-06	3.167E-06	3.412E-06	3.649E-06	3.883E-06
Gd156	1.317E-05	1.317E-05	1.317E-05	1.317E-05	1.317E-05	1.317E-05	1.317E-05
Gd157	4.263E-08	4.263E-08	4.263E-08	4.263E-08	4.263E-08	4.263E-08	4.263E-08
Gd158	5.221E-06	5.221E-06	5.221E-06	5.221E-06	5.221E-06	5.221E-06	5.221E-06
Tb159	8.657E-07	8.657E-07	8.657E-07	8.657E-07	8.657E-07	8.657E-07	8.657E-07
Gd160	4.225E-07	4.225E-07	4.225E-07	4.225E-07	4.225E-07	4.225E-07	4.225E-07
Dy160	5.109E-08	5.109E-08	5.109E-08	5.109E-08	5.109E-08	5.109E-08	5.109E-08
Dy161	1.599E-07	1.599E-07	1.599E-07	1.599E-07	1.599E-07	1.599E-07	1.599E-07
Dy162	1.248E-07	1.248E-07	1.248E-07	1.248E-07	1.248E-07	1.248E-07	1.248E-07
Dy163	7.501E-08	7.501E-08	7.501E-08	7.501E-08	7.501E-08	7.501E-08	7.501E-08
Dy164	1.397E-08	1.397E-08	1.397E-08	1.397E-08	1.397E-08	1.397E-08	1.397E-08
Ho165	3.216E-08	3.216E-08	3.216E-08	3.216E-08	3.216E-08	3.216E-08	3.216E-08
Ho166m	1.668E-10	1.666E-10	1.664E-10	1.662E-10	1.659E-10	1.655E-10	9.394E-11
Er166	9.668E-09	9.668E-09	9.668E-09	9.669E-09	9.669E-09	9.669E-09	9.741E-09
Er167	1.487E-09	1.487E-09	1.487E-09	1.487E-09	1.487E-09	1.487E-09	1.487E-09
Er168	1.948E-09	1.948E-09	1.948E-09	1.948E-09	1.948E-09	1.948E-09	1.948E-09
Tm169	7.135E-12	7.135E-12	7.135E-12	7.135E-12	7.135E-12	7.135E-12	7.135E-12
Er170	1.530E-15	1.530E-15	1.530E-15	1.530E-15	1.530E-15	1.530E-15	1.530E-15
Yb170	1.036E-12	1.036E-12	1.036E-12	1.036E-12	1.036E-12	1.036E-12	1.036E-12
Tm171	1.734E-15	8.423E-16	4.091E-16	1.987E-16	6.729E-17	1.107E-17	0.00
Yb171	2.881E-14	2.970E-14	3.014E-14	3.035E-14	3.048E-14	3.053E-14	3.054E-14
Yb172	4.682E-16	4.682E-16	4.682E-16	4.682E-16	4.682E-16	4.682E-16	4.682E-16
TOTAL	1.547E-02	1.547E-02	1.547E-02	1.547E-02	1.547E-02	1.547E-02	1.547E-02

TABLE F.3.b. Fission Product Inventory by Isotope at 20 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	2.342E-08	2.094E-08	1.871E-08	1.673E-08	1.413E-08	1.068E-08	1.376E-32
Li 6	1.454E-10	1.454E-10	1.454E-10	1.454E-10	1.454E-10	1.454E-10	1.454E-10
Li 7	6.136E-12	6.136E-12	6.136E-12	6.136E-12	6.136E-12	6.136E-12	6.136E-12
Be 9	1.182E-11	1.182E-11	1.182E-11	1.182E-11	1.182E-11	1.182E-11	1.182E-11
Be 10	7.884E-11	7.884E-11	7.884E-11	7.884E-11	7.884E-11	7.884E-11	7.881E-11
C 14	1.593E-11	1.592E-11	1.592E-11	1.592E-11	1.591E-11	1.590E-11	1.412E-11
Zn 66	2.337E-14	2.337E-14	2.337E-14	2.337E-14	2.337E-14	2.337E-14	2.337E-14
Zn 67	9.766E-16	9.766E-16	9.766E-16	9.766E-16	9.766E-16	9.766E-16	9.766E-16
Ga 71	5.241E-13	5.241E-13	5.241E-13	5.241E-13	5.241E-13	5.241E-13	5.241E-13
Ge 72	1.312E-08	1.312E-08	1.312E-08	1.312E-08	1.312E-08	1.312E-08	1.312E-08
Ge 73	2.788E-08	2.788E-08	2.788E-08	2.788E-08	2.788E-08	2.788E-08	2.788E-08
Ge 74	5.933E-08	5.933E-08	5.933E-08	5.933E-08	5.933E-08	5.933E-08	5.933E-08
As 75	1.253E-07	1.253E-07	1.253E-07	1.253E-07	1.253E-07	1.253E-07	1.253E-07
Ge 76	3.104E-07	3.104E-07	3.104E-07	3.104E-07	3.104E-07	3.104E-07	3.104E-07
Se 76	2.149E-09	2.149E-09	2.149E-09	2.149E-09	2.149E-09	2.149E-09	2.149E-09
Se 77	6.490E-07	6.490E-07	6.490E-07	6.490E-07	6.490E-07	6.490E-07	6.490E-07
Se 78	1.471E-06	1.471E-06	1.471E-06	1.471E-06	1.471E-06	1.471E-06	1.471E-06
Se 79	3.632E-06	3.631E-06	3.631E-06	3.631E-06	3.631E-06	3.631E-06	3.593E-06
Br 79	3.115E-10	3.890E-10	4.665E-10	5.440E-10	6.602E-10	8.540E-10	3.862E-08
Se 80	8.260E-06	8.260E-06	8.260E-06	8.260E-06	8.260E-06	8.260E-06	8.260E-06
Kr 80	1.283E-10	1.283E-10	1.283E-10	1.283E-10	1.283E-10	1.283E-10	1.283E-10
Br 81	1.368E-05	1.368E-05	1.368E-05	1.368E-05	1.368E-05	1.368E-05	1.368E-05
Kr 81	9.977E-12	9.977E-12	9.976E-12	9.976E-12	9.976E-12	9.976E-12	9.944E-12
Se 82	2.102E-05	2.102E-05	2.102E-05	2.102E-05	2.102E-05	2.102E-05	2.102E-05
Kr 82	4.066E-07	4.066E-07	4.066E-07	4.066E-07	4.066E-07	4.066E-07	4.066E-07
Kr 83	2.849E-05	2.849E-05	2.849E-05	2.849E-05	2.849E-05	2.849E-05	2.849E-05
Kr 84	6.832E-05	6.832E-05	6.832E-05	6.832E-05	6.832E-05	6.832E-05	6.832E-05
Kr 85	9.816E-06	8.625E-06	7.579E-06	6.660E-06	5.485E-06	3.970E-06	1.206E-33
Rb 85	6.677E-05	6.796E-05	6.901E-05	6.993E-05	7.110E-05	7.262E-05	7.659E-05
Kr 86	1.200E-04	1.200E-04	1.200E-04	1.200E-04	1.200E-04	1.200E-04	1.200E-04
Sr 86	1.598E-07	1.598E-07	1.598E-07	1.598E-07	1.598E-07	1.598E-07	1.598E-07
Rb 87	1.543E-04	1.543E-04	1.543E-04	1.543E-04	1.543E-04	1.543E-04	1.543E-04
Sr 87	1.231E-09	1.231E-09	1.231E-09	1.231E-09	1.231E-09	1.231E-09	1.233E-09
Sr 88	2.215E-04	2.215E-04	2.215E-04	2.215E-04	2.215E-04	2.215E-04	2.215E-04
Y 89	2.896E-04	2.896E-04	2.896E-04	2.896E-04	2.896E-04	2.896E-04	2.896E-04
Sr 90	2.896E-04	2.761E-04	2.633E-04	2.510E-04	2.337E-04	2.075E-04	1.537E-14
Y 90	7.262E-08	6.924E-08	6.602E-08	6.295E-08	5.861E-08	5.204E-08	3.854E-18
Zr 90	6.168E-05	7.515E-05	8.799E-05	1.002E-04	1.175E-04	1.438E-04	3.513E-04
Y 91	1.187E-16	2.070E-20	3.609E-24	6.293E-28	1.449E-33	0.00	0.00
Zr 91	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.726E-04
Zr 92	4.007E-04	4.007E-04	4.007E-04	4.007E-04	4.007E-04	4.007E-04	4.007E-04

TABLE F.3.b. Fission Product Inventory by Isotope at 20 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Zr 93	4.497E-04	4.497E-04	4.497E-04	4.497E-04	4.497E-04	4.497E-04	4.495E-04
Nb 93	3.699E-10	5.326E-10	7.190E-10	9.268E-10	1.274E-09	1.934E-09	2.003E-07
Nb 93m	1.272E-09	1.517E-09	1.738E-09	1.937E-09	2.201E-09	2.560E-09	3.796E-09
Zr 94	4.564E-04	4.564E-04	4.564E-04	4.564E-04	4.564E-04	4.564E-04	4.564E-04
Nb 94	4.213E-10	4.212E-10	4.212E-10	4.212E-10	4.211E-10	4.211E-10	4.072E-10
Zr 95	1.685E-15	6.162E-19	2.253E-22	8.237E-26	5.759E-31	0.00	0.00
Nb 95	2.056E-15	7.516E-19	2.748E-22	1.005E-25	5.250E-33	0.00	0.00
Mo 95	4.738E-04	4.738E-04	4.738E-04	4.738E-04	4.738E-04	4.738E-04	4.738E-04
Zr 96	4.910E-04	4.910E-04	4.910E-04	4.910E-04	4.910E-04	4.910E-04	4.910E-04
Mo 96	1.364E-05	1.364E-05	1.364E-05	1.364E-05	1.364E-05	1.364E-05	1.364E-05
Mo 97	4.836E-04	4.836E-04	4.836E-04	4.836E-04	4.836E-04	4.836E-04	4.836E-04
Mo 98	5.003E-04	5.003E-04	5.003E-04	5.003E-04	5.003E-04	5.003E-04	5.003E-04
Tc 98	2.396E-09	2.396E-09	2.396E-09	2.396E-09	2.396E-09	2.396E-09	2.396E-09
Tc 99	4.871E-04	4.871E-04	4.871E-04	4.870E-04	4.870E-04	4.870E-04	4.855E-04
Ru 99	1.255E-08	1.572E-08	1.889E-08	2.206E-08	2.682E-08	3.474E-08	1.585E-06
Mo100	5.625E-04	5.625E-04	5.625E-04	5.625E-04	5.625E-04	5.625E-04	5.625E-04
Ru100	3.630E-05	3.630E-05	3.630E-05	3.630E-05	3.630E-05	3.630E-05	3.630E-05
Ru101	4.703E-04	4.703E-04	4.703E-04	4.703E-04	4.703E-04	4.703E-04	4.703E-04
Ru102	4.519E-04	4.519E-04	4.519E-04	4.519E-04	4.519E-04	4.519E-04	4.519E-04
Rh102	9.151E-11	5.674E-11	3.518E-11	2.181E-11	1.065E-11	3.223E-12	0.00
Rh103	3.099E-04	3.099E-04	3.099E-04	3.099E-04	3.099E-04	3.099E-04	3.099E-04
Ru104	3.074E-04	3.074E-04	3.074E-04	3.074E-04	3.074E-04	3.074E-04	3.074E-04
Pd104	8.997E-05	8.997E-05	8.997E-05	8.997E-05	8.997E-05	8.997E-05	8.997E-05
Pd105	2.204E-04	2.204E-04	2.204E-04	2.204E-04	2.204E-04	2.204E-04	2.204E-04
Ru106	1.135E-06	2.869E-07	7.251E-08	1.833E-08	2.329E-09	7.482E-11	0.00
Rh106	1.067E-12	2.696E-13	6.816E-14	1.723E-14	2.189E-15	7.032E-17	0.00
Pd106	1.807E-04	1.816E-04	1.818E-04	1.819E-04	1.819E-04	1.819E-04	1.819E-04
Pd107	1.154E-04	1.154E-04	1.154E-04	1.154E-04	1.154E-04	1.154E-04	1.153E-04
Ag107	9.240E-11	1.170E-10	1.416E-10	1.663E-10	2.032E-10	2.647E-10	1.233E-08
Pd108	7.859E-05	7.859E-05	7.859E-05	7.859E-05	7.859E-05	7.859E-05	7.859E-05
Ag108m	5.746E-13	5.684E-13	5.622E-13	5.561E-13	5.471E-13	5.323E-13	2.532E-15
Cd108	1.360E-10	1.360E-10	1.360E-10	1.360E-10	1.360E-10	1.360E-10	1.361E-10
Ag109	4.343E-05	4.343E-05	4.343E-05	4.343E-05	4.343E-05	4.343E-05	4.343E-05
Cd109	3.694E-15	1.240E-15	4.166E-16	1.399E-16	2.722E-17	1.779E-18	0.00
Pd110	2.587E-05	2.587E-05	2.587E-05	2.587E-05	2.587E-05	2.587E-05	2.587E-05
Ag110m	5.915E-10	7.797E-11	1.028E-11	1.355E-12	6.485E-14	4.091E-16	0.00
Cd110	1.160E-05	1.160E-05	1.160E-05	1.160E-05	1.160E-05	1.160E-05	1.160E-05
Cd111	1.475E-05	1.475E-05	1.475E-05	1.475E-05	1.475E-05	1.475E-05	1.475E-05
Cd112	9.082E-06	9.082E-06	9.082E-06	9.082E-06	9.082E-06	9.082E-06	9.082E-06
Cd113	1.376E-07	1.376E-07	1.376E-07	1.376E-07	1.376E-07	1.376E-07	1.377E-07
Cd113m	1.008E-07	9.167E-08	8.336E-08	7.581E-08	6.574E-08	5.184E-08	3.116E-28

TABLE F.3.b. Fission Product Inventory by Isotope at 20 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
In113	4.353E-08	5.266E-08	6.096E-08	6.851E-08	7.857E-08	9.245E-08	1.442E-07
Cd114	1.283E-05	1.283E-05	1.283E-05	1.283E-05	1.283E-05	1.283E-05	1.283E-05
Sn114	6.113E-10	6.113E-10	6.113E-10	6.113E-10	6.113E-10	6.113E-10	6.113E-10
In115	2.090E-06	2.090E-06	2.090E-06	2.090E-06	2.090E-06	2.090E-06	2.090E-06
Sn115	1.928E-07	1.928E-07	1.928E-07	1.928E-07	1.928E-07	1.928E-07	1.928E-07
Cd116	4.944E-06	4.944E-06	4.944E-06	4.944E-06	4.944E-06	4.944E-06	4.944E-06
Sn116	3.652E-06	3.652E-06	3.652E-06	3.652E-06	3.652E-06	3.652E-06	3.652E-06
Sn117	5.013E-06	5.013E-06	5.013E-06	5.013E-06	5.013E-06	5.013E-06	5.013E-06
Sn118	5.061E-06	5.061E-06	5.061E-06	5.061E-06	5.061E-06	5.061E-06	5.061E-06
Sn119	5.035E-06	5.035E-06	5.035E-06	5.035E-06	5.035E-06	5.035E-06	5.035E-06
Sn119m	4.463E-11	5.651E-12	7.156E-13	9.061E-14	4.083E-15	2.330E-17	0.00
Sn120	5.140E-06	5.140E-06	5.140E-06	5.140E-06	5.140E-06	5.140E-06	5.140E-06
Sn121m	1.816E-09	1.766E-09	1.718E-09	1.671E-09	1.603E-09	1.496E-09	1.868E-15
Sb121	5.143E-06	5.143E-06	5.143E-06	5.143E-06	5.143E-06	5.143E-06	5.145E-06
Sn122	5.672E-06	5.672E-06	5.672E-06	5.672E-06	5.672E-06	5.672E-06	5.672E-06
Te122	2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.124E-07	2.124E-07
Sn123	1.519E-12	3.014E-14	5.980E-16	1.186E-17	3.312E-20	1.836E-24	0.00
Sb123	6.284E-06	6.285E-06	6.285E-06	6.285E-06	6.285E-06	6.285E-06	6.285E-06
Te123	2.217E-09	2.217E-09	2.217E-09	2.217E-09	2.217E-09	2.217E-09	2.217E-09
Te123m	9.574E-16	1.392E-17	2.024E-19	2.937E-21	8.305E-24	2.117E-28	0.00
Sn124	7.688E-06	7.688E-06	7.688E-06	7.688E-06	7.688E-06	7.688E-06	7.688E-06
Te124	1.603E-07	1.603E-07	1.603E-07	1.603E-07	1.603E-07	1.603E-07	1.603E-07
Sb125	1.667E-06	1.011E-06	6.127E-07	3.714E-07	1.753E-07	5.017E-08	0.00
Te125	9.609E-06	1.027E-05	1.068E-05	1.092E-05	1.112E-05	1.125E-05	1.130E-05
Te125m	2.332E-08	1.414E-08	8.572E-09	5.197E-09	2.452E-09	7.017E-10	0.00
Sn126	1.633E-05	1.633E-05	1.633E-05	1.633E-05	1.633E-05	1.633E-05	1.622E-05
Sb126	7.757E-13	7.757E-13	7.757E-13	7.757E-13	7.757E-13	7.757E-13	7.704E-13
Sb126m	5.898E-15	5.898E-15	5.898E-15	5.898E-15	5.898E-15	5.897E-15	5.858E-15
Te126	4.018E-07	4.021E-07	4.023E-07	4.025E-07	4.028E-07	4.034E-07	5.139E-07
Te127	2.104E-15	2.021E-17	1.942E-19	1.866E-21	1.758E-24	1.590E-29	0.00
Te127m	6.009E-13	5.774E-15	5.548E-17	5.331E-19	5.021E-22	4.543E-27	0.00
I127	3.319E-05	3.319E-05	3.319E-05	3.319E-05	3.319E-05	3.319E-05	3.319E-05
Te128	6.559E-05	6.559E-05	6.559E-05	6.559E-05	6.559E-05	6.559E-05	6.559E-05
Xe128	1.095E-06	1.095E-06	1.095E-06	1.095E-06	1.095E-06	1.095E-06	1.095E-06
I129	1.084E-04	1.084E-04	1.084E-04	1.084E-04	1.084E-04	1.084E-04	1.084E-04
Xe129	3.859E-09	3.869E-09	3.878E-09	3.888E-09	3.902E-09	3.926E-09	8.617E-09
Te130	2.112E-04	2.112E-04	2.112E-04	2.112E-04	2.112E-04	2.112E-04	2.112E-04
Xe130	4.553E-06	4.553E-06	4.553E-06	4.553E-06	4.553E-06	4.553E-06	4.553E-06
Xe131	2.941E-04	2.941E-04	2.941E-04	2.941E-04	2.941E-04	2.941E-04	2.941E-04
Xe132	6.111E-04	6.111E-04	6.111E-04	6.111E-04	6.111E-04	6.111E-04	6.111E-04
Ba132	7.191E-10	7.191E-10	7.191E-10	7.191E-10	7.191E-10	7.191E-10	7.191E-10

TABLE F.3.b. Fission Product Inventory by Isotope at 20 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cs133	7.217E-04	7.217E-04	7.217E-04	7.217E-04	7.217E-04	7.217E-04	7.217E-04
Xe134	8.888E-04	8.888E-04	8.888E-04	8.888E-04	8.888E-04	8.888E-04	8.888E-04
Cs134	5.760E-06	2.941E-06	1.501E-06	7.665E-07	2.796E-07	5.207E-08	0.00
Ba134	5.807E-05	6.089E-05	6.233E-05	6.307E-05	6.355E-05	6.378E-05	6.383E-05
Cs135	2.798E-04	2.798E-04	2.798E-04	2.798E-04	2.798E-04	2.798E-04	2.797E-04
Ba135	8.325E-08	8.342E-08	8.359E-08	8.376E-08	8.401E-08	8.443E-08	1.671E-07
Xe136	1.303E-03	1.303E-03	1.303E-03	1.303E-03	1.303E-03	1.303E-03	1.303E-03
Ba136	9.375E-06	9.375E-06	9.375E-06	9.375E-06	9.375E-06	9.375E-06	9.375E-06
Cs137	6.200E-04	5.920E-04	5.653E-04	5.398E-04	5.036E-04	4.487E-04	6.577E-14
Ba137	1.243E-04	1.523E-04	1.790E-04	2.045E-04	2.407E-04	2.956E-04	7.443E-04
Ba137m	9.486E-11	9.058E-11	8.649E-11	8.258E-11	7.705E-11	6.864E-11	1.006E-20
Ba138	7.772E-04	7.772E-04	7.772E-04	7.772E-04	7.772E-04	7.772E-04	7.772E-04
La138	4.096E-09	4.096E-09	4.096E-09	4.096E-09	4.096E-09	4.096E-09	4.096E-09
La139	7.447E-04	7.447E-04	7.447E-04	7.447E-04	7.447E-04	7.447E-04	7.447E-04
Ce140	7.505E-04	7.505E-04	7.505E-04	7.505E-04	7.505E-04	7.505E-04	7.505E-04
Pr141	6.874E-04	6.874E-04	6.874E-04	6.874E-04	6.874E-04	6.874E-04	6.874E-04
Ce142	6.877E-04	6.877E-04	6.877E-04	6.877E-04	6.877E-04	6.877E-04	6.877E-04
Nd142	9.863E-06	9.863E-06	9.863E-06	9.863E-06	9.863E-06	9.863E-06	9.863E-06
Nd143	5.439E-04	5.439E-04	5.439E-04	5.439E-04	5.439E-04	5.439E-04	5.439E-04
Ce144	8.011E-07	1.349E-07	2.273E-08	3.827E-09	2.646E-10	3.080E-12	0.00
Pr144	3.383E-11	5.697E-12	9.596E-13	1.616E-13	1.117E-14	1.300E-16	0.00
Pr144m	1.691E-13	2.848E-14	4.797E-15	8.079E-16	5.584E-17	6.501E-19	0.00
Nd144	7.439E-04	7.445E-04	7.446E-04	7.446E-04	7.447E-04	7.447E-04	7.447E-04
Nd145	4.308E-04	4.308E-04	4.308E-04	4.308E-04	4.308E-04	4.308E-04	4.308E-04
Nd146	3.989E-04	3.989E-04	3.989E-04	3.989E-04	3.989E-04	3.989E-04	3.989E-04
Pm146	1.372E-09	1.067E-09	8.289E-10	6.442E-10	4.414E-10	2.351E-10	0.00
Sm146	3.609E-09	3.722E-09	3.810E-09	3.879E-09	3.954E-09	4.030E-09	4.117E-09
Pm147	2.182E-05	1.287E-05	7.585E-06	4.472E-06	2.024E-06	5.401E-07	0.00
Sm147	1.487E-04	1.576E-04	1.629E-04	1.660E-04	1.685E-04	1.700E-04	1.705E-04
Nd148	2.234E-04	2.234E-04	2.234E-04	2.234E-04	2.234E-04	2.234E-04	2.234E-04
Sm148	8.630E-05	8.630E-05	8.630E-05	8.630E-05	8.630E-05	8.630E-05	8.630E-05
Sm149	1.911E-06	1.911E-06	1.911E-06	1.911E-06	1.911E-06	1.911E-06	1.911E-06
Nd150	1.048E-04	1.048E-04	1.048E-04	1.048E-04	1.048E-04	1.048E-04	1.048E-04
Sm150	1.468E-04	1.468E-04	1.468E-04	1.468E-04	1.468E-04	1.468E-04	1.468E-04
Eu150	1.931E-13	1.858E-13	1.788E-13	1.720E-13	1.624E-13	1.475E-13	9.418E-22
Sm151	9.447E-06	9.303E-06	9.161E-06	9.021E-06	8.815E-06	8.482E-06	4.471E-09
Eu151	4.613E-07	6.057E-07	7.479E-07	8.879E-07	1.094E-06	1.427E-06	9.904E-06
Sm152	8.533E-05	8.533E-05	8.533E-05	8.533E-05	8.534E-05	8.534E-05	8.536E-05
Eu152	4.093E-08	3.696E-08	3.338E-08	3.014E-08	2.587E-08	2.005E-08	4.084E-30
Gd152	2.351E-08	2.462E-08	2.561E-08	2.651E-08	2.771E-08	2.933E-08	3.491E-08
Eu153	5.783E-05	5.783E-05	5.783E-05	5.783E-05	5.783E-05	5.783E-05	5.783E-05

TABLE F.3.b. Fission Product Inventory by Isotope at 20 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Gd153	1.936E-11	2.389E-12	2.949E-13	3.639E-14	1.578E-15	8.444E-18	0.00
Sm154	2.059E-05	2.059E-05	2.059E-05	2.059E-05	2.059E-05	2.059E-05	2.059E-05
Eu154	9.638E-06	8.204E-06	6.982E-06	5.943E-06	4.666E-06	3.119E-06	0.00
Gd154	7.501E-06	8.936E-06	1.016E-05	1.120E-05	1.247E-05	1.402E-05	1.714E-05
Eu155	2.628E-06	1.987E-06	1.503E-06	1.136E-06	7.471E-07	3.714E-07	0.00
Gd155	3.516E-06	4.157E-06	4.642E-06	5.008E-06	5.398E-06	5.773E-06	6.145E-06
Gd156	2.322E-05	2.322E-05	2.322E-05	2.322E-05	2.322E-05	2.322E-05	2.322E-05
Gd157	5.429E-08	5.429E-08	5.429E-08	5.429E-08	5.429E-08	5.429E-08	5.429E-08
Gd158	8.279E-06	8.279E-06	8.279E-06	8.279E-06	8.279E-06	8.279E-06	8.279E-06
Tb159	1.341E-06	1.341E-06	1.341E-06	1.341E-06	1.341E-06	1.341E-06	1.341E-06
Gd160	6.564E-07	6.564E-07	6.564E-07	6.564E-07	6.564E-07	6.564E-07	6.564E-07
Dy160	1.018E-07	1.018E-07	1.018E-07	1.018E-07	1.018E-07	1.018E-07	1.018E-07
Dy161	2.339E-07	2.339E-07	2.339E-07	2.339E-07	2.339E-07	2.339E-07	2.339E-07
Dy162	1.942E-07	1.942E-07	1.942E-07	1.942E-07	1.942E-07	1.942E-07	1.942E-07
Dy163	1.283E-07	1.283E-07	1.283E-07	1.283E-07	1.283E-07	1.283E-07	1.283E-07
Dy164	2.117E-08	2.117E-08	2.117E-08	2.117E-08	2.117E-08	2.117E-08	2.117E-08
Ho165	5.688E-08	5.688E-08	5.688E-08	5.688E-08	5.688E-08	5.688E-08	5.688E-08
Ho166m	3.848E-10	3.844E-10	3.840E-10	3.835E-10	3.829E-10	3.817E-10	2.167E-10
Er166	1.712E-08	1.712E-08	1.712E-08	1.712E-08	1.712E-08	1.713E-08	1.729E-08
Er167	1.914E-09	1.914E-09	1.914E-09	1.914E-09	1.914E-09	1.914E-09	1.914E-09
Er168	3.433E-09	3.433E-09	3.433E-09	3.433E-09	3.433E-09	3.433E-09	3.433E-09
Tm169	1.644E-11	1.644E-11	1.644E-11	1.644E-11	1.644E-11	1.644E-11	1.644E-11
Er170	4.824E-15	4.824E-15	4.824E-15	4.824E-15	4.824E-15	4.824E-15	4.824E-15
Yb170	3.254E-12	3.254E-12	3.254E-12	3.254E-12	3.254E-12	3.254E-12	3.254E-12
Tm171	7.580E-15	3.682E-15	1.789E-15	8.688E-16	2.941E-16	4.837E-17	0.00
Yb171	1.241E-13	1.280E-13	1.299E-13	1.308E-13	1.314E-13	1.316E-13	1.317E-13
Yb172	2.749E-15	2.749E-15	2.749E-15	2.749E-15	2.749E-15	2.749E-15	2.749E-15
TOTAL	2.060E-02	2.060E-02	2.060E-02	2.060E-02	2.060E-02	2.060E-02	2.060E-02

TABLE F.3.c. Fission Product Inventory by Isotope at 25 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	2.989E-08	2.672E-08	2.388E-08	2.134E-08	1.804E-08	1.362E-08	1.759E-32
Li 6	1.566E-10	1.566E-10	1.566E-10	1.566E-10	1.566E-10	1.566E-10	1.566E-10
Li 7	7.655E-12	7.655E-12	7.655E-12	7.655E-12	7.655E-12	7.655E-12	7.655E-12
Be 9	1.474E-11	1.474E-11	1.474E-11	1.474E-11	1.474E-11	1.474E-11	1.474E-11
Be 10	9.835E-11	9.835E-11	9.835E-11	9.835E-11	9.835E-11	9.835E-11	9.831E-11
C 14	1.987E-11	1.986E-11	1.986E-11	1.986E-11	1.985E-11	1.984E-11	1.762E-11
Zn 66	2.772E-14	2.772E-14	2.772E-14	2.772E-14	2.772E-14	2.772E-14	2.772E-14
Zn 67	1.153E-15	1.153E-15	1.153E-15	1.153E-15	1.153E-15	1.153E-15	1.153E-15
Ga 71	6.748E-13	6.748E-13	6.748E-13	6.748E-13	6.748E-13	6.748E-13	6.748E-13
Ge 72	1.684E-08	1.684E-08	1.684E-08	1.684E-08	1.684E-08	1.684E-08	1.684E-08
Ge 73	3.495E-08	3.495E-08	3.495E-08	3.495E-08	3.495E-08	3.495E-08	3.495E-08
Ge 74	7.445E-08	7.445E-08	7.445E-08	7.445E-08	7.445E-08	7.445E-08	7.445E-08
As 75	1.552E-07	1.552E-07	1.552E-07	1.552E-07	1.552E-07	1.552E-07	1.552E-07
Ge 76	3.814E-07	3.814E-07	3.814E-07	3.814E-07	3.814E-07	3.814E-07	3.814E-07
Se 76	3.368E-09	3.368E-09	3.368E-09	3.368E-09	3.368E-09	3.368E-09	3.368E-09
Se 77	7.890E-07	7.890E-07	7.890E-07	7.890E-07	7.890E-07	7.890E-07	7.890E-07
Se 78	1.833E-06	1.833E-06	1.833E-06	1.833E-06	1.833E-06	1.833E-06	1.833E-06
Se 79	4.479E-06	4.479E-06	4.479E-06	4.479E-06	4.478E-06	4.478E-06	4.432E-06
Br 79	3.846E-10	4.802E-10	5.757E-10	6.713E-10	8.147E-10	1.054E-09	4.764E-08
Se 80	1.016E-05	1.016E-05	1.016E-05	1.016E-05	1.016E-05	1.016E-05	1.016E-05
Kr 80	1.721E-10	1.721E-10	1.721E-10	1.721E-10	1.721E-10	1.721E-10	1.721E-10
Br 81	1.665E-05	1.665E-05	1.665E-05	1.665E-05	1.665E-05	1.665E-05	1.665E-05
Kr 81	1.515E-11	1.515E-11	1.515E-11	1.515E-11	1.515E-11	1.515E-11	1.510E-11
Se 82	2.560E-05	2.560E-05	2.560E-05	2.560E-05	2.560E-05	2.560E-05	2.560E-05
Kr 82	6.171E-07	6.171E-07	6.171E-07	6.171E-07	6.171E-07	6.171E-07	6.171E-07
Kr 83	3.301E-05	3.301E-05	3.301E-05	3.301E-05	3.301E-05	3.301E-05	3.301E-05
Kr 84	8.432E-05	8.432E-05	8.432E-05	8.432E-05	8.432E-05	8.432E-05	8.432E-05
Kr 85	1.184E-05	1.041E-05	9.144E-06	8.035E-06	6.618E-06	4.790E-06	1.457E-33
Rb 85	8.046E-05	8.190E-05	8.316E-05	8.427E-05	8.569E-05	8.752E-05	9.231E-05
Kr 86	1.442E-04	1.442E-04	1.442E-04	1.442E-04	1.442E-04	1.442E-04	1.442E-04
Sr 86	2.461E-07	2.461E-07	2.461E-07	2.461E-07	2.461E-07	2.461E-07	2.461E-07
Rb 87	1.852E-04	1.852E-04	1.852E-04	1.852E-04	1.852E-04	1.852E-04	1.852E-04
Sr 87	1.932E-09	1.932E-09	1.932E-09	1.932E-09	1.932E-09	1.932E-09	1.935E-09
Sr 88	2.657E-04	2.657E-04	2.657E-04	2.657E-04	2.657E-04	2.657E-04	2.657E-04
Y 89	3.469E-04	3.469E-04	3.469E-04	3.469E-04	3.469E-04	3.469E-04	3.469E-04
Sr 90	3.469E-04	3.307E-04	3.154E-04	3.007E-04	2.800E-04	2.486E-04	1.841E-14
Y 90	8.698E-08	8.294E-08	7.909E-08	7.541E-08	7.021E-08	6.233E-08	4.617E-18
Zr 90	7.421E-05	9.034E-05	1.057E-04	1.204E-04	1.411E-04	1.725E-04	4.212E-04
Y 91	1.389E-16	2.423E-20	4.224E-24	7.364E-28	1.695E-33	0.00	0.00
Zr 91	4.485E-04	4.485E-04	4.485E-04	4.485E-04	4.485E-04	4.485E-04	4.485E-04
Zr 92	4.854E-04	4.854E-04	4.854E-04	4.854E-04	4.854E-04	4.854E-04	4.854E-04
Zr 93	5.469E-04	5.469E-04	5.469E-04	5.469E-04	5.469E-04	5.469E-04	5.466E-04

TABLE F.3.c. Fission Product Inventory by Isotope at 25 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Nr 93	4.524E-10	6.506E-10	8.775E-10	1.130E-09	1.553E-09	2.356E-09	2.436E-07
Nb 93m	1.550E-09	1.847E-09	2.116E-09	2.358E-09	2.679E-09	3.115E-09	4.616E-09
Zr 94	5.602E-04	5.602E-04	5.602E-04	5.602E-04	5.602E-04	5.602E-04	5.602E-04
Nb 94	5.736E-10	5.735E-10	5.735E-10	5.734E-10	5.734E-10	5.733E-10	5.544E-10
Zr 95	2.050E-15	7.495E-19	2.740E-22	1.002E-25	7.005E-31	0.00	0.00
Nb 95	2.500E-15	9.142E-19	3.343E-22	1.222E-25	6.386E-33	0.00	0.00
Mo 95	5.781E-04	5.781E-04	5.781E-04	5.781E-04	5.781E-04	5.781E-04	5.781E-04
Zr 96	6.057E-04	6.057E-04	6.057E-04	6.057E-04	6.057E-04	6.057E-04	6.057E-04
Mo 96	2.155E-05	2.155E-05	2.155E-05	2.155E-05	2.155E-05	2.155E-05	2.155E-05
Mo 97	5.998E-04	5.998E-04	5.998E-04	5.998E-04	5.998E-04	5.998E-04	5.998E-04
Mo 98	6.238E-04	6.238E-04	6.238E-04	6.238E-04	6.238E-04	6.238E-04	6.238E-04
Tc 98	3.801E-09	3.801E-09	3.801E-09	3.801E-09	3.801E-09	3.801E-09	3.801E-09
Tc 99	5.964E-04	5.964E-04	5.964E-04	5.964E-04	5.964E-04	5.964E-04	5.945E-04
Ru 99	1.538E-08	1.926E-08	2.314E-08	2.702E-08	3.285E-08	4.255E-08	1.942E-06
Mo100	7.034E-04	7.034E-04	7.034E-04	7.034E-04	7.034E-04	7.034E-04	7.034E-04
Ru100	5.752E-05	5.752E-05	5.752E-05	5.752E-05	5.752E-05	5.752E-05	5.752E-05
Ru101	5.879E-04	5.879E-04	5.879E-04	5.879E-04	5.879E-04	5.879E-04	5.879E-04
Ru102	5.774E-04	5.774E-04	5.774E-04	5.774E-04	5.774E-04	5.774E-04	5.774E-04
Rh102	1.446E-10	8.968E-11	5.560E-11	3.447E-11	1.683E-11	5.094E-12	0.00
Rh103	3.752E-04	3.752E-04	3.752E-04	3.752E-04	3.752E-04	3.752E-04	3.752E-04
Ru104	4.065E-04	4.065E-04	4.065E-04	4.065E-04	4.065E-04	4.065E-04	4.065E-04
Pd104	1.421E-04	1.421E-04	1.421E-04	1.421E-04	1.421E-04	1.421E-04	1.421E-04
Pd105	2.923E-04	2.923E-04	2.923E-04	2.923E-04	2.923E-04	2.923E-04	2.923E-04
Ru106	1.585E-06	4.005E-07	1.012E-07	2.559E-08	3.252E-09	1.045E-10	0.00
Rh106	1.489E-12	3.765E-13	9.516E-14	2.405E-14	3.057E-15	9.818E-17	0.00
Pd106	2.558E-04	2.570E-04	2.573E-04	2.574E-04	2.574E-04	2.574E-04	2.574E-04
Pd107	1.621E-04	1.621E-04	1.621E-04	1.621E-04	1.621E-04	1.621E-04	1.621E-04
Ag107	1.295E-10	1.641E-10	1.987E-10	2.333E-10	2.852E-10	3.717E-10	1.732E-08
Pd108	1.113E-04	1.113E-04	1.113E-04	1.113E-04	1.113E-04	1.113E-04	1.113E-04
Ag108m	8.219E-13	8.130E-13	8.042E-13	7.954E-13	7.825E-13	7.614E-13	3.621E-15
Cd108	2.405E-10	2.405E-10	2.405E-10	2.405E-10	2.405E-10	2.405E-10	2.405E-10
Ag109	5.913E-05	5.913E-05	5.913E-05	5.913E-05	5.913E-05	5.913E-05	5.913E-05
Cd109	8.116E-15	2.725E-15	9.152E-16	3.073E-16	5.980E-17	3.908E-18	0.00
Pd110	3.648E-05	3.648E-05	3.648E-05	3.648E-05	3.648E-05	3.648E-05	3.648E-05
Ag110m	1.037E-09	1.367E-10	1.803E-11	2.376E-12	1.137E-13	7.173E-16	0.00
Cd110	2.046E-05	2.046E-05	2.046E-05	2.046E-05	2.046E-05	2.046E-05	2.046E-05
Cd111	2.044E-05	2.044E-05	2.044E-05	2.044E-05	2.044E-05	2.044E-05	2.044E-05
Cd112	1.236E-05	1.236E-05	1.236E-05	1.236E-05	1.236E-05	1.236E-05	1.236E-05
Cd113	1.458E-07	1.458E-07	1.458E-07	1.458E-07	1.458E-07	1.458E-07	1.459E-07
Cd113m	1.394E-07	1.267E-07	1.153E-07	1.048E-07	9.088E-08	7.167E-08	4.307E-28
In113	5.956E-08	7.218E-08	8.366E-08	9.410E-08	1.080E-07	1.272E-07	1.988E-07
Cd114	1.702E-05	1.702E-05	1.702E-05	1.702E-05	1.702E-05	1.702E-05	1.702E-05

TABLE F.3.c. Fission Product Inventory by Isotope at 25 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Sn114	1.037E-09	1.037E-09	1.037E-09	1.037E-09	1.037E-09	1.037E-09	1.037E-09
In115	2.237E-06	2.237E-06	2.237E-06	2.237E-06	2.237E-06	2.237E-06	2.237E-06
Sn115	2.480E-07	2.480E-07	2.480E-07	2.480E-07	2.480E-07	2.480E-07	2.480E-07
Cd116	6.356E-06	6.356E-06	6.356E-06	6.356E-06	6.356E-06	6.356E-06	6.356E-06
Sn116	5.216E-06	5.216E-06	5.216E-06	5.216E-06	5.216E-06	5.216E-06	5.216E-06
Sn117	6.434E-06	6.434E-06	6.434E-06	6.434E-06	6.434E-06	6.434E-06	6.434E-06
Sn118	6.492E-06	6.492E-06	6.492E-06	6.492E-06	6.492E-06	6.492E-06	6.492E-06
Sn119	6.466E-06	6.466E-06	6.466E-06	6.466E-06	6.466E-06	6.466E-06	6.466E-06
Sn119m	5.988E-11	7.583E-12	9.602E-13	1.216E-13	5.479E-15	3.127E-17	0.00
Sn120	6.595E-06	6.595E-06	6.595E-06	6.595E-06	6.595E-06	6.595E-06	6.595E-06
Sn121m	2.413E-09	2.347E-09	2.283E-09	2.221E-09	2.130E-09	1.987E-09	2.482E-15
Sb121	6.517E-06	6.517E-06	6.517E-06	6.517E-06	6.517E-06	6.517E-06	6.519E-06
Sn122	7.263E-06	7.263E-06	7.263E-06	7.263E-06	7.263E-06	7.263E-06	7.263E-06
Te122	3.437E-07	3.437E-07	3.437E-07	3.437E-07	3.437E-07	3.437E-07	3.437E-07
Sn123	1.955E-12	3.879E-14	7.697E-16	1.527E-17	4.265E-20	2.364E-24	0.00
Sn123	7.987E-06	7.987E-06	7.987E-06	7.987E-06	7.987E-06	7.987E-06	7.987E-06
Te123	4.142E-09	4.142E-09	4.142E-09	4.142E-09	4.142E-09	4.142E-09	4.142E-09
Te123m	2.003E-15	2.912E-17	4.234E-19	6.158E-21	1.741E-23	4.438E-28	0.00
Sn124	9.816E-06	9.816E-06	9.816E-06	9.816E-06	9.816E-06	9.816E-06	9.816E-06
Te124	2.608E-07	2.608E-07	2.608E-07	2.608E-07	2.608E-07	2.608E-07	2.608E-07
Sb125	2.163E-06	1.311E-06	7.950E-07	4.820E-07	2.275E-07	6.510E-08	0.00
Te125	1.243E-05	1.330E-05	1.382E-05	1.414E-05	1.440E-05	1.456E-05	1.463E-05
Te125m	3.026E-08	1.835E-08	1.112E-08	6.743E-09	3.182E-09	9.105E-10	0.00
Sn126	2.109E-05	2.109E-05	2.109E-05	2.109E-05	2.109E-05	2.109E-05	2.095E-05
Sb126	1.002E-12	1.002E-12	1.002E-12	1.002E-12	1.002E-12	1.002E-12	9.953E-13
Sb126m	7.620E-15	7.620E-15	7.620E-15	7.620E-15	7.619E-15	7.619E-15	7.568E-15
Te126	5.481E-07	5.484E-07	5.487E-07	5.490E-07	5.494E-07	5.501E-07	6.929E-07
Te127	2.753E-15	2.645E-17	2.542E-19	2.442E-21	2.300E-24	2.081E-29	0.00
Te127m	7.864E-13	7.556E-15	7.260E-17	6.975E-19	6.569E-22	5.944E-27	0.00
I127	4.282E-05	4.282E-05	4.282E-05	4.282E-05	4.282E-05	4.282E-05	4.282E-05
Te128	8.404E-05	8.404E-05	8.404E-05	8.404E-05	8.404E-05	8.404E-05	8.404E-05
Xe128	1.813E-06	1.813E-06	1.813E-06	1.813E-06	1.813E-06	1.813E-06	1.813E-06
I129	1.375E-04	1.375E-04	1.375E-04	1.375E-04	1.375E-04	1.375E-04	1.375E-04
Xe129	8.013E-09	8.025E-09	8.037E-09	8.049E-09	8.067E-09	8.098E-09	1.405E-08
Te130	2.685E-04	2.685E-04	2.685E-04	2.685E-04	2.685E-04	2.685E-04	2.685E-04
Xe130	7.384E-06	7.384E-06	7.384E-06	7.384E-06	7.384E-06	7.384E-06	7.384E-06
Xe131	3.494E-04	3.494E-04	3.494E-04	3.494E-04	3.494E-04	3.494E-04	3.494E-04
Xe132	7.915E-04	7.915E-04	7.915E-04	7.915E-04	7.915E-04	7.915E-04	7.915E-04
Ba132	1.137E-09	1.137E-09	1.137E-09	1.137E-09	1.137E-09	1.137E-09	1.137E-09
Cs133	8.787E-04	8.787E-04	8.787E-04	8.787E-04	8.787E-04	8.787E-04	8.787E-04
Xe134	1.109E-03	1.109E-03	1.109E-03	1.109E-03	1.109E-03	1.109E-03	1.109E-03
Cs134	8.883E-06	4.535E-06	2.315E-06	1.182E-06	4.311E-07	8.029E-08	0.00

TABLE F.3.c. Fission Product Inventory by Isotope at 25 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ba134	8.958E-05	9.393E-05	9.614E-05	9.728E-05	9.803E-05	9.838E-05	9.846E-05
Cs135	3.022E-04	3.022E-04	3.022E-04	3.022E-04	3.022E-04	3.022E-04	3.021E-04
Ba135	1.650E-07	1.652E-07	1.654E-07	1.656E-07	1.659E-07	1.663E-07	2.556E-07
Xe136	1.685E-03	1.685E-03	1.685E-03	1.685E-03	1.685E-03	1.685E-03	1.685E-03
Ba136	1.291E-05	1.291E-05	1.291E-05	1.291E-05	1.291E-05	1.291E-05	1.291E-05
Cs137	7.757E-04	7.407E-04	7.073E-04	6.753E-04	6.301E-04	5.613E-04	8.228E-14
Ba137	1.555E-04	1.905E-04	2.239E-04	2.559E-04	3.011E-04	3.699E-04	9.312E-04
Ba137m	1.187E-10	1.133E-10	1.082E-10	1.033E-10	9.640E-11	8.588E-11	1.259E-20
Ba138	9.636E-04	9.636E-04	9.636E-04	9.636E-04	9.636E-04	9.636E-04	9.636E-04
La138	4.579E-09	4.579E-09	4.579E-09	4.579E-09	4.579E-09	4.579E-09	4.579E-09
La139	9.222E-04	9.222E-04	9.222E-04	9.222E-04	9.222E-04	9.222E-04	9.222E-04
Ce140	9.337E-04	9.337E-04	9.337E-04	9.337E-04	9.337E-04	9.337E-04	9.337E-04
Pr141	8.490E-04	8.490E-04	8.490E-04	8.490E-04	8.490E-04	8.490E-04	8.490E-04
Ce142	8.512E-04	8.512E-04	8.512E-04	8.512E-04	8.512E-04	8.512E-04	8.512E-04
Nd142	1.569E-05	1.569E-05	1.569E-05	1.569E-05	1.569E-05	1.569E-05	1.569E-05
Nd143	6.311E-04	6.311E-04	6.311E-04	6.311E-04	6.311E-04	6.311E-04	6.311E-04
Ce144	9.791E-07	1.649E-07	2.777E-08	4.678E-09	3.233E-10	3.764E-12	0.00
Pr144	4.134E-11	6.963E-12	1.173E-12	1.975E-13	1.365E-14	1.589E-16	0.00
Pr144m	2.067E-13	3.481E-14	5.862E-15	9.874E-16	6.825E-17	7.945E-19	0.00
Nd144	9.541E-04	9.549E-04	9.550E-04	9.551E-04	9.551E-04	9.551E-04	9.551E-04
Nd145	5.216E-04	5.216E-04	5.216E-04	5.216E-04	5.216E-04	5.216E-04	5.216E-04
Nd146	5.054E-04	5.054E-04	5.054E-04	5.054E-04	5.054E-04	5.054E-04	5.054E-04
Pm146	2.004E-09	1.557E-09	1.210E-09	9.407E-10	6.445E-10	3.432E-10	0.00
Sm146	5.270E-09	5.435E-09	5.564E-09	5.664E-09	5.773E-09	5.885E-09	6.012E-09
Pm147	2.389E-05	1.408E-05	8.303E-06	4.895E-06	2.216E-06	5.913E-07	0.00
Sm147	1.627E-04	1.725E-04	1.783E-04	1.817E-04	1.843E-04	1.860E-04	1.866E-04
Nd148	2.791E-04	2.791E-04	2.791E-04	2.791E-04	2.791E-04	2.791E-04	2.791E-04
Sm148	1.206E-04	1.206E-04	1.206E-04	1.206E-04	1.206E-04	1.206E-04	1.206E-04
Sm149	2.067E-06	2.067E-06	2.067E-06	2.067E-06	2.067E-06	2.067E-06	2.067E-06
Nd150	1.336E-04	1.336E-04	1.336E-04	1.336E-04	1.336E-04	1.336E-04	1.336E-04
Sm150	1.842E-04	1.842E-04	1.842E-04	1.842E-04	1.842E-04	1.842E-04	1.842E-04
Eu150	2.127E-13	2.046E-13	1.969E-13	1.895E-13	1.788E-13	1.624E-13	1.037E-21
Sm151	1.030E-05	1.014E-05	9.984E-06	9.831E-06	9.606E-06	9.244E-06	4.872E-09
Eu151	4.989E-07	6.563E-07	8.113E-07	9.639E-07	1.188E-06	1.551E-06	1.079E-05
Sm152	1.030E-04	1.030E-04	1.030E-04	1.030E-04	1.030E-04	1.030E-04	1.030E-04
Eu152	3.636E-08	3.284E-08	2.966E-08	2.678E-08	2.298E-08	1.781E-08	3.629E-30
Gd152	2.102E-08	2.200E-08	2.288E-08	2.369E-08	2.474E-08	2.618E-08	3.115E-08
Eu153	7.813E-05	7.813E-05	7.813E-05	7.813E-05	7.813E-05	7.813E-05	7.813E-05
Gd153	2.369E-11	2.923E-12	3.607E-13	4.452E-14	1.930E-15	1.033E-17	0.00
Sm154	2.758E-05	2.758E-05	2.758E-05	2.758E-05	2.758E-05	2.758E-05	2.758E-05
Eu154	1.511E-05	1.286E-05	1.095E-05	9.316E-06	7.315E-06	4.889E-06	0.00
Gd154	1.176E-05	1.401E-05	1.592E-05	1.755E-05	1.956E-05	2.198E-05	2.687E-05

TABLE F.3.c. Fission Product Inventory by Isotope at 25 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Eu155	3.894E-06	2.944E-06	2.226E-06	1.683E-06	1.107E-06	5.502E-07	0.00
Gd155	5.191E-06	6.140E-06	6.858E-06	7.401E-06	7.978E-06	8.534E-06	9.085E-06
Gd156	3.778E-05	3.778E-05	3.778E-05	3.778E-05	3.778E-05	3.778E-05	3.778E-05
Gd157	6.903E-08	6.903E-08	6.903E-08	6.903E-08	6.903E-08	6.903E-08	6.903E-08
Gd158	1.213E-05	1.213E-05	1.213E-05	1.213E-05	1.213E-05	1.213E-05	1.213E-05
Tb159	1.897E-06	1.897E-06	1.897E-06	1.897E-06	1.897E-06	1.897E-06	1.897E-06
Gd160	9.288E-07	9.288E-07	9.288E-07	9.288E-07	9.288E-07	9.288E-07	9.288E-07
Tb160	3.092E-17	2.811E-20	2.555E-23	2.323E-26	6.367E-31	0.00	0.00
Dy160	1.736E-07	1.736E-07	1.736E-07	1.736E-07	1.736E-07	1.736E-07	1.736E-07
Dy161	3.155E-07	3.155E-07	3.155E-07	3.155E-07	3.155E-07	3.155E-07	3.155E-07
Dy162	2.734E-07	2.734E-07	2.734E-07	2.734E-07	2.734E-07	2.734E-07	2.734E-07
Dy163	1.973E-07	1.973E-07	1.973E-07	1.973E-07	1.973E-07	1.973E-07	1.973E-07
Dy164	3.039E-08	3.039E-08	3.039E-08	3.039E-08	3.039E-08	3.039E-08	3.039E-08
Ho165	9.151E-08	9.151E-08	9.151E-08	9.151E-08	9.151E-08	9.151E-08	9.151E-08
Ho166m	7.628E-10	7.619E-10	7.610E-10	7.602E-10	7.588E-10	7.567E-10	4.296E-10
Er166	2.812E-08	2.812E-08	2.812E-08	2.812E-08	2.812E-08	2.813E-08	2.845E-08
Er167	2.401E-09	2.401E-09	2.401E-09	2.401E-09	2.401E-09	2.401E-09	2.401E-09
Er168	5.391E-09	5.391E-09	5.391E-09	5.391E-09	5.391E-09	5.391E-09	5.391E-09
Tm169	3.146E-11	3.146E-11	3.146E-11	3.146E-11	3.146E-11	3.146E-11	3.146E-11
Er170	1.182E-14	1.182E-14	1.182E-14	1.182E-14	1.182E-14	1.182E-14	1.182E-14
Yb170	7.944E-12	7.944E-12	7.944E-12	7.944E-12	7.944E-12	7.944E-12	7.944E-12
Tm171	2.406E-14	1.169E-14	5.676E-15	2.757E-15	9.335E-16	1.535E-16	0.00
Yb171	3.894E-13	4.018E-13	4.078E-13	4.107E-13	4.126E-13	4.133E-13	4.135E-13
Yb172	1.105E-14	1.105E-14	1.105E-14	1.105E-14	1.105E-14	1.105E-14	1.105E-14
TOTAL	2.571E-02	2.571E-02	2.571E-02	2.571E-02	2.571E-02	2.571E-02	2.571E-02

TABLE F.3.d. Fission Product Inventory by Isotope at 30 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	3.653E-08	3.265E-08	2.918E-08	2.608E-08	2.204E-08	1.665E-08	2.145E-32
Li 6	1.619E-10	1.619E-10	1.619E-10	1.619E-10	1.619E-10	1.619E-10	1.619E-10
Li 7	9.169E-12	9.169E-12	9.169E-12	9.169E-12	9.169E-12	9.169E-12	9.169E-12
Be 9	1.765E-11	1.765E-11	1.765E-11	1.765E-11	1.765E-11	1.765E-11	1.765E-11
Be 10	1.178E-10	1.178E-10	1.178E-10	1.178E-10	1.178E-10	1.178E-10	1.177E-10
C 14	2.380E-11	2.379E-11	2.379E-11	2.378E-11	2.377E-11	2.376E-11	2.110E-11
Zn 66	3.165E-14	3.165E-14	3.165E-14	3.165E-14	3.165E-14	3.165E-14	3.165E-14
Zn 67	1.310E-15	1.310E-15	1.310E-15	1.310E-15	1.310E-15	1.310E-15	1.310E-15
Ga 71	8.283E-13	8.283E-13	8.283E-13	8.283E-13	8.283E-13	8.283E-13	8.283E-13
Ge 72	2.071E-08	2.071E-08	2.071E-08	2.071E-08	2.071E-08	2.071E-08	2.071E-08
Ge 73	4.205E-08	4.205E-08	4.205E-08	4.205E-08	4.205E-08	4.205E-08	4.205E-08
Ge 74	8.977E-08	8.977E-08	8.977E-08	8.977E-08	8.977E-08	8.977E-08	8.977E-08
As 75	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07
Ge 76	4.506E-07	4.506E-07	4.506E-07	4.506E-07	4.506E-07	4.506E-07	4.506E-07
Se 76	4.881E-09	4.881E-09	4.881E-09	4.881E-09	4.881E-09	4.881E-09	4.881E-09
Se 77	9.213E-07	9.213E-07	9.213E-07	9.213E-07	9.213E-07	9.213E-07	9.213E-07
Se 78	2.194E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06
Se 79	5.306E-06	5.306E-06	5.306E-06	5.306E-06	5.306E-06	5.306E-06	5.250E-06
Br 79	4.558E-10	5.690E-10	6.823E-10	7.955E-10	9.654E-10	1.248E-09	5.644E-08
Se 80	1.201E-05	1.201E-05	1.201E-05	1.201E-05	1.201E-05	1.201E-05	1.201E-05
Kr 80	2.181E-10	2.181E-10	2.181E-10	2.181E-10	2.181E-10	2.181E-10	2.181E-10
Br 81	1.946E-05	1.946E-05	1.946E-05	1.946E-05	1.946E-05	1.946E-05	1.946E-05
Kr 81	2.153E-11	2.153E-11	2.153E-11	2.153E-11	2.153E-11	2.153E-11	2.146E-11
Se 82	2.999E-05	2.999E-05	2.999E-05	2.999E-05	2.999E-05	2.999E-05	2.999E-05
Kr 82	8.687E-07	8.687E-07	8.687E-07	8.687E-07	8.687E-07	8.687E-07	8.687E-07
Kr 83	3.667E-05	3.667E-05	3.667E-05	3.667E-05	3.667E-05	3.667E-05	3.667E-05
Kr 84	1.001E-04	1.001E-04	1.001E-04	1.001E-04	1.001E-04	1.001E-04	1.001E-04
Kr 85	1.375E-05	1.208E-05	1.062E-05	9.329E-06	7.684E-06	5.561E-06	1.679E-33
Rb 85	9.330E-05	9.497E-05	9.643E-05	9.772E-05	9.937E-05	1.015E-04	1.071E-04
Kr 86	1.669E-04	1.669E-04	1.669E-04	1.669E-04	1.669E-04	1.669E-04	1.669E-04
Sr 86	3.518E-07	3.518E-07	3.518E-07	3.518E-07	3.518E-07	3.518E-07	3.518E-07
Rb 87	2.140E-04	2.140E-04	2.140E-04	2.140E-04	2.140E-04	2.140E-04	2.140E-04
Sr 87	2.883E-09	2.883E-09	2.883E-09	2.883E-09	2.883E-09	2.883E-09	2.886E-09
Sr 88	3.068E-04	3.068E-04	3.068E-04	3.068E-04	3.068E-04	3.068E-04	3.068E-04
Y 89	3.998E-04	3.998E-04	3.998E-04	3.998E-04	3.998E-04	3.998E-04	3.998E-04
Sr 90	3.999E-04	3.813E-04	3.636E-04	3.467E-04	3.228E-04	2.866E-04	2.123E-14
Y 90	1.003E-07	9.562E-08	9.118E-08	8.694E-08	8.095E-08	7.186E-08	5.323E-18
Zr 90	8.593E-05	1.045E-04	1.223E-04	1.392E-04	1.631E-04	1.993E-04	4.859E-04
Y 91	1.568E-16	2.733E-20	4.766E-24	8.309E-28	1.913E-33	0.00	0.00
Zr 91	5.195E-04	5.195E-04	5.195E-04	5.195E-04	5.195E-04	5.195E-04	5.195E-04
Zr 92	5.658E-04	5.658E-04	5.658E-04	5.658E-04	5.658E-04	5.658E-04	5.658E-04
Zr 93	6.394E-04	6.394E-04	6.394E-04	6.394E-04	6.394E-04	6.394E-04	6.392E-04

TABLE F.3.d. Fission Product Inventory by Isotope at 30 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Nb 93	5.318E-10	7.638E-10	1.029E-09	1.326E-09	1.820E-09	2.759E-09	2.849E-07
Nb 93M	1.815E-09	2.163E-09	2.476E-09	2.760E-09	3.134E-09	3.644E-09	5.398E-09
Zr 94	6.611E-04	6.611E-04	6.611E-04	6.611E-04	6.611E-04	6.611E-04	6.611E-04
Nb 94	7.338E-10	7.338E-10	7.337E-10	7.337E-10	7.336E-10	7.335E-10	7.093E-10
Zr 95	2.401E-15	8.778E-19	3.210E-22	1.173E-25	8.204E-31	0.00	0.00
Nb 95	2.928E-15	1.071E-18	3.915E-22	1.431E-25	7.479E-33	0.00	0.00
Mo 95	6.775E-04	6.775E-04	6.775E-04	6.775E-04	6.775E-04	6.775E-04	6.775E-04
Zr 96	7.179E-04	7.179E-04	7.179E-04	7.179E-04	7.179E-04	7.179E-04	7.179E-04
Mo 96	3.148E-05	3.148E-05	3.148E-05	3.148E-05	3.148E-05	3.148E-05	3.148E-05
Mo 97	7.143E-04	7.143E-04	7.143E-04	7.143E-04	7.143E-04	7.143E-04	7.143E-04
Mo 98	7.469E-04	7.469E-04	7.469E-04	7.469E-04	7.469E-04	7.469E-04	7.469E-04
Tc 98	5.569E-09	5.569E-09	5.569E-09	5.569E-09	5.569E-09	5.569E-09	5.568E-09
Tc 99	7.004E-04	7.004E-04	7.004E-04	7.004E-04	7.004E-04	7.004E-04	6.982E-04
Ru 99	1.806E-08	2.262E-08	2.718E-08	3.174E-08	3.858E-08	4.997E-08	2.280E-06
Mo100	8.442E-04	8.442E-04	8.442E-04	8.442E-04	8.442E-04	8.442E-04	8.442E-04
Ru100	8.416E-05	8.416E-05	8.416E-05	8.416E-05	8.416E-05	8.416E-05	8.416E-05
Ru101	7.047E-04	7.047E-04	7.047E-04	7.047E-04	7.047E-04	7.047E-04	7.047E-04
Ru102	7.072E-04	7.072E-04	7.072E-04	7.072E-04	7.072E-04	7.072E-04	7.072E-04
Rh102	2.102E-10	1.303E-10	8.081E-11	5.010E-11	2.446E-11	7.404E-12	0.00
Rh103	4.330E-04	4.330E-04	4.330E-04	4.330E-04	4.330E-04	4.330E-04	4.330E-04
Ru104	5.120E-04	5.120E-04	5.120E-04	5.120E-04	5.120E-04	5.120E-04	5.120E-04
Pd104	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04	2.064E-04
Pd105	3.673E-04	3.673E-04	3.673E-04	3.673E-04	3.673E-04	3.673E-04	3.673E-04
Ru106	2.078E-06	5.254E-07	1.328E-07	3.356E-08	4.265E-09	1.370E-10	0.00
Rh106	1.954E-12	4.938E-13	1.248E-13	3.155E-14	4.009E-15	1.288E-16	0.00
Pd106	3.413E-04	3.429E-04	3.433E-04	3.434E-04	3.434E-04	3.434E-04	3.434E-04
Pd107	2.139E-04	2.139E-04	2.139E-04	2.139E-04	2.139E-04	2.139E-04	2.138E-04
Ag107	1.705E-10	2.161E-10	2.618E-10	3.074E-10	3.759E-10	4.900E-10	2.285E-08
Pd108	1.477E-04	1.477E-04	1.477E-04	1.477E-04	1.477E-04	1.477E-04	1.477E-04
Ag108m	1.101E-12	1.089E-12	1.077E-12	1.065E-12	1.048E-12	1.020E-12	4.850E-15
Cd108	3.844E-10	3.844E-10	3.844E-10	3.844E-10	3.844E-10	3.845E-10	3.845E-10
Ag109	7.532E-05	7.532E-05	7.532E-05	7.532E-05	7.532E-05	7.532E-05	7.532E-05
Cd109	1.552E-14	5.212E-15	1.750E-15	5.876E-16	1.143E-16	7.472E-18	0.00
Pd110	4.835E-05	4.835E-05	4.835E-05	4.835E-05	4.835E-05	4.835E-05	4.835E-05
Ag110m	1.646E-09	2.169E-10	2.860E-11	3.769E-12	1.804E-13	1.138E-15	0.00
Cd110	3.262E-05	3.262E-05	3.262E-05	3.262E-05	3.262E-05	3.262E-05	3.262E-05
Cd111	2.681E-05	2.681E-05	2.681E-05	2.681E-05	2.681E-05	2.681E-05	2.681E-05
Cd112	1.601E-05	1.601E-05	1.601E-05	1.601E-05	1.601E-05	1.601E-05	1.601E-05
Cd113	1.501E-07	1.501E-07	1.501E-07	1.501E-07	1.501E-07	1.502E-07	1.503E-07
Cd113m	1.843E-07	1.676E-07	1.524E-07	1.386E-07	1.202E-07	9.478E-08	5.697E-28
In113	7.800E-08	9.470E-08	1.099E-07	1.237E-07	1.421E-07	1.675E-07	2.621E-07
Cd114	2.148E-05	2.148E-05	2.148E-05	2.148E-05	2.148E-05	2.148E-05	2.148E-05

TABLE F.3.d. Fission Product Inventory by Isotope at 30 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Sn114	1.623E-09	1.623E-09	1.623E-09	1.623E-09	1.623E-09	1.623E-09	1.623E-09
In115	2.332E-06	2.332E-06	2.332E-06	2.332E-06	2.332E-06	2.332E-06	2.332E-06
Sn115	3.057E-07	3.057E-07	3.057E-07	3.057E-07	3.057E-07	3.057E-07	3.057E-07
Cd116	7.834E-06	7.834E-06	7.834E-06	7.834E-06	7.834E-06	7.834E-06	7.834E-06
Sn116	6.939E-06	6.939E-06	6.939E-06	6.939E-06	6.939E-06	6.939E-06	6.939E-06
Sn117	7.919E-06	7.919E-06	7.919E-06	7.919E-06	7.919E-06	7.919E-06	7.919E-06
Sn118	7.986E-06	7.986E-06	7.986E-06	7.986E-06	7.986E-06	7.986E-06	7.986E-06
Sn119	7.960E-06	7.960E-06	7.960E-06	7.960E-06	7.960E-06	7.960E-06	7.960E-06
Sn119m	7.709E-11	9.762E-12	1.236E-12	1.565E-13	7.053E-15	4.025E-17	0.00
Sn120	8.112E-06	8.112E-06	8.112E-06	8.112E-06	8.112E-06	8.112E-06	8.112E-06
Sn121m	3.041E-09	2.958E-09	2.877E-09	2.798E-09	2.684E-09	2.505E-09	3.128E-15
Sb121	7.913E-06	7.913E-06	7.913E-06	7.913E-06	7.913E-06	7.913E-06	7.916E-06
Sn122	8.918E-06	8.918E-06	8.918E-06	8.918E-06	8.918E-06	8.918E-06	8.918E-06
Te122	5.131E-07	5.131E-07	5.131E-07	5.131E-07	5.131E-07	5.131E-07	5.131E-07
Sn123	2.417E-12	4.795E-14	9.512E-16	1.887E-17	5.272E-20	2.923E-24	0.00
Sb123	9.728E-06	9.728E-06	9.728E-06	9.728E-06	9.728E-06	9.728E-06	9.728E-06
Te123	6.916E-09	6.916E-09	6.916E-09	6.916E-09	6.916E-09	6.916E-09	6.916E-09
Te123m	3.745E-15	5.445E-17	7.916E-19	1.151E-20	1.652E-23	4.210E-28	0.00
Sn124	1.202E-05	1.202E-05	1.202E-05	1.202E-05	1.202E-05	1.202E-05	1.202E-05
Te124	3.923E-07	3.923E-07	3.923E-07	3.923E-07	3.923E-07	3.923E-07	3.923E-07
Sb125	2.682E-06	1.626E-06	9.858E-07	5.976E-07	2.821E-07	8.072E-08	0.00
Te125	1.538E-05	1.645E-05	1.710E-05	1.749E-05	1.781E-05	1.801E-05	1.810E-05
Te125m	3.752E-08	2.275E-08	1.379E-08	8.361E-09	3.946E-09	1.129E-09	0.00
Sn126	2.605E-05	2.605E-05	2.605E-05	2.605E-05	2.605E-05	2.605E-05	2.587E-05
Sb126	1.238E-12	1.238E-12	1.238E-12	1.238E-12	1.238E-12	1.238E-12	1.229E-12
Sb126m	9.410E-15	9.410E-15	9.409E-15	9.409E-15	9.409E-15	9.409E-15	9.345E-15
Te126	7.123E-07	7.127E-07	7.131E-07	7.134E-07	7.140E-07	7.149E-07	8.912E-07
Te127	3.439E-15	3.304E-17	3.175E-19	3.051E-21	2.873E-24	2.599E-29	0.00
Te127m	9.823E-13	9.438E-15	9.069E-17	8.713E-19	8.206E-22	7.425E-27	0.00
I127	5.270E-05	5.270E-05	5.270E-05	5.270E-05	5.270E-05	5.270E-05	5.270E-05
Te128	1.030E-04	1.030E-04	1.030E-04	1.030E-04	1.030E-04	1.030E-04	1.030E-04
Xe128	2.761E-06	2.761E-06	2.761E-06	2.761E-06	2.761E-06	2.761E-06	2.761E-06
I129	1.668E-04	1.668E-04	1.668E-04	1.668E-04	1.668E-04	1.668E-04	1.668E-04
Xe129	1.481E-08	1.482E-08	1.484E-08	1.485E-08	1.487E-08	1.491E-08	2.212E-08
Te130	3.268E-04	3.268E-04	3.268E-04	3.268E-04	3.268E-04	3.268E-04	3.268E-04
Xe130	1.104E-05	1.104E-05	1.104E-05	1.104E-05	1.104E-05	1.104E-05	1.104E-05
Xe131	3.969E-04	3.969E-04	3.969E-04	3.969E-04	3.969E-04	3.969E-04	3.969E-04
Xe132	9.821E-04	9.821E-04	9.821E-04	9.821E-04	9.821E-04	9.821E-04	9.821E-04
Ba132	1.659E-09	1.659E-09	1.659E-09	1.659E-09	1.659E-09	1.659E-09	1.659E-09
Cs133	1.026E-03	1.026E-03	1.026E-03	1.026E-03	1.026E-03	1.026E-03	1.026E-03
Xe134	1.328E-03	1.328E-03	1.328E-03	1.328E-03	1.328E-03	1.328E-03	1.328E-03
Cs134	1.263E-05	6.450E-06	3.293E-06	1.681E-06	6.132E-07	1.142E-07	0.00

TABLE F.3.d. Fission Product Inventory by Isotope at 30 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ba134	1.274E-04	1.336E-04	1.368E-04	1.384E-04	1.394E-04	1.399E-04	1.401E-04
Cs135	3.212E-04	3.212E-04	3.212E-04	3.212E-04	3.212E-04	3.212E-04	3.211E-04
Ba135	2.914E-07	2.916E-07	2.918E-07	2.920E-07	2.923E-07	2.928E-07	3.876E-07
Xe136	2.074E-03	2.074E-03	2.074E-03	2.074E-03	2.074E-03	2.074E-03	2.074E-03
Ba136	1.677E-05	1.677E-05	1.677E-05	1.677E-05	1.677E-05	1.677E-05	1.677E-05
Cs137	9.315E-04	8.894E-04	8.493E-04	8.109E-04	7.566E-04	6.741E-04	9.880E-14
Ba137	1.867E-04	2.287E-04	2.689E-04	3.072E-04	3.616E-04	4.441E-04	1.118E-03
Ba137m	1.425E-10	1.361E-10	1.299E-10	1.241E-10	1.158E-10	1.031E-10	1.512E-20
Ba138	1.148E-03	1.148E-03	1.148E-03	1.148E-03	1.148E-03	1.148E-03	1.148E-03
La138	4.902E-09	4.902E-09	4.902E-09	4.902E-09	4.902E-09	4.902E-09	4.902E-09
La139	1.097E-03	1.097E-03	1.097E-03	1.097E-03	1.097E-03	1.097E-03	1.097E-03
Ce140	1.116E-03	1.116E-03	1.116E-03	1.116E-03	1.116E-03	1.116E-03	1.116E-03
Pr141	1.007E-03	1.007E-03	1.007E-03	1.007E-03	1.007E-03	1.007E-03	1.007E-03
Ce142	1.012E-03	1.012E-03	1.012E-03	1.012E-03	1.012E-03	1.012E-03	1.012E-03
Nd142	2.306E-05	2.306E-05	2.306E-05	2.306E-05	2.306E-05	2.306E-05	2.306E-05
Nd143	7.015E-04	7.015E-04	7.015E-04	7.015E-04	7.015E-04	7.015E-04	7.015E-04
Ce144	1.151E-06	1.939E-07	3.266E-08	5.500E-09	3.802E-10	4.426E-12	0.00
Pr144	4.861E-11	8.187E-12	1.379E-12	2.322E-13	1.605E-14	1.869E-16	0.00
Pr144m	2.430E-13	4.093E-14	6.893E-15	1.161E-15	8.024E-17	9.342E-19	0.00
Nd144	1.174E-03	1.175E-03	1.175E-03	1.175E-03	1.175E-03	1.175E-03	1.175E-03
Nd145	6.063E-04	6.063E-04	6.063E-04	6.063E-04	6.063E-04	6.063E-04	6.063E-04
Nd146	6.155E-04	6.155E-04	6.155E-04	6.155E-04	6.155E-04	6.155E-04	6.155E-04
Pm146	2.707E-09	2.104E-09	1.635E-09	1.271E-09	8.708E-10	4.637E-10	0.00
Sm146	7.108E-09	7.331E-09	7.505E-09	7.640E-09	7.788E-09	7.938E-09	8.110E-09
Pm147	2.515E-05	1.482E-05	8.740E-06	5.152E-06	2.332E-06	6.224E-07	0.00
Sm147	1.709E-04	1.812E-04	1.873E-04	1.909E-04	1.937E-04	1.954E-04	1.960E-04
Nd148	3.349E-04	3.349E-04	3.349E-04	3.349E-04	3.349E-04	3.349E-04	3.349E-04
Sm148	1.560E-04	1.560E-04	1.560E-04	1.560E-04	1.560E-04	1.560E-04	1.560E-04
Sm149	2.218E-06	2.218E-06	2.218E-06	2.218E-06	2.218E-06	2.218E-06	2.218E-06
Nd150	1.631E-04	1.631E-04	1.631E-04	1.631E-04	1.631E-04	1.631E-04	1.631E-04
Sm150	2.217E-04	2.217E-04	2.217E-04	2.217E-04	2.217E-04	2.217E-04	2.217E-04
Eu150	2.301E-13	2.214E-13	2.131E-13	2.050E-13	1.935E-13	1.757E-13	1.123E-21
Sm151	1.101E-05	1.084E-05	1.068E-05	1.052E-05	1.028E-05	9.887E-06	5.212E-09
Eu151	5.309E-07	6.992E-07	8.650E-07	1.028E-06	1.268E-06	1.657E-06	1.154E-05
Sm152	1.186E-04	1.186E-04	1.186E-04	1.186E-04	1.186E-04	1.186E-04	1.186E-04
Eu152	3.217E-08	2.905E-08	2.624E-08	2.370E-08	2.034E-08	1.576E-08	3.211E-30
Gd152	1.862E-08	1.949E-08	2.028E-08	2.098E-08	2.192E-08	2.319E-08	2.759E-08
Eu153	9.864E-05	9.864E-05	9.864E-05	9.864E-05	9.864E-05	9.864E-05	9.864E-05
Gd153	2.753E-11	3.397E-12	4.192E-13	5.174E-14	2.243E-15	1.200E-17	0.00
Sm154	3.515E-05	3.515E-05	3.515E-05	3.515E-05	3.515E-05	3.515E-05	3.515E-05
Eu154	2.141E-05	1.822E-05	1.551E-05	1.320E-05	1.037E-05	6.927E-06	0.00
Gd154	1.668E-05	1.987E-05	2.258E-05	2.489E-05	2.772E-05	3.116E-05	3.809E-05

TABLE F.3.d. Fission Product Inventory by Isotope at 30 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Eu155	5.394E-06	4.078E-06	3.084E-06	2.332E-06	1.533E-06	7.622E-07	0.00
Gd155	7.178E-06	8.493E-06	9.488E-06	1.024E-05	1.104E-05	1.181E-05	1.257E-05
Gd156	5.815E-05	5.815E-05	5.815E-05	5.815E-05	5.815E-05	5.815E-05	5.815E-05
Gd157	8.765E-08	8.765E-08	8.765E-08	8.765E-08	8.765E-08	8.765E-08	8.765E-08
Gd158	1.695E-05	1.695E-05	1.695E-05	1.695E-05	1.695E-05	1.695E-05	1.695E-05
Tb159	2.520E-06	2.520E-06	2.520E-06	2.520E-06	2.520E-06	2.520E-06	2.520E-06
Gd160	1.234E-06	1.234E-06	1.234E-06	1.234E-06	1.234E-06	1.234E-06	1.234E-06
Tb160	5.060E-17	4.600E-20	4.182E-23	3.802E-26	1.042E-30	0.00	0.00
Dy160	2.685E-07	2.685E-07	2.685E-07	2.685E-07	2.685E-07	2.685E-07	2.685E-07
Dy161	4.037E-07	4.037E-07	4.037E-07	4.037E-07	4.037E-07	4.037E-07	4.037E-07
Dy162	3.610E-07	3.610E-07	3.610E-07	3.610E-07	3.610E-07	3.610E-07	3.610E-07
Dy163	2.827E-07	2.827E-07	2.827E-07	2.827E-07	2.827E-07	2.827E-07	2.827E-07
Dy164	4.179E-08	4.179E-08	4.179E-08	4.179E-08	4.179E-08	4.179E-08	4.179E-08
Ho165	1.389E-07	1.389E-07	1.389E-07	1.389E-07	1.389E-07	1.389E-07	1.389E-07
Ho166m	1.378E-09	1.377E-09	1.375E-09	1.373E-09	1.371E-09	1.367E-09	7.762E-10
Er166	4.411E-08	4.412E-08	4.412E-08	4.412E-08	4.412E-08	4.413E-08	4.472E-08
Er167	3.001E-09	3.001E-09	3.001E-09	3.001E-09	3.001E-09	3.001E-09	3.001E-09
Er168	7.961E-09	7.961E-09	7.961E-09	7.961E-09	7.961E-09	7.961E-09	7.961E-09
Tm169	5.396E-11	5.396E-11	5.396E-11	5.396E-11	5.396E-11	5.396E-11	5.396E-11
Er170	2.484E-14	2.484E-14	2.484E-14	2.484E-14	2.484E-14	2.484E-14	2.484E-14
Tm170	5.042E-17	9.829E-19	1.915E-20	3.833E-22	1.153E-23	6.115E-28	0.00
Yb170	1.663E-11	1.663E-11	1.663E-11	1.663E-11	1.663E-11	1.663E-11	1.663E-11
Tm171	6.295E-14	3.058E-14	1.485E-14	7.215E-15	2.443E-15	4.017E-16	0.00
Yb171	1.006E-12	1.039E-12	1.054E-12	1.062E-12	1.067E-12	1.069E-12	1.069E-12
Yb172	3.516E-14	3.516E-14	3.516E-14	3.516E-14	3.516E-14	3.516E-14	3.516E-14
TOTAL	3.082E-02	3.082E-02	3.082E-02	3.082E-02	3.082E-02	3.082E-02	3.082E-02

TABLE F.3.e. Fission Product Inventory by Isotope at 35 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 3	4.334E-08	3.874E-08	3.462E-08	3.095E-08	2.615E-08	1.975E-08	2.548E-32
Li 6	1.627E-10	1.627E-10	1.627E-10	1.627E-10	1.627E-10	1.627E-10	1.627E-10
Li 7	1.068E-11	1.068E-11	1.068E-11	1.068E-11	1.068E-11	1.068E-11	1.068E-11
Be 9	2.055E-11	2.055E-11	2.055E-11	2.055E-11	2.055E-11	2.055E-11	2.055E-11
Be 10	1.372E-10	1.372E-10	1.372E-10	1.372E-10	1.372E-10	1.372E-10	1.371E-10
C 14	2.772E-11	2.771E-11	2.770E-11	2.770E-11	2.769E-11	2.767E-11	2.458E-11
Zn 66	3.519E-14	3.519E-14	3.519E-14	3.519E-14	3.519E-14	3.519E-14	3.519E-14
Zn 67	1.448E-15	1.448E-15	1.448E-15	1.448E-15	1.448E-15	1.448E-15	1.448E-15
Ga 71	9.842E-13	9.842E-13	9.842E-13	9.842E-13	9.842E-13	9.842E-13	9.842E-13
Ge 72	2.475E-08	2.475E-08	2.475E-08	2.475E-08	2.475E-08	2.475E-08	2.475E-08
Ge 73	4.919E-08	4.919E-08	4.919E-08	4.919E-08	4.919E-08	4.919E-08	4.919E-08
Ge 74	1.053E-07	1.053E-07	1.053E-07	1.053E-07	1.053E-07	1.053E-07	1.053E-07
As 75	2.136E-07	2.136E-07	2.136E-07	2.136E-07	2.136E-07	2.136E-07	2.136E-07
Ge 76	5.182E-07	5.182E-07	5.182E-07	5.182E-07	5.182E-07	5.182E-07	5.182E-07
Se 76	6.695E-09	6.695E-09	6.695E-09	6.695E-09	6.695E-09	6.695E-09	6.695E-09
Se 77	1.046E-06	1.046E-06	1.046E-06	1.046E-06	1.046E-06	1.046E-06	1.046E-06
Se 78	2.553E-06	2.553E-06	2.553E-06	2.553E-06	2.553E-06	2.553E-06	2.553E-06
Se 79	6.115E-06	6.115E-06	6.114E-06	6.114E-06	6.114E-06	6.114E-06	6.050E-06
Br 79	5.252E-10	6.557E-10	7.862E-10	9.167E-10	1.112E-09	1.439E-09	6.504E-08
Se 80	1.381E-05	1.381E-05	1.381E-05	1.381E-05	1.381E-05	1.381E-05	1.381E-05
Kr 80	2.660E-10	2.660E-10	2.660E-10	2.660E-10	2.660E-10	2.660E-10	2.660E-10
Br 81	2.213E-05	2.213E-05	2.213E-05	2.213E-05	2.213E-05	2.213E-05	2.213E-05
Kr 81	2.924E-11	2.924E-11	2.924E-11	2.924E-11	2.924E-11	2.924E-11	2.915E-11
Se 82	3.420E-05	3.420E-05	3.420E-05	3.420E-05	3.420E-05	3.420E-05	3.420E-05
Kr 82	1.160E-06	1.160E-06	1.160E-06	1.160E-06	1.160E-06	1.160E-06	1.160E-06
Kr 83	3.954E-05	3.954E-05	3.954E-05	3.954E-05	3.954E-05	3.954E-05	3.954E-05
Kr 84	1.157E-04	1.157E-04	1.157E-04	1.157E-04	1.157E-04	1.157E-04	1.157E-04
Kr 85	1.554E-05	1.366E-05	1.200E-05	1.055E-05	8.686E-06	6.286E-06	1.905E-33
Rb 85	1.053E-04	1.072E-04	1.089E-04	1.103E-04	1.122E-04	1.146E-04	1.209E-04
Kr 86	1.880E-04	1.880E-04	1.880E-04	1.880E-04	1.880E-04	1.880E-04	1.880E-04
Sr 86	4.777E-07	4.777E-07	4.777E-07	4.777E-07	4.777E-07	4.777E-07	4.777E-07
Rb 87	2.407E-04	2.407E-04	2.407E-04	2.407E-04	2.407E-04	2.407E-04	2.407E-04
Sr 87	4.148E-09	4.148E-09	4.148E-09	4.148E-09	4.148E-09	4.148E-09	4.152E-09
Sr 88	3.449E-04	3.449E-04	3.449E-04	3.449E-04	3.449E-04	3.449E-04	3.449E-04
Y 89	4.486E-04	4.486E-04	4.486E-04	4.486E-04	4.486E-04	4.486E-04	4.486E-04
Sr 90	4.488E-04	4.280E-04	4.081E-04	3.891E-04	3.623E-04	3.216E-04	2.382E-14
Y 90	1.125E-07	1.073E-07	1.023E-07	9.757E-08	9.085E-08	8.065E-08	5.974E-18
Zr 90	9.687E-05	1.177E-04	1.376E-04	1.566E-04	1.834E-04	2.241E-04	5.458E-04
Y 91	1.719E-16	2.996E-20	5.224E-24	9.109E-28	2.097E-33	0.00	0.00
Zr 91	5.858E-04	5.858E-04	5.858E-04	5.858E-04	5.858E-04	5.858E-04	5.858E-04
Zr 92	6.420E-04	6.420E-04	6.420E-04	6.420E-04	6.420E-04	6.420E-04	6.420E-04
Zr 93	7.276E-04	7.276E-04	7.276E-04	7.276E-04	7.276E-04	7.276E-04	7.273E-04

TABLE F.3.e. Fission Product Inventory by Isotope at 35 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Nb 93	6.082E-10	8.726E-10	1.175E-09	1.512E-09	2.076E-09	3.144E-09	3.241E-07
Nb 93M	2.069E-09	2.464E-09	2.821E-09	3.143E-09	3.569E-09	4.148E-09	6.142E-09
Zr 94	7.593E-04	7.593E-04	7.593E-04	7.593E-04	7.593E-04	7.593E-04	7.593E-04
Nb 94	9.008E-10	9.007E-10	9.007E-10	9.006E-10	9.005E-10	9.003E-10	8.707E-10
Zr 95	2.735E-15	1.000E-18	3.656E-22	1.337E-25	9.346E-31	0.00	0.00
Nb 95	3.336E-15	1.220E-18	4.460E-22	1.631E-25	8.520E-33	0.00	0.00
Mo 95	7.721E-04	7.721E-04	7.721E-04	7.721E-04	7.721E-04	7.721E-04	7.721E-04
Zr 96	8.278E-04	8.278E-04	8.278E-04	8.278E-04	8.278E-04	8.278E-04	8.278E-04
Mo 96	4.353E-05	4.353E-05	4.353E-05	4.353E-05	4.353E-05	4.353E-05	4.353E-05
Mo 97	8.274E-04	8.274E-04	8.274E-04	8.274E-04	8.274E-04	8.274E-04	8.274E-04
Mo 98	8.696E-04	8.696E-04	8.696E-04	8.696E-04	8.696E-04	8.696E-04	8.696E-04
Tc 98	7.718E-09	7.718E-09	7.718E-09	7.718E-09	7.718E-09	7.718E-09	7.717E-09
Tc 99	7.988E-04	7.988E-04	7.988E-04	7.988E-04	7.988E-04	7.988E-04	7.963E-04
Ru 99	2.061E-08	2.581E-08	3.101E-08	3.620E-08	4.400E-08	5.700E-08	2.600E-06
Mo100	9.849E-04	9.849E-04	9.849E-04	9.849E-04	9.849E-04	9.849E-04	9.849E-04
Ru100	1.165E-04	1.165E-04	1.165E-04	1.165E-04	1.165E-04	1.165E-04	1.165E-04
Ru101	8.207E-04	8.207E-04	8.207E-04	8.207E-04	8.207E-04	8.207E-04	8.207E-04
Ru102	8.414E-04	8.414E-04	8.414E-04	8.414E-04	8.414E-04	8.414E-04	8.414E-04
Rh102	2.878E-10	1.785E-10	1.106E-10	6.860E-11	3.349E-11	1.014E-11	0.00
Rh103	4.835E-04	4.835E-04	4.835E-04	4.835E-04	4.835E-04	4.835E-04	4.835E-04
Ru104	6.237E-04	6.237E-04	6.237E-04	6.237E-04	6.237E-04	6.237E-04	6.237E-04
Pd104	2.825E-04	2.825E-04	2.825E-04	2.825E-04	2.825E-04	2.825E-04	2.825E-04
Pd105	4.449E-04	4.449E-04	4.449E-04	4.449E-04	4.449E-04	4.449E-04	4.449E-04
Ru106	2.619E-06	6.620E-07	1.673E-07	4.229E-08	5.375E-09	1.726E-10	0.00
Rh106	2.462E-12	6.222E-13	1.573E-13	3.975E-14	5.052E-15	1.623E-16	0.00
Pd106	4.375E-04	4.395E-04	4.400E-04	4.401E-04	4.401E-04	4.401E-04	4.401E-04
Pd107	2.703E-04	2.703E-04	2.703E-04	2.703E-04	2.703E-04	2.703E-04	2.703E-04
Ag107	2.151E-10	2.728E-10	3.305E-10	3.881E-10	4.747E-10	6.189E-10	2.889E-08
Pd108	1.874E-04	1.874E-04	1.874E-04	1.874E-04	1.874E-04	1.874E-04	1.874E-04
Ag108m	1.413E-12	1.397E-12	1.382E-12	1.367E-12	1.345E-12	1.309E-12	6.223E-15
Cd108	5.725E-10	5.725E-10	5.725E-10	5.725E-10	5.725E-10	5.725E-10	5.726E-10
Ag109	9.178E-05	9.178E-05	9.178E-05	9.178E-05	9.178E-05	9.178E-05	9.178E-05
Cd109	2.688E-14	9.026E-15	3.031E-15	1.018E-15	1.980E-16	1.294E-17	0.00
Pd110	6.144E-05	6.144E-05	6.144E-05	6.144E-05	6.144E-05	6.144E-05	6.144E-05
Ag110	3.677E-17	4.846E-18	6.389E-19	8.421E-20	4.031E-21	2.543E-23	0.00
Ag110m	2.426E-09	3.198E-10	4.216E-11	5.557E-12	2.660E-13	1.678E-15	0.00
Cd110	4.842E-05	4.843E-05	4.843E-05	4.843E-05	4.843E-05	4.843E-05	4.843E-05
Cd111	3.389E-05	3.389E-05	3.389E-05	3.389E-05	3.389E-05	3.389E-05	3.389E-05
Cd112	2.006E-05	2.006E-05	2.006E-05	2.006E-05	2.006E-05	2.006E-05	2.006E-05
Cd113	1.549E-07	1.550E-07	1.550E-07	1.550E-07	1.550E-07	1.551E-07	1.552E-07
Cd113m	2.365E-07	2.151E-07	1.956E-07	1.778E-07	1.542E-07	1.216E-07	7.310E-28
In113	9.915E-08	1.206E-07	1.400E-07	1.577E-07	1.814E-07	2.139E-07	3.354E-07

TABLE F.3.e. Fission Product Inventory by Isotope at 35 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cd114	2.624E-05	2.624E-05	2.624E-05	2.624E-05	2.624E-05	2.624E-05	2.624E-05
Sn114	2.401E-09	2.401E-09	2.401E-09	2.401E-09	2.401E-09	2.401E-09	2.401E-09
In115	2.400E-06	2.400E-06	2.400E-06	2.400E-06	2.400E-06	2.400E-06	2.400E-06
Sn115	3.658E-07	3.658E-07	3.658E-07	3.658E-07	3.658E-07	3.658E-07	3.658E-07
Cd116	9.378E-06	9.378E-06	9.378E-06	9.378E-06	9.378E-06	9.378E-06	9.378E-06
Sn116	8.800E-06	8.800E-06	8.800E-06	8.800E-06	8.800E-06	8.800E-06	8.800E-06
Sn117	9.468E-06	9.468E-06	9.468E-06	9.468E-06	9.468E-06	9.468E-06	9.468E-06
Sn118	9.546E-06	9.546E-06	9.546E-06	9.546E-06	9.546E-06	9.546E-06	9.546E-06
Sn119	9.519E-06	9.519E-06	9.519E-06	9.519E-06	9.519E-06	9.519E-06	9.519E-06
Sn119m	9.641E-11	1.221E-11	1.546E-12	1.958E-13	8.820E-15	5.032E-17	0.00
Sn120	9.694E-06	9.694E-06	9.694E-06	9.694E-06	9.694E-06	9.694E-06	9.694E-06
Sn121m	3.699E-09	3.598E-09	3.499E-09	3.403E-09	3.265E-09	3.046E-09	3.804E-15
Sb121	9.327E-06	9.327E-06	9.327E-06	9.327E-06	9.328E-06	9.328E-06	9.331E-06
Sn122	1.064E-05	1.064E-05	1.064E-05	1.064E-05	1.064E-05	1.064E-05	1.064E-05
Te122	7.244E-07	7.244E-07	7.244E-07	7.244E-07	7.244E-07	7.244E-07	7.244E-07
Sn123	2.899E-12	5.751E-14	1.141E-15	2.264E-17	6.321E-20	3.504E-24	0.00
Sb123	1.151E-05	1.151E-05	1.151E-05	1.151E-05	1.151E-05	1.151E-05	1.151E-05
Te123	1.070E-08	1.070E-08	1.070E-08	1.070E-08	1.070E-08	1.070E-08	1.070E-08
Te123m	6.428E-15	9.346E-17	1.359E-18	1.976E-20	2.848E-23	7.258E-28	0.00
Sn124	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05	1.429E-05
Te124	5.587E-07	5.587E-07	5.587E-07	5.587E-07	5.587E-07	5.587E-07	5.587E-07
Sb125	3.224E-06	1.955E-06	1.185E-06	7.183E-07	3.391E-07	9.702E-08	0.00
Te125	1.844E-05	1.972E-05	2.050E-05	2.098E-05	2.136E-05	2.161E-05	2.171E-05
Te125m	4.510E-08	2.735E-08	1.658E-08	1.005E-08	4.742E-09	1.357E-09	0.00
Sn126	3.119E-05	3.119E-05	3.119E-05	3.119E-05	3.119E-05	3.119E-05	3.098E-05
Sb126	1.482E-12	1.482E-12	1.482E-12	1.482E-12	1.482E-12	1.482E-12	1.472E-12
Sb126m	1.127E-14	1.127E-14	1.127E-14	1.127E-14	1.127E-14	1.127E-14	1.119E-14
Te126	8.962E-07	8.966E-07	8.971E-07	8.975E-07	8.981E-07	8.992E-07	1.110E-06
Te127	4.159E-15	3.996E-17	3.839E-19	3.689E-21	3.474E-24	3.143E-29	0.00
Te127m	1.188E-12	1.141E-14	1.097E-16	1.054E-18	9.924E-22	8.979E-27	0.00
I127	6.277E-05	6.277E-05	6.277E-05	6.277E-05	6.277E-05	6.277E-05	6.277E-05
Te128	1.224E-04	1.224E-04	1.224E-04	1.224E-04	1.224E-04	1.224E-04	1.224E-04
Xe128	3.964E-06	3.964E-06	3.964E-06	3.964E-06	3.964E-06	3.964E-06	3.964E-06
I129	1.959E-04	1.959E-04	1.959E-04	1.959E-04	1.959E-04	1.959E-04	1.959E-04
Xe129	2.519E-08	2.521E-08	2.523E-08	2.524E-08	2.527E-08	2.531E-08	3.379E-08
Te130	3.862E-04	3.862E-04	3.862E-04	3.862E-04	3.862E-04	3.862E-04	3.862E-04
Xe130	1.560E-05	1.560E-05	1.560E-05	1.560E-05	1.560E-05	1.560E-05	1.560E-05
Xe131	4.369E-04	4.369E-04	4.369E-04	4.369E-04	4.369E-04	4.369E-04	4.369E-04
Xe132	1.183E-03	1.183E-03	1.183E-03	1.183E-03	1.183E-03	1.183E-03	1.183E-03
Ba132	2.290E-09	2.290E-09	2.290E-09	2.290E-09	2.290E-09	2.290E-09	2.290E-09
Cs133	1.162E-03	1.162E-03	1.162E-03	1.162E-03	1.162E-03	1.162E-03	1.162E-03
Xe134	1.547E-03	1.547E-03	1.547E-03	1.547E-03	1.547E-03	1.547E-03	1.547E-03

TABLE F.3.e. Fission Product Inventory by Isotope at 35 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cs134	1.696E-05	8.660E-06	4.421E-06	2.257E-06	8.233E-07	1.533E-07	0.00
Ba134	1.712E-04	1.795E-04	1.837E-04	1.859E-04	1.873E-04	1.880E-04	1.882E-04
Cs135	3.393E-04	3.393E-04	3.393E-04	3.393E-04	3.393E-04	3.393E-04	3.392E-04
Ba135	4.740E-07	4.742E-07	4.744E-07	4.746E-07	4.749E-07	4.754E-07	5.757E-07
Xe136	2.470E-03	2.470E-03	2.470E-03	2.470E-03	2.470E-03	2.470E-03	2.470E-03
Ba136	2.099E-05	2.099E-05	2.099E-05	2.099E-05	2.099E-05	2.099E-05	2.099E-05
Cs137	1.087E-03	1.038E-03	9.914E-04	9.467E-04	8.833E-04	7.869E-04	1.153E-13
Ba137	2.179E-04	2.670E-04	3.139E-04	3.586E-04	4.220E-04	5.184E-04	1.305E-03
Ba137m	1.664E-10	1.588E-10	1.517E-10	1.448E-10	1.351E-10	1.204E-10	1.765E-20
Ba138	1.330E-03	1.330E-03	1.330E-03	1.330E-03	1.330E-03	1.330E-03	1.330E-03
La138	5.081E-09	5.081E-09	5.081E-09	5.081E-09	5.081E-09	5.081E-09	5.081E-09
La139	1.269E-03	1.269E-03	1.269E-03	1.269E-03	1.269E-03	1.269E-03	1.269E-03
Ce140	1.297E-03	1.297E-03	1.297E-03	1.297E-03	1.297E-03	1.297E-03	1.297E-03
Pr141	1.161E-03	1.161E-03	1.161E-03	1.161E-03	1.161E-03	1.161E-03	1.161E-03
Ce142	1.171E-03	1.171E-03	1.171E-03	1.171E-03	1.171E-03	1.171E-03	1.171E-03
Nd142	3.208E-05	3.208E-05	3.208E-05	3.208E-05	3.208E-05	3.208E-05	3.208E-05
Nd143	7.565E-04	7.565E-04	7.565E-04	7.565E-04	7.565E-04	7.565E-04	7.565E-04
Ce144	1.317E-06	2.219E-07	3.737E-08	6.294E-09	4.350E-10	5.064E-12	0.00
Pr144	5.562E-11	9.368E-12	1.578E-12	2.657E-13	1.837E-14	2.138E-16	0.00
Pr144m	2.781E-13	4.683E-14	7.887E-15	1.328E-15	9.182E-17	1.069E-18	0.00
Nd144	1.403E-03	1.404E-03	1.404E-03	1.404E-03	1.404E-03	1.404E-03	1.404E-03
Nd145	6.848E-04	6.848E-04	6.848E-04	6.848E-04	6.848E-04	6.848E-04	6.848E-04
Nd146	7.294E-04	7.294E-04	7.294E-04	7.294E-04	7.294E-04	7.294E-04	7.294E-04
Pm146	3.465E-09	2.693E-09	2.093E-09	1.627E-09	1.115E-09	5.936E-10	0.00
Sm146	9.070E-09	9.356E-09	9.578E-09	9.751E-09	9.940E-09	1.013E-08	1.035E-08
Pm147	2.582E-05	1.522E-05	8.973E-06	5.290E-06	2.394E-06	6.389E-07	0.00
Sm147	1.746E-04	1.852E-04	1.915E-04	1.952E-04	1.981E-04	1.998E-04	2.005E-04
Nd148	3.906E-04	3.906E-04	3.906E-04	3.906E-04	3.906E-04	3.906E-04	3.906E-04
Sm148	1.917E-04	1.917E-04	1.917E-04	1.917E-04	1.917E-04	1.917E-04	1.917E-04
Sm149	2.393E-06	2.393E-06	2.393E-06	2.393E-06	2.393E-06	2.393E-06	2.393E-06
Nd150	1.934E-04	1.934E-04	1.934E-04	1.934E-04	1.934E-04	1.934E-04	1.934E-04
Sm150	2.591E-04	2.591E-04	2.591E-04	2.591E-04	2.591E-04	2.591E-04	2.591E-04
Eu150	2.459E-13	2.366E-13	2.276E-13	2.190E-13	2.067E-13	1.878E-13	1.200E-21
Sm151	1.176E-05	1.158E-05	1.140E-05	1.123E-05	1.097E-05	1.056E-05	5.565E-09
Eu151	5.649E-07	7.446E-07	9.216E-07	1.096E-06	1.352E-06	1.767E-06	1.232E-05
Sm152	1.323E-04	1.323E-04	1.323E-04	1.323E-04	1.323E-04	1.323E-04	1.323E-04
Eu152	2.838E-08	2.563E-08	2.314E-08	2.090E-08	1.794E-08	1.390E-08	2.832E-30
Gd152	1.640E-08	1.716E-08	1.786E-08	1.848E-08	1.931E-08	2.043E-08	2.430E-08
Eu153	1.186E-04	1.186E-04	1.186E-04	1.186E-04	1.186E-04	1.186E-04	1.186E-04
Gd153	3.087E-11	3.810E-12	4.702E-13	5.803E-14	2.516E-15	1.346E-17	0.00
Sm154	4.331E-05	4.331E-05	4.331E-05	4.331E-05	4.331E-05	4.331E-05	4.331E-05

TABLE F.3.e. Fission Product Inventory by Isotope at 35 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Eu154	2.820E-05	2.400E-05	2.043E-05	1.739E-05	1.365E-05	9.125E-06	0.00
Gd154	2.200E-05	2.620E-05	2.978E-05	3.282E-05	3.655E-05	4.108E-05	5.020E-05
Eu155	7.073E-06	5.348E-06	4.044E-06	3.058E-06	2.010E-06	9.994E-07	0.00
Gd155	9.393E-06	1.112E-05	1.242E-05	1.341E-05	1.446E-05	1.547E-05	1.647E-05
Gd156	8.542E-05	8.542E-05	8.542E-05	8.542E-05	8.542E-05	8.542E-05	8.542E-05
Gd157	1.124E-07	1.124E-07	1.124E-07	1.124E-07	1.124E-07	1.124E-07	1.124E-07
Gd158	2.305E-05	2.305E-05	2.305E-05	2.305E-05	2.305E-05	2.305E-05	2.305E-05
Tb159	3.216E-06	3.216E-06	3.216E-06	3.216E-06	3.216E-06	3.216E-06	3.216E-06
Gd160	1.570E-06	1.570E-06	1.570E-06	1.570E-06	1.570E-06	1.570E-06	1.570E-06
Tb160	7.675E-17	6.978E-20	6.343E-23	5.767E-26	1.581E-30	0.00	0.00
Dy160	3.871E-07	3.871E-07	3.871E-07	3.871E-07	3.871E-07	3.871E-07	3.871E-07
Dy161	5.013E-07	5.013E-07	5.013E-07	5.013E-07	5.013E-07	5.013E-07	5.013E-07
Dy162	4.568E-07	4.568E-07	4.568E-07	4.568E-07	4.568E-07	4.568E-07	4.568E-07
Dy163	3.849E-07	3.849E-07	3.849E-07	3.849E-07	3.849E-07	3.849E-07	3.849E-07
Dy164	5.561E-08	5.561E-08	5.561E-08	5.561E-08	5.561E-08	5.561E-08	5.561E-08
Ho165	2.021E-07	2.021E-07	2.021E-07	2.021E-07	2.021E-07	2.021E-07	2.021E-07
Ho166m	2.335E-09	2.333E-09	2.330E-09	2.327E-09	2.323E-09	2.317E-09	1.315E-09
Er166	6.710E-08	6.710E-08	6.711E-08	6.711E-08	6.711E-08	6.712E-08	6.812E-08
Er167	3.807E-09	3.807E-09	3.807E-09	3.807E-09	3.807E-09	3.807E-09	3.807E-09
Er168	1.136E-08	1.136E-08	1.136E-08	1.136E-08	1.136E-08	1.136E-08	1.136E-08
Tm169	8.636E-11	8.636E-11	8.636E-11	8.636E-11	8.636E-11	8.636E-11	8.636E-11
Er170	4.712E-14	4.712E-14	4.712E-14	4.712E-14	4.712E-14	4.712E-14	4.712E-14
Tm170	9.658E-17	1.883E-18	3.668E-20	7.103E-22	0.00	0.00	0.00
Yb170	3.140E-11	3.140E-11	3.140E-11	3.140E-11	3.140E-11	3.140E-11	3.140E-11
Tm171	1.447E-13	7.030E-14	3.415E-14	1.659E-14	5.616E-15	9.236E-16	0.00
Yb171	2.279E-12	2.354E-12	2.390E-12	2.408E-12	2.419E-12	2.423E-12	2.424E-12
Yb172	9.526E-14	9.526E-14	9.526E-14	9.526E-14	9.526E-14	9.526E-14	9.526E-14
TOTAL	3.592E-02	3.592E-02	3.592E-02	3.592E-02	3.592E-02	3.592E-02	3.592E-02

TABLE F.4.a. Actinide Inventory by Isotope at 15 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He 4	2.102E-07	2.358E-07	2.629E-07	2.916E-07	3.370E-07	4.179E-07	1.187E-05
Pb207	3.782E-15	6.199E-15	9.272E-15	1.303E-14	1.998E-14	3.529E-14	1.303E-10
Pb208	7.697E-12	1.178E-11	1.628E-11	2.101E-11	2.832E-11	4.053E-11	2.949E-10
Pb212	3.392E-15	3.858E-15	4.140E-15	4.296E-15	4.375E-15	4.307E-15	4.423E-19
Ra224	2.959E-14	3.365E-14	3.612E-14	3.748E-14	3.817E-14	3.757E-14	3.858E-18
Ra226	1.985E-13	2.900E-13	3.990E-13	5.255E-13	7.482E-13	1.207E-12	2.139E-09
Ac227	3.638E-14	4.745E-14	5.896E-14	7.088E-14	8.947E-14	1.222E-13	9.156E-12
Th228	5.748E-12	6.525E-12	7.002E-12	7.265E-12	7.404E-12	7.295E-12	7.498E-16
Th229	1.886E-13	1.992E-13	2.107E-13	2.230E-13	2.432E-13	2.812E-13	2.318E-10
Th230	4.688E-09	5.681E-09	6.676E-09	7.674E-09	9.175E-09	1.169E-08	5.603E-07
Th231	5.828E-14	5.828E-14	5.828E-14	5.828E-14	5.829E-14	5.829E-14	5.876E-14
Th232	5.349E-10	6.667E-10	7.986E-10	9.305E-10	1.128E-09	1.458E-09	6.771E-08
Th234	1.396E-11	1.396E-11	1.396E-11	1.396E-11	1.396E-11	1.396E-11	1.396E-11
Pa231	3.165E-10	3.443E-10	3.721E-10	3.999E-10	4.416E-10	5.110E-10	1.402E-08
Pa233	5.136E-12	5.155E-12	5.178E-12	5.203E-12	5.247E-12	5.333E-12	1.969E-11
U232	2.708E-10	2.822E-10	2.870E-10	2.878E-10	2.847E-10	2.747E-10	2.776E-14
U233	1.186E-09	1.288E-09	1.390E-09	1.493E-09	1.645E-09	1.893E-09	1.325E-07
U234	1.780E-04	1.785E-04	1.789E-04	1.793E-04	1.799E-04	1.808E-04	2.048E-04
U235	1.433E-02	1.433E-02	1.433E-02	1.433E-02	1.433E-02	1.434E-02	1.445E-02
U236	2.265E-03	2.266E-03	2.266E-03	2.266E-03	2.266E-03	2.267E-03	2.377E-03
U237	1.219E-11	1.107E-11	1.005E-11	9.130E-12	7.902E-12	6.212E-12	7.237E-19
U238	9.615E-01	9.615E-01	9.615E-01	9.615E-01	9.615E-01	9.615E-01	9.615E-01
Np235	1.815E-14	5.054E-15	1.407E-15	3.919E-16	5.760E-17	2.357E-18	0.00
Np236	1.044E-10	1.044E-10	1.044E-10	1.044E-10	1.044E-10	1.044E-10	1.038E-10
Np237	1.512E-04	1.518E-04	1.524E-04	1.532E-04	1.545E-04	1.570E-04	5.797E-04
Np238	8.685E-14	8.606E-14	8.528E-14	8.450E-14	8.336E-14	8.148E-14	9.339E-16
Np239	6.110E-12	6.108E-12	6.107E-12	6.106E-12	6.104E-12	6.101E-12	5.565E-12
Pu236	4.415E-11	2.715E-11	1.670E-11	1.027E-11	4.951E-12	1.468E-12	2.315E-16
Pu238	2.731E-05	2.688E-05	2.646E-05	2.605E-05	2.545E-05	2.447E-05	1.596E-08
Pu239	4.269E-03	4.269E-03	4.269E-03	4.268E-03	4.268E-03	4.267E-03	4.149E-03
Pu240	1.137E-03	1.137E-03	1.137E-03	1.137E-03	1.136E-03	1.136E-03	1.024E-03
Pu241	3.936E-04	3.575E-04	3.247E-04	2.949E-04	2.552E-04	2.006E-04	2.340E-11
Pu242	8.436E-05	8.436E-05	8.436E-05	8.436E-05	8.436E-05	8.436E-05	8.429E-05
Pu244	6.287E-10	6.287E-10	6.287E-10	6.287E-10	6.287E-10	6.287E-10	6.287E-10
Am241	1.568E-04	1.924E-04	2.245E-04	2.536E-04	2.919E-04	3.439E-04	1.145E-04
Am242m	4.632E-07	4.590E-07	4.548E-07	4.507E-07	4.446E-07	4.346E-07	4.981E-09
Am242	5.541E-12	5.491E-12	5.441E-12	5.391E-12	5.318E-12	5.198E-12	5.958E-14
Am243	7.109E-06	7.108E-06	7.107E-06	7.105E-06	7.103E-06	7.100E-06	6.476E-06
Cm242	1.448E-09	1.127E-09	1.103E-09	1.092E-09	1.078E-09	1.052E-09	1.205E-11
Cm243	3.550E-08	3.381E-08	3.221E-08	3.068E-08	2.852E-08	2.526E-08	1.125E-18
Cm244	6.262E-07	5.800E-07	5.373E-07	4.977E-07	4.437E-07	3.664E-07	1.879E-23

TABLE F.4.a. Actinide Inventory by Isotope at 15 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cm245	1.520E-08	1.520E-08	1.520E-08	1.520E-08	1.519E-08	1.519E-08	1.402E-08
Cm246	7.210E-10	7.208E-10	7.206E-10	7.204E-10	7.201E-10	7.196E-10	6.233E-10
Cm247	2.834E-12	2.834E-12	2.834E-12	2.834E-12	2.834E-12	2.834E-12	2.834E-12
Cm248	5.869E-14	5.869E-14	5.869E-14	5.869E-14	5.869E-14	5.869E-14	5.857E-14
TOTAL	9.845E-01	9.845E-01	9.845E-01	9.845E-01	9.845E-01	9.845E-01	9.845E-01

TABLE F.4.b. Actinide Inventory by Isotope at 20 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He 4	4.055E-07	4.472E-07	4.911E-07	5.371E-07	6.093E-07	7.368E-07	1.710E-05
Pb207	4.042E-15	6.586E-15	9.784E-15	1.365E-14	2.071E-14	3.596E-14	1.049E-10
Pb208	1.295E-11	2.017E-11	2.819E-11	3.669E-11	4.987E-11	7.197E-11	5.333E-10
Pb212	5.951E-15	6.855E-15	7.413E-15	7.729E-15	7.904E-15	7.802E-15	7.906E-19
Ra224	5.192E-14	5.980E-14	6.467E-14	6.742E-14	6.895E-14	6.806E-14	6.897E-18
Ra226	1.832E-13	2.678E-13	3.688E-13	4.861E-13	6.931E-13	1.121E-12	2.230E-09
Ac227	3.851E-14	4.965E-14	6.101E-14	7.255E-14	9.018E-14	1.204E-13	7.328E-12
Th228	1.009E-11	1.160E-11	1.254E-11	1.307E-11	1.338E-11	1.321E-11	1.340E-15
Th229	3.120E-13	3.252E-13	3.397E-13	3.555E-13	3.817E-13	4.317E-13	3.462E-10
Th230	4.330E-09	5.257E-09	6.188E-09	7.124E-09	8.537E-09	1.091E-08	5.907E-07
Th231	4.627E-14	4.628E-14	4.628E-14	4.628E-14	4.628E-14	4.628E-14	4.680E-14
Th232	6.493E-10	8.083E-10	9.673E-10	1.126E-09	1.365E-09	1.762E-09	8.190E-08
Th234	1.390E-11	1.390E-11	1.390E-11	1.390E-11	1.390E-11	1.390E-11	1.390E-11
Pa231	3.246E-10	3.467E-10	3.687E-10	3.908E-10	4.239E-10	4.790E-10	1.122E-08
Pa231	7.685E-12	7.713E-12	7.746E-12	7.785E-12	7.851E-12	7.978E-12	2.954E-11
U232	4.838E-10	5.074E-10	5.178E-10	5.203E-10	5.157E-10	4.980E-10	4.981E-14
U233	1.461E-09	1.613E-09	1.766E-09	1.919E-09	2.147E-09	2.518E-09	1.983E-07
U234	1.659E-04	1.668E-04	1.676E-04	1.684E-04	1.696E-04	1.715E-04	2.194E-04
U235	1.138E-02	1.138E-02	1.138E-02	1.138E-02	1.138E-02	1.138E-02	1.151E-02
U236	2.731E-03	2.731E-03	2.732E-03	2.732E-03	2.733E-03	2.733E-03	2.884E-03
U237	1.837E-11	1.669E-11	1.515E-11	1.376E-11	1.191E-11	9.365E-12	4.082E-18
U238	9.576E-01	.576E-01	9.576E-01	9.576E-01	9.576E-01	9.576E-01	9.576E-01
Np235	3.389E-14	9.437E-15	2.628E-15	7.318E-16	1.075E-16	4.401E-18	0.00
Np236	1.793E-10	1.793E-10	1.793E-10	1.793E-10	1.793E-10	1.793E-10	1.782E-10
Np237	2.263E-04	2.271E-04	2.281E-04	2.292E-04	2.311E-04	2.349E-04	8.697E-04
Np238	1.348E-13	1.336E-13	1.324E-13	1.312E-13	1.294E-13	1.265E-13	1.450E-15
Np239	1.813E-11	1.813E-11	1.813E-11	1.812E-11	1.812E-11	1.811E-11	1.652E-11
Pu236	8.737E-11	5.373E-11	3.304E-11	2.032E-11	9.797E-12	2.905E-12	3.977E-16
Pu238	5.425E-05	5.340E-05	5.257E-05	5.175E-05	5.055E-05	4.860E-05	2.938E-08
Pu239	4.668E-03	4.668E-03	4.668E-03	4.668E-03	4.667E-03	4.666E-03	4.538E-03
Pu240	1.553E-03	1.553E-03	1.553E-03	1.553E-03	1.553E-03	1.552E-03	1.400E-03
Pu241	5.934E-04	5.389E-04	4.895E-04	4.445E-04	3.848E-04	3.025E-04	1.320E-10
Pu242	1.762E-04	1.762E-04	1.762E-04	1.762E-04	1.762E-04	1.762E-04	1.760E-04
Pu244	2.726E-09	2.726E-09	2.726E-09	2.726E-09	2.726E-09	2.726E-09	2.726E-09
Am241	2.331E-04	2.867E-04	3.352E-04	3.789E-04	4.368E-04	5.152E-04	1.720E-04
Am242m	7.191E-07	7.125E-07	7.061E-07	6.997E-07	6.902E-07	6.746E-07	7.732E-09
Am242	8.602E-12	8.524E-12	8.446E-12	8.369E-12	8.256E-12	8.070E-12	9.249E-14
Am243	2.110E-05	2.110E-05	2.109E-05	2.109E-05	2.108E-05	2.107E-05	1.922E-05
Cm242	2.392E-09	1.756E-09	1.712E-09	1.695E-09	1.673E-09	1.632E-09	1.870E-11
Cm243	9.973E-08	9.500E-08	9.049E-08	8.619E-08	8.013E-08	7.095E-08	3.161E-18
Cm244	2.695E-06	2.497E-06	2.313E-06	2.142E-06	1.910E-06	1.577E-06	8.087E-23

TABLE F.4.b. Actinide Inventory by Isotope at 20 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cm245	8.576E-08	8.574E-08	8.573E-08	8.572E-08	8.570E-08	8.566E-08	7.908E-08
Cm246	5.846E-09	5.845E-09	5.843E-09	5.841E-09	5.839E-09	5.834E-09	5.054E-09
Cm247	3.180E-11	3.180E-11	3.180E-11	3.180E-11	3.180E-11	3.180E-11	3.180E-11
Cm248	9.181E-13	9.181E-13	9.181E-13	9.181E-13	9.181E-13	9.181E-13	9.162E-13
Cf249	6.575E-15	6.588E-15	6.570E-15	6.546E-15	6.507E-15	6.443E-15	9.276E-16
TOTAL	9.794E-01	9.794E-01	9.794E-01	9.794E-01	9.794E-01	9.794E-01	9.794E-01

TABLE F.4.c. Actinide Inventory by Isotope at 25 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He 4	6.634E-07	7.265E-07	7.921E-07	8.599E-07	9.650E-07	1.148E-06	2.200E-05
Pb207	4.186E-15	6.794E-15	1.005E-14	1.394E-14	2.100E-14	3.599E-14	8.366E-11
Pb208	1.964E-11	3.097E-11	4.366E-11	5.716E-11	7.816E-11	1.134E-10	8.513E-10
Pb212	9.301E-15	1.081E-14	1.175E-14	1.229E-14	1.261E-14	1.247E-14	1.245E-18
Ra224	8.114E-14	9.429E-14	1.025E-13	1.072E-13	1.100E-13	1.088E-13	1.086E-17
Ra226	1.687E-13	2.467E-13	3.401E-13	4.490E-13	6.415E-13	1.041E-12	2.406E-09
Ac227	3.963E-14	5.069E-14	6.177E-14	7.286E-14	8.953E-14	1.174E-13	5.802E-12
Th228	1.576E-11	1.828E-11	1.987E-11	2.079E-11	2.133E-11	2.112E-11	2.110E-15
Th229	4.782E-13	4.936E-13	5.107E-13	5.297E-13	5.614E-13	6.228E-13	4.558E-10
Th230	3.991E-09	4.858E-09	5.732E-09	6.613E-09	7.950E-09	1.021E-08	6.452E-07
Th231	3.628E-14	3.628E-14	3.628E-14	3.629E-14	3.629E-14	3.629E-14	3.683E-14
Th232	7.397E-10	9.194E-10	1.099E-09	1.279E-09	1.549E-09	1.998E-09	9.285E-08
Th234	1.384E-11	1.384E-11	1.384E-11	1.384E-11	1.384E-11	1.384E-11	1.384E-11
Pa231	3.266E-10	3.439E-10	3.612E-10	3.785E-10	4.045E-10	4.477E-10	8.882E-09
Pa233	1.040E-11	1.043E-11	1.048E-11	1.053E-11	1.061E-11	1.078E-11	3.865E-11
U232	7.658E-10	8.065E-10	8.251E-10	8.303E-10	8.238E-10	7.963E-10	7.857E-14
U233	1.692E-09	1.897E-09	2.104E-09	2.311E-09	2.619E-09	3.120E-09	2.605E-07
U234	1.548E-04	1.562E-04	1.575E-04	1.589E-04	1.609E-04	1.641E-04	2.438E-04
U235	8.923E-03	8.924E-03	8.924E-03	8.924E-03	8.925E-03	8.925E-03	9.059E-03
U236	3.088E-03	3.088E-03	3.089E-03	3.089E-03	3.090E-03	3.091E-03	3.277E-03
U237	2.382E-11	2.164E-11	1.965E-11	1.785E-11	1.545E-11	1.214E-11	1.453E-17
U238	9.535E-01	9.535E-01	9.535E-01	9.535E-01	9.535E-01	9.535E-01	9.535E-01
Np235	5.395E-14	1.502E-14	4.184E-15	1.165E-15	1.712E-16	7.006E-18	0.00
Np236	2.668E-10	2.668E-10	2.668E-10	2.668E-10	2.668E-10	2.668E-10	2.652E-10
Np237	3.062E-04	3.072E-04	3.085E-04	3.099E-04	3.124E-04	3.173E-04	1.138E-03
Np238	1.735E-13	1.719E-13	1.704E-13	1.688E-13	1.665E-13	1.628E-13	1.866E-15
Np239	3.986E-11	3.985E-11	3.984E-11	3.984E-11	3.983E-11	3.981E-11	3.631E-11
Pu236	1.476E-10	9.078E-11	5.582E-11	3.433E-11	1.655E-11	4.909E-12	5.917E-16
Pu238	9.031E-05	8.890E-05	8.751E-05	8.615E-05	8.414E-05	8.090E-05	4.578E-08
Pu239	4.882E-03	4.882E-03	4.882E-03	4.881E-03	4.881E-03	4.880E-03	4.749E-03
Pu240	1.918E-03	1.918E-03	1.918E-03	1.918E-03	1.918E-03	1.918E-03	1.733E-03
Pu241	7.694E-04	6.988E-04	6.346E-04	5.764E-04	4.989E-04	3.922E-04	4.697E-10
Pu242	3.037E-04	3.037E-04	3.037E-04	3.037E-04	3.037E-04	3.037E-04	3.033E-04
Pu244	8.135E-09	8.135E-09	8.135E-09	8.135E-09	8.135E-09	8.135E-09	8.135E-09
Am241	2.990E-04	3.686E-04	4.314E-04	4.882E-04	5.632E-04	6.650E-04	2.224E-04
Am242m	9.254E-07	9.170E-07	9.087E-07	9.005E-07	8.882E-07	8.682E-07	9.951E-09
Am242	1.107E-11	1.097E-11	1.087E-11	1.077E-11	1.063E-11	1.039E-11	1.190E-13
Am243	4.638E-05	4.637E-05	4.636E-05	4.635E-05	4.634E-05	4.632E-05	4.225E-05
Cm242	3.289E-09	2.269E-09	2.204E-09	2.182E-09	2.153E-09	2.101E-09	2.407E-11
Cm243	2.063E-07	1.966E-07	1.872E-07	1.783E-07	1.658E-07	1.468E-07	6.541E-18
Cm244	7.936E-06	7.351E-06	6.810E-06	6.308E-06	5.624E-06	4.644E-06	2.381E-22
Cm245	3.051E-07	3.051E-07	3.050E-07	3.050E-07	3.049E-07	3.048E-07	2.814E-07

TABLE F.4.c. Actinide Inventory by Isotope at 25 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cm246	2.795E-08	2.794E-08	2.794E-08	2.793E-08	2.791E-08	2.789E-08	2.416E-08
Cm247	1.984E-10	1.984E-10	1.984E-10	1.984E-10	1.984E-10	1.984E-10	1.984E-10
Cm248	7.564E-12	7.564E-12	7.564E-12	7.564E-12	7.564E-12	7.564E-12	7.549E-12
Cf249	6.561E-14	6.574E-14	6.556E-14	6.532E-14	6.494E-14	6.430E-14	9.257E-15
Cf250	8.035E-15	7.227E-15	6.500E-15	5.846E-15	4.987E-15	3.826E-15	1.698E-24
Cf251	3.785E-15	3.779E-15	3.773E-15	3.768E-15	3.759E-15	3.744E-15	1.757E-15
TOTAL	9.743E-01	9.743E-01	9.743E-01	9.743E-01	9.743E-01	9.743E-01	9.743E-01

TABLE F.4.d. Actinide Inventory by Isotope at 30 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He 4	9.838E-07	1.076E-06	1.170E-06	1.266E-06	1.412E-06	1.661E-06	2.633E-05
Pb207	4.230E-15	6.848E-15	1.009E-14	1.396E-14	2.090E-14	3.548E-14	6.595E-11
Pb208	2.767E-11	4.407E-11	6.253E-11	8.223E-11	1.129E-10	1.646E-10	1.247E-09
Pb212	1.341E-14	1.569E-14	1.712E-14	1.796E-14	1.845E-14	1.828E-14	1.798E-18
Bi212	1.272E-15	1.488E-15	1.624E-15	1.703E-15	1.750E-15	1.734E-15	1.706E-19
Ra224	1.170E-13	1.369E-13	1.494E-13	1.566E-13	1.610E-13	1.594E-13	1.568E-17
Ra226	1.548E-13	2.267E-13	3.130E-13	4.139E-13	5.929E-13	9.667E-13	2.657E-09
Ac227	3.989E-14	5.074E-14	6.145E-14	7.204E-14	8.772E-14	1.133E-13	4.533E-12
Th228	2.273E-11	2.654E-11	2.896E-11	3.037E-11	3.123E-11	3.095E-11	3.048E-15
Th229	6.948E-13	7.121E-13	7.315E-13	7.532E-13	7.900E-13	8.622E-13	5.516E-10
Th230	3.670E-09	4.481E-09	5.304E-09	6.138E-09	7.409E-09	9.582E-09	7.212E-07
Th231	2.799E-14	2.800E-14	2.800E-14	2.800E-14	2.800E-14	2.800E-14	2.856E-14
Th232	8.093E-10	1.004E-09	1.200E-09	1.395E-09	1.687E-09	2.176E-09	1.011E-07
Th234	1.378E-11	1.378E-11	1.378E-11	1.378E-11	1.378E-11	1.378E-11	1.378E-11
Pa231	3.236E-10	3.370E-10	3.503E-10	3.636E-10	3.836E-10	4.170E-10	6.940E-09
Pa233	1.316E-11	1.320E-11	1.325E-11	1.331E-11	1.340E-11	1.360E-11	4.616E-11
U232	1.115E-09	1.178E-09	1.207E-09	1.216E-09	1.208E-09	1.168E-09	1.136E-13
U233	1.883E-09	2.143E-09	2.404E-09	2.666E-09	3.055E-09	3.688E-09	3.136E-07
U234	1.445E-04	1.466E-04	1.486E-04	1.506E-04	1.536E-04	1.584E-04	2.769E-04
U235	6.885E-03	6.885E-03	6.885E-03	6.886E-03	6.886E-03	6.887E-03	7.024E-03
U236	3.352E-03	3.352E-03	3.353E-03	3.353E-03	3.354E-03	3.355E-03	3.576E-03
U237	2.792E-11	2.535E-11	2.303E-11	2.091E-11	1.810E-11	1.423E-11	3.956E-17
U238	9.491E-01	9.491E-01	9.491E-01	9.491E-01	9.491E-01	9.491E-01	9.491E-01
Np235	7.757E-14	2.160E-14	6.015E-15	1.675E-15	2.462E-16	1.007E-17	0.00
Np236	3.614E-10	3.614E-10	3.614E-10	3.614E-10	3.613E-10	3.613E-10	3.592E-10
Np237	3.874E-04	3.886E-04	3.901E-04	3.918E-04	3.947E-04	4.003E-04	1.359E-03
Np238	1.966E-13	1.948E-13	1.930E-13	1.913E-13	1.887E-13	1.844E-13	2.114E-15
Np239	7.314E-11	7.312E-11	7.311E-11	7.310E-11	7.308E-11	7.304E-11	6.662E-11
Pu236	2.250E-10	1.384E-10	8.509E-11	5.233E-11	2.523E-11	7.483E-12	8.015E-16
Pu238	1.345E-04	1.324E-04	1.303E-04	1.283E-04	1.253E-04	1.204E-04	6.438E-08
Pu239	5.019E-03	5.019E-03	5.019E-03	5.019E-03	5.018E-03	5.018E-03	4.886E-03
Pu240	2.262E-03	2.263E-03	2.264E-03	2.264E-03	2.265E-03	2.266E-03	2.052E-03
Pu241	9.016E-04	8.188E-04	7.437E-04	6.754E-04	5.846E-04	4.595E-04	1.279E-09
Pu242	4.531E-04	4.531E-04	4.531E-04	4.531E-04	4.531E-04	4.531E-04	4.525E-04
Pu244	1.953E-08	1.953E-08	1.953E-08	1.953E-08	1.953E-08	1.953E-08	1.953E-08
Am241	3.467E-04	4.282E-04	5.019E-04	5.684E-04	6.563E-04	7.756E-04	2.599E-04
Am242m	1.048E-06	1.039E-06	1.029E-06	1.020E-06	1.006E-06	9.835E-07	1.127E-08
Am242	1.254E-11	1.243E-11	1.231E-11	1.220E-11	1.204E-11	1.177E-11	1.348E-13
Am243	8.511E-05	8.509E-05	8.507E-05	8.506E-05	8.503E-05	8.499E-05	7.752E-05
Cm242	4.021E-09	2.584E-09	2.497E-09	2.472E-09	2.439E-09	2.380E-09	2.727E-11
Cm243	3.596E-07	3.425E-07	3.262E-07	3.108E-07	2.889E-07	2.558E-07	1.140E-17
Cm244	1.867E-05	1.729E-05	1.602E-05	1.484E-05	1.323E-05	1.092E-05	5.601E-22

TABLE F.4.d. Actinide Inventory by Isotope at 30 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cm245	8.311E-07	8.310E-07	8.308E-07	8.307E-07	8.305E-07	8.302E-07	7.664E-07
Cm246	9.770E-08	9.767E-08	9.764E-08	9.761E-08	9.757E-08	9.750E-08	8.446E-08
Cm247	8.626E-10	8.626E-10	8.626E-10	8.626E-10	8.626E-10	8.626E-10	8.625E-10
Cm248	4.164E-11	4.164E-11	4.164E-11	4.164E-11	4.164E-11	4.164E-11	4.156E-11
Bk249	3.196E-15	6.568E-16	1.350E-16	2.774E-17	2.585E-18	4.948E-20	0.00
Cf249	4.198E-13	4.206E-13	4.195E-13	4.180E-13	4.155E-13	4.114E-13	5.923E-14
Cf250	5.681E-14	5.110E-14	4.596E-14	4.134E-14	3.526E-14	2.706E-14	1.516E-23
Cf251	2.929E-14	2.925E-14	2.920E-14	2.916E-14	2.909E-14	2.898E-14	1.360E-14
Cf252	3.264E-15	1.930E-15	1.141E-15	6.746E-16	3.067E-16	8.244E-17	0.00
TOTAL	9.691E-01	9.691E-01	9.691E-01	9.691E-01	9.691E-01	9.691E-01	9.691E-01

TABLE F.4.e. Actinide Inventory by Isotope at 35 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He 4	1.358E-06	1.490E-06	1.623E-06	1.757E-06	1.957E-06	2.291E-06	3.087E-05
Pb207	4.188E-15	6.769E-15	9.954E-15	1.373E-14	2.048E-14	3.451E-14	5.163E-11
Pb208	3.687E-11	5.920E-11	8.442E-11	1.114E-10	1.536E-10	2.246E-10	1.714E-09
Pb212	1.820E-14	2.141E-14	2.344E-14	2.462E-14	2.534E-14	2.513E-14	2.439E-18
Bi212	1.727E-15	2.031E-15	2.223E-15	2.336E-15	2.404E-15	2.384E-15	2.313E-19
Ra224	1.588E-13	1.867E-13	2.045E-13	2.148E-13	2.211E-13	2.192E-13	2.127E-17
Ra226	1.415E-13	2.076E-13	2.873E-13	3.807E-13	5.473E-13	8.976E-13	2.969E-09
Ac227	3.940E-14	4.991E-14	6.019E-14	7.024E-14	8.492E-14	1.085E-13	3.511E-12
Th228	3.085E-11	3.621E-11	3.964E-11	4.164E-11	4.289E-11	4.256E-11	4.134E-15
Th229	9.640E-13	9.828E-13	1.004E-12	1.028E-12	1.070E-12	1.152E-12	6.480E-10
Th230	3.366E-09	4.127E-09	4.904E-09	5.695E-09	6.912E-09	9.013E-09	8.144E-07
Th231	2.134E-14	2.134E-14	2.134E-14	2.134E-14	2.134E-14	2.134E-14	2.191E-14
Th232	8.594E-10	1.065E-09	1.270E-09	1.476E-09	1.784E-09	2.298E-09	1.066E-07
Th234	1.371E-11	1.371E-11	1.371E-11	1.371E-11	1.371E-11	1.371E-11	1.371E-11
Pa231	3.162E-10	3.263E-10	3.365E-10	3.467E-10	3.619E-10	3.873E-10	5.374E-09
Pa233	1.590E-11	1.594E-11	1.600E-11	1.607E-11	1.618E-11	1.640E-11	5.377E-11
U232	1.524E-09	1.615E-09	1.657E-09	1.671E-09	1.660E-09	1.606E-09	1.542E-13
U233	2.042E-09	2.356E-09	2.672E-09	2.988E-09	3.458E-09	4.221E-09	3.672E-07
U234	1.351E-04	1.379E-04	1.407E-04	1.435E-04	1.476E-04	1.541E-04	3.171E-04
U235	5.247E-03	5.248E-03	5.248E-03	5.248E-03	5.249E-03	5.249E-03	5.389E-03
U236	3.528E-03	3.529E-03	3.529E-03	3.530E-03	3.531E-03	3.532E-03	3.780E-03
U237	3.217E-11	2.922E-11	2.653E-11	2.410E-11	2.086E-11	1.640E-11	8.891E-17
U238	9.446E-01	9.446E-01	9.446E-01	9.446E-01	9.446E-01	9.446E-01	9.446E-01
Np235	1.037E-13	2.887E-14	8.039E-15	2.239E-15	3.290E-16	1.346E-17	0.00
Np236	4.589E-10	4.589E-10	4.589E-10	4.589E-10	4.589E-10	4.589E-10	4.562E-10
Np237	4.680E-04	4.694E-04	4.711E-04	4.730E-04	4.763E-04	4.828E-04	1.583E-03
Np238	2.055E-13	2.037E-13	2.018E-13	2.000E-13	1.973E-13	1.928E-13	2.210E-15
Np239	1.192E-10	1.192E-10	1.192E-10	1.192E-10	1.191E-10	1.191E-10	1.086E-10
Pu236	3.186E-10	1.959E-10	1.205E-10	7.409E-11	3.573E-11	1.060E-11	1.018E-15
Pu238	1.850E-04	1.821E-04	1.792E-04	1.764E-04	1.723E-04	1.657E-04	8.457E-08
Pu239	5.095E-03	5.095E-03	5.094E-03	5.094E-03	5.094E-03	5.093E-03	4.964E-03
Pu240	2.521E-03	2.523E-03	2.525E-03	2.527E-03	2.529E-03	2.532E-03	2.302E-03
Pu241	1.039E-03	9.436E-04	8.570E-04	7.783E-04	6.737E-04	5.296E-04	2.875E-09
Pu242	6.195E-04	6.195E-04	6.195E-04	6.195E-04	6.195E-04	6.195E-04	6.187E-04
Pu244	4.017E-08	4.017E-08	4.017E-08	4.017E-08	4.017E-08	4.017E-08	4.017E-08
Am241	3.935E-04	4.875E-04	5.724E-04	6.491E-04	7.504E-04	8.879E-04	2.983E-04
Am242m	1.096E-06	1.086E-06	1.076E-06	1.067E-06	1.052E-06	1.028E-06	1.179E-05
Am242	1.311E-11	1.299E-11	1.288E-11	1.276E-11	1.259E-11	1.230E-11	1.410E-13
Am243	1.388E-04	1.387E-04	1.387E-04	1.387E-04	1.386E-04	1.386E-04	1.264E-04
Cm242	4.557E-09	2.718E-09	2.612E-09	2.585E-09	2.550E-09	2.489E-09	2.851E-11
Cm243	5.494E-07	5.234E-07	4.985E-07	4.748E-07	4.414E-07	3.909E-07	1.742E-17

TABLE F.4.e. Actinide Inventory by Isotope at 35 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cm244	3.733E-05	3.458E-05	3.203E-05	2.967E-05	2.645E-05	2.185E-05	1.120E-21
Cm245	1.868E-06	1.868E-06	1.867E-06	1.867E-06	1.866E-06	1.866E-06	1.722E-06
Cm246	2.752E-07	2.752E-07	2.751E-07	2.750E-07	2.749E-07	2.747E-07	2.379E-07
Cm247	2.942E-09	2.942E-09	2.942E-09	2.942E-09	2.942E-09	2.942E-09	2.942E-09
Cm248	1.749E-10	1.749E-10	1.749E-10	1.749E-10	1.749E-10	1.749E-10	1.746E-10
Bk249	1.529E-14	3.142E-15	6.457E-16	1.327E-16	1.236E-17	2.368E-19	0.00
Cf249	1.990E-12	1.995E-12	1.989E-12	1.982E-12	1.970E-12	1.951E-12	2.809E-13
C250	2.910E-13	2.617E-13	2.354E-13	2.117E-13	1.806E-13	1.386E-13	9.721E-23
Cf251	1.607E-13	1.604E-13	1.602E-13	1.599E-13	1.596E-13	1.589E-13	7.460E-14
Cf252	2.214E-14	1.309E-14	7.738E-15	4.575E-15	2.080E-15	5.592E-16	0.00
TOTAL	9.640E-01	9.640E-01	9.640E-01	9.640E-01	9.640E-01	9.640E-01	9.640E-01

TABLE F.5.a. Fission Product Inventory by Element at 15 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H	1.716E-08	1.534E-08	1.371E-08	1.225E-08	1.035E-08	7.820E-09	1.008E-32
Li	1.313E-10	1.313E-10	1.313E-10	1.313E-10	1.313E-10	1.313E-10	1.313E-10
Be	6.815E-11	6.815E-11	6.815E-11	6.815E-11	6.815E-11	6.815E-11	6.812E-11
C	1.197E-11	1.197E-11	1.197E-11	1.196E-11	1.196E-11	1.195E-11	1.062E-11
Zn	1.932E-14	1.932E-14	1.932E-14	1.932E-14	1.932E-14	1.932E-14	1.932E-14
Ga	3.774E-13	3.774E-13	3.774E-13	3.774E-13	3.774E-13	3.774E-13	3.774E-13
Ge	3.118E-07	3.118E-07	3.118E-07	3.118E-07	3.118E-07	3.118E-07	3.118E-07
As	9.486E-08	9.486E-08	9.486E-08	9.486E-08	9.486E-08	9.486E-08	9.486E-08
Se	2.686E-05	2.686E-05	2.686E-05	2.686E-05	2.686E-05	2.686E-05	2.683E-05
Br	1.053E-05	1.053E-05	1.053E-05	1.053E-05	1.053E-05	1.053E-05	1.056E-05
Kr	1.768E-04	1.758E-04	1.750E-04	1.743E-04	1.734E-04	1.722E-04	1.691E-04
Rb	1.728E-04	1.738E-04	1.746E-04	1.753E-04	1.762E-04	1.774E-04	1.805E-04
Sr	4.008E-04	3.902E-04	3.802E-04	3.706E-04	3.570E-04	3.364E-04	1.736E-04
Y	2.274E-04	2.274E-04	2.274E-04	2.274E-04	2.274E-04	2.274E-04	2.273E-04
Zr	1.720E-03	1.730E-03	1.740E-03	1.750E-03	1.763E-03	1.784E-03	1.947E-03
Nb	1.544E-09	1.859E-09	2.173E-09	2.488E-09	2.960E-09	3.746E-09	1.579E-07
Mo	1.535E-03	1.535E-03	1.535E-03	1.535E-03	1.535E-03	1.535E-03	1.535E-03
Tc	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.726E-04	3.714E-04
Ru	9.200E-04	9.194E-04	9.193E-04	9.193E-04	9.193E-04	9.193E-04	9.205E-04
Rh	2.381E-04	2.381E-04	2.381E-04	2.381E-04	2.381E-04	2.381E-04	2.381E-04
Pd	4.617E-04	4.623E-04	4.624E-04	4.625E-04	4.625E-04	4.625E-04	4.625E-04
Ag	2.895E-05	2.895E-05	2.895E-05	2.895E-05	2.895E-05	2.895E-05	2.895E-05
Cd	3.445E-05	3.445E-05	3.444E-05	3.443E-05	3.443E-05	3.442E-05	3.438E-05
In	1.898E-06	1.904E-06	1.909E-06	1.914E-06	1.921E-06	1.931E-06	1.966E-06
Sn	3.873E-05	3.873E-05	3.873E-05	3.873E-05	3.873E-05	3.873E-05	3.865E-05
Sb	9.616E-06	9.146E-06	8.860E-06	8.688E-06	8.547E-06	8.457E-06	8.422E-06
Te	2.103E-04	2.108E-04	2.111E-04	2.113E-04	2.114E-04	2.115E-04	2.116E-04
I	1.035E-04	1.035E-04	1.035E-04	1.035E-04	1.035E-04	1.035E-04	1.035E-04
Xe	2.276E-03	2.276E-03	2.276E-03	2.276E-03	2.276E-03	2.276E-03	2.276E-03
Cs	1.273E-03	1.250E-03	1.229E-03	1.210E-03	1.182E-03	1.141E-03	8.050E-04
Ba	7.207E-04	7.433E-04	7.641E-04	7.837E-04	8.110E-04	8.523E-04	1.189E-03
La	5.643E-04	5.643E-04	5.643E-04	5.643E-04	5.643E-04	5.643E-04	5.643E-04
Ce	1.088E-03	1.088E-03	1.087E-03	1.087E-03	1.087E-03	1.087E-03	1.087E-03
Pr	5.218E-04	5.218E-04	5.218E-04	5.218E-04	5.218E-04	5.218E-04	5.218E-04
Nd	1.861E-03	1.862E-03	1.862E-03	1.862E-03	1.862E-03	1.862E-03	1.862E-03
Pm	1.877E-05	1.107E-05	6.524E-06	3.846E-06	1.741E-06	4.647E-07	0.00
Sm	3.822E-04	3.898E-04	3.942E-04	3.968E-04	3.987E-04	3.997E-04	3.924E-04
Eu	4.603E-05	4.497E-05	4.413E-05	4.345E-05	4.270E-05	4.191E-05	4.769E-05
Gd	2.521E-05	2.640E-05	2.737E-05	2.817E-05	2.911E-05	3.020E-05	3.214E-05
Tb	8.657E-07	8.657E-07	8.657E-07	8.657E-07	8.657E-07	8.657E-07	8.657E-07
Dy	4.248E-07	4.248E-07	4.248E-07	4.248E-07	4.248E-07	4.248E-07	4.248E-07
Ho	3.233E-08	3.233E-08	3.233E-08	3.233E-08	3.233E-08	3.233E-08	3.225E-08

TABLE F.5.a. Fission Product Inventory by Element at 15 MWd/kgM, g/gU (contd)

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Er	1.310E-08	1.310E-08	1.310E-08	1.310E-08	1.310E-08	1.310E-08	1.318E-08
Tm	7.137E-12	7.136E-12	7.135E-12	7.135E-12	7.135E-12	7.135E-12	7.135E-12
Yb	1.065E-12	1.066E-12	1.066E-12	1.067E-12	1.067E-12	1.067E-12	1.067E-12
TOTAL	1.547E-02	1.547E-02	1.547E-02	1.547E-02	1.547E-02	1.547E-02	1.547E-02

TABLE F.5.b. Fission Product Inventory by Element at 20 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H	2.342E-08	2.094E-08	1.871E-08	1.673E-08	1.413E-08	1.068E-08	1.376E-32
Li	1.516E-10	1.516E-10	1.516E-10	1.516E-10	1.516E-10	1.516E-10	1.516E-10
Be	9.066E-11	9.066E-11	9.066E-11	9.066E-11	9.066E-11	9.066E-11	9.063E-11
C	1.593E-11	1.592E-11	1.592E-11	1.592E-11	1.591E-11	1.590E-11	1.412E-11
Zn	2.436E-14	2.436E-14	2.436E-14	2.436E-14	2.436E-14	2.436E-14	2.436E-14
Ga	5.241E-13	5.241E-13	5.241E-13	5.241E-13	5.241E-13	5.241E-13	5.241E-13
Ge	4.107E-07	4.107E-07	4.107E-07	4.107E-07	4.107E-07	4.107E-07	4.107E-07
As	1.253E-07	1.253E-07	1.253E-07	1.253E-07	1.253E-07	1.253E-07	1.253E-07
Se	3.503E-05	3.503E-05	3.503E-05	3.503E-05	3.503E-05	3.503E-05	3.500E-05
Br	1.368E-05	1.368E-05	1.368E-05	1.368E-05	1.368E-05	1.368E-05	1.372E-05
Kr	2.270E-04	2.258E-04	2.248E-04	2.239E-04	2.227E-04	2.212E-04	2.172E-04
Rb	2.210E-04	2.222E-04	2.233E-04	2.242E-04	2.254E-04	2.269E-04	2.309E-04
Sr	5.112E-04	4.978E-04	4.849E-04	4.727E-04	4.554E-04	4.292E-04	2.216E-04
Y	2.897E-04	2.897E-04	2.897E-04	2.897E-04	2.897E-04	2.897E-04	2.896E-04
Zr	2.232E-03	2.246E-03	2.258E-03	2.271E-03	2.288E-03	2.314E-03	2.521E-03
Nb	2.063E-09	2.470E-09	2.878E-09	3.285E-09	3.896E-09	4.915E-09	2.045E-07
Mo	2.034E-03	2.034E-03	2.034E-03	2.034E-03	2.034E-03	2.034E-03	2.034E-03
Tc	4.871E-04	4.871E-04	4.871E-04	4.871E-04	4.870E-04	4.870E-04	4.855E-04
Ru	1.267E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.266E-03	1.268E-03
Rh	3.099E-04	3.099E-04	3.099E-04	3.099E-04	3.099E-04	3.099E-04	3.099E-04
Pd	7.110E-04	7.118E-04	7.120E-04	7.121E-04	7.121E-04	7.121E-04	7.121E-04
Ag	4.343E-05	4.343E-05	4.343E-05	4.343E-05	4.343E-05	4.343E-05	4.344E-05
Cd	5.345E-05	5.344E-05	5.344E-05	5.343E-05	5.342E-05	5.340E-05	5.335E-05
In	2.133E-06	2.142E-06	2.151E-06	2.158E-06	2.168E-06	2.182E-06	2.234E-06
Sn	5.378E-05	5.378E-05	5.378E-05	5.378E-05	5.378E-05	5.378E-05	5.367E-05
Sb	1.309E-05	1.244E-05	1.204E-05	1.180E-05	1.160E-05	1.148E-05	1.143E-05
Te	2.872E-04	2.878E-04	2.882E-04	2.885E-04	2.887E-04	2.888E-04	2.890E-04
I	1.416E-04	1.416E-04	1.416E-04	1.416E-04	1.416E-04	1.416E-04	1.416E-04
Xe	3.102E-03	3.102E-03	3.102E-03	3.102E-03	3.102E-03	3.102E-03	3.102E-03
Cs	1.627E-03	1.597E-03	1.568E-03	1.542E-03	1.505E-03	1.450E-03	1.001E-03
Ba	9.690E-04	9.998E-04	1.028E-03	1.054E-03	1.091E-03	1.146E-03	1.595E-03
La	7.447E-04	7.447E-04	7.447E-04	7.447E-04	7.447E-04	7.447E-04	7.447E-04
Ce	1.439E-03	1.438E-03	1.438E-03	1.438E-03	1.438E-03	1.438E-03	1.438E-03
Pr	6.874E-04	6.874E-04	6.874E-04	6.874E-04	6.874E-04	6.874E-04	6.874E-04
Nd	2.456E-03	2.456E-03	2.456E-03	2.456E-03	2.456E-03	2.456E-03	2.456E-03
Pm	2.183E-05	1.287E-05	7.586E-06	4.472E-06	2.025E-06	5.404E-07	0.00
Sm	4.991E-04	5.079E-04	5.131E-04	5.160E-04	5.183E-04	5.194E-04	5.115E-04
Eu	7.060E-05	6.866E-05	6.710E-05	6.583E-05	6.436E-05	6.277E-05	6.773E-05
Gd	4.325E-05	4.533E-05	4.703E-05	4.844E-05	5.011E-05	5.203E-05	5.553E-05
Tb	1.341E-06	1.341E-06	1.341E-06	1.341E-06	1.341E-06	1.341E-06	1.341E-06
Dy	6.793E-07	6.793E-07	6.793E-07	6.793E-07	6.793E-07	6.793E-07	6.793E-07

TABLE F.5.b. Fission Product Inventory by Element at 20 MWd/kgM, g/gU (contd)

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ho	5.726E-08	5.726E-08	5.726E-08	5.726E-08	5.726E-08	5.726E-08	5.709E-08
Er	2.247E-08	2.247E-08	2.247E-08	2.247E-08	2.247E-08	2.247E-08	2.264E-08
Tm	1.645E-11	1.645E-11	1.645E-11	1.644E-11	1.644E-11	1.644E-11	1.644E-11
Yb	3.381E-12	3.385E-12	3.387E-12	3.388E-12	3.388E-12	3.389E-12	3.389E-12
TOTAL	2.060E-02	2.060E-02	2.060E-02	2.060E-02	2.060E-02	2.060E-02	2.060E-02

TABLE F.5.c. Fission Product Inventory by Element at 25 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H	2.989E-08	2.672E-08	2.388E-08	2.134E-08	1.804E-08	1.362E-08	1.759E-32
Li	1.643E-10	1.643E-10	1.643E-10	1.643E-10	1.643E-10	1.643E-10	1.643E-10
Be	1.131E-10	1.131E-10	1.131E-10	1.131E-10	1.131E-10	1.131E-10	1.130E-10
C	1.987E-11	1.986E-11	1.986E-11	1.986E-11	1.985E-11	1.984E-11	1.762E-11
Zn	2.888E-14	2.888E-14	2.888E-14	2.888E-14	2.888E-14	2.888E-14	2.888E-14
Ga	6.748E-13	6.748E-13	6.748E-13	6.748E-13	6.748E-13	6.748E-13	6.748E-13
Ge	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07
As	1.552E-07	1.552E-07	1.552E-07	1.552E-07	1.552E-07	1.552E-07	1.552E-07
Se	4.287E-05	4.287E-05	4.287E-05	4.287E-05	4.287E-05	4.287E-05	4.283E-05
Br	1.665E-05	1.665E-05	1.665E-05	1.665E-05	1.665E-05	1.665E-05	1.670E-05
Kr	2.740E-04	2.726E-04	2.713E-04	2.702E-04	2.688E-04	2.670E-04	2.622E-04
Rb	2.657E-04	2.671E-04	2.684E-04	2.695E-04	2.709E-04	2.727E-04	2.775E-04
Sr	6.128E-04	5.967E-04	5.813E-04	5.667E-04	5.460E-04	5.145E-04	2.660E-04
Y	3.470E-04	3.469E-04	3.469E-04	3.469E-04	3.469E-04	3.469E-04	3.469E-04
Zr	2.721E-03	2.737E-03	2.752E-03	2.767E-03	2.788E-03	2.819E-03	3.068E-03
Nb	2.576E-09	3.071E-09	3.567E-09	4.062E-09	4.805E-09	6.044E-09	2.488E-07
Mo	2.527E-03	2.527E-03	2.527E-03	2.527E-03	2.527E-03	2.527E-03	2.527E-03
Tc	5.964E-04	5.964E-04	5.964E-04	5.964E-04	5.964E-04	5.964E-04	5.945E-04
Ru	1.631E-03	1.630E-03	1.629E-03	1.629E-03	1.629E-03	1.629E-03	1.631E-03
Rh	3.752E-04	3.752E-04	3.752E-04	3.752E-04	3.752E-04	3.752E-04	3.752E-04
Pd	1.000E-03	1.001E-03	1.002E-03	1.002E-03	1.002E-03	1.002E-03	1.002E-03
Ag	5.913E-05	5.913E-05	5.913E-05	5.913E-05	5.913E-05	5.913E-05	5.915E-05
Cd	7.692E-05	7.691E-05	7.690E-05	7.689E-05	7.687E-05	7.685E-05	7.678E-05
In	2.297E-06	2.310E-06	2.321E-06	2.331E-06	2.345E-06	2.365E-06	2.436E-06
Sn	6.963E-05	6.963E-05	6.963E-05	6.963E-05	6.963E-05	6.963E-05	6.948E-05
Sb	1.667E-05	1.581E-05	1.530E-05	1.499E-05	1.473E-05	1.457E-05	1.451E-05
Te	3.661E-04	3.670E-04	3.675E-04	3.678E-04	3.681E-04	3.682E-04	3.684E-04
I	1.804E-04	1.804E-04	1.804E-04	1.804E-04	1.804E-04	1.804E-04	1.804E-04
Xe	3.943E-03	3.943E-03	3.943E-03	3.943E-03	3.943E-03	3.943E-03	3.943E-03
Cs	1.966E-03	1.926E-03	1.891E-03	1.857E-03	1.812E-03	1.742E-03	1.181E-03
Ba	1.222E-03	1.261E-03	1.297E-03	1.330E-03	1.376E-03	1.445E-03	2.006E-03
La	9.222E-04	9.222E-04	9.222E-04	9.222E-04	9.222E-04	9.222E-04	9.222E-04
Ce	1.786E-03	1.785E-03	1.785E-03	1.785E-03	1.785E-03	1.785E-03	1.785E-03
Pr	8.490E-04	8.490E-04	8.490E-04	8.490E-04	8.490E-04	8.490E-04	8.490E-04
Nd	3.041E-03	3.041E-03	3.042E-03	3.042E-03	3.042E-03	3.042E-03	3.042E-03
Pm	2.389E-05	1.409E-05	8.304E-06	4.896E-06	2.216E-06	5.916E-07	0.00
Sm	6.103E-04	6.200E-04	6.256E-04	6.289E-04	6.313E-04	6.326E-04	6.240E-04
Eu	9.767E-05	9.462E-05	9.214E-05	9.012E-05	8.776E-05	8.514E-05	8.892E-05
Gd	6.788E-05	7.108E-05	7.372E-05	7.589E-05	7.847E-05	8.145E-05	8.690E-05
Tb	1.897E-06	1.897E-06	1.897E-06	1.897E-06	1.897E-06	1.897E-06	1.897E-06
Dy	9.902E-07	9.902E-07	9.902E-07	9.902E-07	9.902E-07	9.902E-07	9.902E-07
Ho	9.227E-08	9.227E-08	9.227E-08	9.227E-08	9.226E-08	9.226E-08	9.194E-08

TABLE F.5.c. Fission Product Inventory by Element at 25 MWd/kgM, g/gU (contd)

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Er	3.591E-08	3.591E-08	3.591E-08	3.592E-08	3.592E-08	3.592E-08	3.625E-08
Tn	3.148E-11	3.147E-11	3.146E-11	3.146E-11	3.146E-11	3.146E-11	3.146E-11
Yn	8.344E-12	8.357E-12	8.363E-12	8.366E-12	8.367E-12	8.368E-12	8.368E-12
TOTAL	2.571E-02	2.571E-02	2.571E-02	2.571E-02	2.571E-02	2.571E-02	2.571E-02

TABLE F.5.d. Fission Product Inventory by Element at 30 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H	3.653E-08	3.265E-08	2.918E-08	2.608E-08	2.204E-08	1.665E-08	2.145E-32
Li	1.710E-10	1.710E-10	1.710E-10	1.710E-10	1.710E-10	1.710E-10	1.710E-10
Be	1.354E-10	1.354E-10	1.354E-10	1.354E-10	1.354E-10	1.354E-10	1.354E-10
C	2.380E-11	2.379E-11	2.379E-11	2.378E-11	2.377E-11	2.376E-11	2.110E-11
Zn	3.298E-14	3.298E-14	3.298E-14	3.298E-14	3.298E-14	3.298E-14	3.298E-14
Ga	8.283E-13	8.283E-13	8.283E-13	8.283E-13	8.283E-13	8.283E-13	8.283E-13
Ge	6.032E-07	6.032E-07	6.032E-07	6.032E-07	6.032E-07	6.032E-07	6.032E-07
As	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07
Se	5.043E-05	5.043E-05	5.043E-05	5.043E-05	5.043E-05	5.043E-05	5.038E-05
Br	1.946E-05	1.946E-05	1.947E-05	1.947E-05	1.947E-05	1.947E-05	1.952E-05
Kr	3.183E-04	3.166E-04	3.152E-04	3.139E-04	3.122E-04	3.101E-04	3.045E-04
Rb	3.073E-04	3.090E-04	3.104E-04	3.117E-04	3.134E-04	3.155E-04	3.210E-04
Sr	7.071E-04	6.885E-04	6.708E-04	6.539E-04	6.300E-04	5.938E-04	3.072E-04
Y	3.999E-04	3.999E-04	3.999E-04	3.999E-04	3.999E-04	3.999E-04	3.998E-04
Zr	3.190E-03	3.208E-03	3.226E-03	3.243E-03	3.267E-03	3.303E-03	3.589E-03
Nb	3.081E-09	3.660E-09	4.240E-09	4.819E-09	5.688E-09	7.136E-09	2.910E-07
Mo	3.015E-03	3.015E-03	3.015E-03	3.015E-03	3.015E-03	3.015E-03	3.015E-03
Tc	7.004E-04	7.004E-04	7.004E-04	7.004E-04	7.004E-04	7.004E-04	6.982E-04
Ru	2.010E-03	2.009E-03	2.008E-03	2.008E-03	2.008E-03	2.008E-03	2.010E-03
Rh	4.330E-04	4.330E-04	4.330E-04	4.330E-04	4.330E-04	4.330E-04	4.330E-04
Pd	1.325E-03	1.326E-03	1.327E-03	1.327E-03	1.327E-03	1.327E-03	1.327E-03
Ag	7.532E-05	7.532E-05	7.532E-05	7.532E-05	7.532E-05	7.532E-05	7.534E-05
Cd	1.051E-04	1.051E-04	1.051E-04	1.051E-04	1.050E-04	1.050E-04	1.049E-04
In	2.410E-06	2.427E-06	2.442E-06	2.456E-06	2.474E-06	2.500E-06	2.594E-06
Sn	8.621E-05	8.621E-05	8.621E-05	8.621E-05	8.621E-05	8.621E-05	8.603E-05
Sb	2.032E-05	1.927E-05	1.863E-05	1.824E-05	1.792E-05	1.772E-05	1.764E-05
Te	4.468E-04	4.479E-04	4.485E-04	4.489E-04	4.492E-04	4.494E-04	4.497E-04
I	2.195E-04	2.195E-04	2.195E-04	2.195E-04	2.195E-04	2.195E-04	2.195E-04
Xe	4.795E-03	4.795E-03	4.795E-03	4.795E-03	4.795E-03	4.795E-03	4.795E-03
Cs	2.291E-03	2.243E-03	2.199E-03	2.159E-03	2.104E-03	2.021E-03	1.347E-03
Ba	1.479E-03	1.527E-03	1.571E-03	1.611E-03	1.666E-03	1.749E-03	2.423E-03
La	1.097E-03	1.097E-03	1.097E-03	1.097E-03	1.097E-03	1.097E-03	1.097E-03
Ce	2.129E-03	2.128E-03	2.128E-03	2.128E-03	2.128E-03	2.128E-03	2.128E-03
Pr	1.007E-03	1.007E-03	1.007E-03	1.007E-03	1.007E-03	1.007E-03	1.007E-03
Nd	3.618E-03	3.619E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03	3.620E-03
Pm	2.515E-05	1.483E-05	8.741E-06	5.154E-06	2.333E-06	6.228E-07	0.00
Sm	7.156E-04	7.257E-04	7.316E-04	7.351E-04	7.376E-04	7.390E-04	7.297E-04
Eu	1.260E-04	1.217E-04	1.181E-04	1.152E-04	1.118E-04	1.080E-04	1.102E-04
Gd	1.003E-04	1.048E-04	1.085E-04	1.116E-04	1.152E-04	1.194E-04	1.271E-04
Tb	2.520E-06	2.520E-06	2.520E-06	2.520E-06	2.520E-06	2.520E-06	2.520E-06
Dy	1.358E-06	1.358E-06	1.358E-06	1.358E-06	1.358E-06	1.358E-06	1.358E-06

TABLE F.5.d. Fission Product Inventory by Element at 30 MWd/kgM, g/gU (contd)

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ho	1.403E-07	1.403E-07	1.403E-07	1.403E-07	1.402E-07	1.402E-07	1.397E-07
Er	5.508E-08	5.508E-08	5.508E-08	5.508E-08	5.508E-08	5.509E-08	5.568E-08
Tm	5.402E-11	5.399E-11	5.397E-11	5.397E-11	5.396E-11	5.396E-11	5.396E-11
Yb	1.767E-11	1.770E-11	1.772E-11	1.772E-11	1.773E-11	1.773E-11	1.773E-11
TOTAL	3.082E-02	3.082E-02	3.082E-02	3.082E-02	3.082E-02	3.082E-02	3.082E-02

TABLE F.5.e. Fission Product Inventory by Element at 35 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H	4.334E-08	3.874E-08	3.462E-08	3.095E-08	2.615E-08	1.975E-08	2.548E-32
Li	1.734E-10	1.734E-10	1.734E-10	1.734E-10	1.734E-10	1.734E-10	1.734E-10
Be	1.577E-10	1.577E-10	1.577E-10	1.577E-10	1.577E-10	1.577E-10	1.577E-10
C	2.772E-11	2.771E-11	2.770E-11	2.770E-11	2.769E-11	2.767E-11	2.458E-11
Zn	3.667E-14	3.667E-14	3.667E-14	3.667E-14	3.667E-14	3.667E-14	3.667E-14
Ga	9.842E-13	9.842E-13	9.842E-13	9.842E-13	9.842E-13	9.842E-13	9.842E-13
Ge	6.974E-07	6.974E-07	6.974E-07	6.974E-07	6.974E-07	6.974E-07	6.974E-07
As	2.136E-07	2.136E-07	2.136E-07	2.136E-07	2.136E-07	2.136E-07	2.136E-07
Se	5.772E-05	5.772E-05	5.772E-05	5.772E-05	5.772E-05	5.772E-05	5.766E-05
Br	2.213E-05	2.213E-05	2.213E-05	2.213E-05	2.213E-05	2.213E-05	2.219E-05
Kr	3.599E-04	3.580E-04	3.564E-04	3.549E-04	3.531E-04	3.507E-04	3.444E-04
Rb	3.460E-04	3.479E-04	3.496E-04	3.510E-04	3.529E-04	3.553E-04	3.616E-04
Sr	7.942E-04	7.734E-04	7.535E-04	7.345E-04	7.077E-04	6.670E-04	3.454E-04
Y	4.487E-04	4.487E-04	4.487E-04	4.487E-04	4.487E-04	4.487E-04	4.486E-04
Zr	3.639E-03	3.660E-03	3.680E-03	3.699E-03	3.726E-03	3.767E-03	4.088E-03
Nb	3.578E-09	4.237E-09	4.897E-09	5.556E-09	6.545E-09	8.193E-09	3.311E-07
Mo	3.498E-03	3.498E-03	3.498E-03	3.498E-03	3.498E-03	3.498E-03	3.498E-03
Tc	7.988E-04	7.988E-04	7.988E-04	7.988E-04	7.988E-04	7.988E-04	7.963E-04
Ru	2.405E-03	2.403E-03	2.402E-03	2.402E-03	2.402E-03	2.402E-03	2.405E-03
Rh	4.835E-04	4.835E-04	4.835E-04	4.835E-04	4.835E-04	4.835E-04	4.835E-04
Pd	1.684E-03	1.686E-03	1.686E-03	1.687E-03	1.687E-03	1.687E-03	1.687E-03
Ag	9.179E-05	9.178E-05	9.178E-05	9.178E-05	9.178E-05	9.178E-05	9.181E-05
Cd	1.384E-04	1.384E-04	1.384E-04	1.383E-04	1.383E-04	1.383E-04	1.382E-04
In	2.499E-06	2.520E-06	2.540E-06	2.557E-06	2.581E-06	2.613E-06	2.735E-06
Sn	1.035E-04	1.035E-04	1.035E-04	1.035E-04	1.035E-04	1.035E-04	1.033E-04
Sb	2.406E-05	2.279E-05	2.202E-05	2.155E-05	2.117E-05	2.093E-05	2.084E-05
Te	5.293E-04	5.305E-04	5.313E-04	5.318E-04	5.321E-04	5.324E-04	5.327E-04
I	2.587E-04	2.587E-04	2.587E-04	2.587E-04	2.587E-04	2.587E-04	2.587E-04
Xe	5.656E-03	5.656E-03	5.656E-03	5.656E-03	5.656E-03	5.656E-03	5.656E-03
Cs	2.606E-03	2.549E-03	2.498E-03	2.451E-03	2.386E-03	2.289E-03	1.502E-03
Ba	1.741E-03	1.798E-03	1.849E-03	1.896E-03	1.961E-03	2.058E-03	2.845E-03
La	1.269E-03	1.269E-03	1.269E-03	1.269E-03	1.269E-03	1.269E-03	1.269E-03
Ce	2.470E-03	2.469E-03	2.468E-03	2.468E-03	2.468E-03	2.468E-03	2.468E-03
Pr	1.161E-03	1.161E-03	1.161E-03	1.161E-03	1.161E-03	1.161E-03	1.161E-03
Nd	4.190E-03	4.191E-03	4.191E-03	4.191E-03	4.191E-03	4.191E-03	4.191E-03
Pm	2.582E-05	1.522E-05	8.975E-06	5.291E-06	2.395E-06	6.395E-07	0.00
Sm	8.152E-04	8.257E-04	8.317E-04	8.352E-04	8.379E-04	8.392E-04	8.293E-04
Eu	1.545E-04	1.487E-04	1.440E-04	1.402E-04	1.357E-04	1.305E-04	1.309E-04
Gd	1.416E-04	1.475E-04	1.524E-04	1.564E-04	1.612E-04	1.667E-04	1.768E-04
Tb	3.216E-06	3.216E-06	3.216E-06	3.216E-06	3.216E-06	3.216E-06	3.216E-06
Dy	1.786E-06	1.786E-06	1.786E-06	1.786E-06	1.786E-06	1.786E-06	1.786E-06

TABLE F.5.e. Fission Product Inventory by Element at 35 MWd/kgM, g/gU (contd)

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ho	2.044E-07	2.044E-07	2.044E-07	2.044E-07	2.044E-07	2.044E-07	2.034E-07
Er	8.227E-08	8.227E-08	8.227E-08	8.227E-08	8.228E-08	8.228E-08	8.329E-08
Tm	8.650E-11	8.643E-11	8.639E-11	8.637E-11	8.636E-11	8.636E-11	8.636E-11
Yb	3.378E-11	3.385E-11	3.389E-11	3.391E-11	3.392E-11	3.392E-11	3.392E-11
TOTAL	3.592E-02	3.592E-02	3.592E-02	3.592E-02	3.592E-02	3.592E-02	3.592E-02

TABLE F.6.a. Actinide Inventory by Element at 15 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He	2.102E-07	2.358E-07	2.629E-07	2.916E-07	3.370E-07	4.179E-07	1.187E-05
Pb	7.705E-12	1.179E-11	1.629E-11	2.103E-11	2.835E-11	4.058E-11	7.308E-10
Ra	2.281E-13	3.237E-13	4.352E-13	5.631E-13	7.865E-13	1.245E-12	2.139E-09
Ac	3.638E-14	4.745E-14	5.896E-14	7.088E-14	8.947E-14	1.222E-13	9.157E-12
Th	5.242E-09	6.368E-09	7.496E-09	8.626E-09	1.033E-08	1.317E-08	6.283E-07
Pa	3.217E-10	3.495E-10	3.773E-10	4.051E-10	4.468E-10	5.163E-10	1.404E-08
U	9.783E-01	9.783E-01	9.783E-01	9.783E-01	9.783E-01	9.783E-01	9.785E-01
Np	1.512E-04	1.518E-04	1.524E-04	1.532E-04	1.545E-04	1.570E-04	5.797E-04
Pu	5.912E-03	5.875E-03	5.841E-03	5.810E-03	5.769E-03	5.713E-03	5.258E-03
Am	1.644E-04	2.000E-04	2.321E-04	2.611E-04	2.995E-04	3.515E-04	1.210E-04
Cm	6.791E-07	6.309E-07	5.865E-07	5.454E-07	4.892E-07	4.086E-07	1.466E-08
TOTAL	9.845E-01	9.845E-01	9.845E-01	9.845E-01	9.845E-01	9.845E-01	9.845E-01

TABLE F.6.b. Actinide Inventory by Element at 20 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He	4.055E-07	4.472E-07	4.911E-07	5.371E-07	6.093E-07	7.368E-07	1.710E-05
Pb	1.296E-11	2.018E-11	2.821E-11	3.671E-11	4.990E-11	7.202E-11	9.537E-10
Ra	2.352E-13	3.277E-13	4.335E-13	5.537E-13	7.622E-13	1.189E-12	2.230E-09
Ac	3.851E-14	4.966E-14	6.101E-14	7.255E-14	9.018E-14	1.204E-13	7.329E-12
Th	5.003E-09	6.091E-09	7.182E-09	8.278E-09	9.929E-09	1.270E-08	6.729E-07
Pa	3.323E-10	3.544E-10	3.765E-10	3.986E-10	4.317E-10	4.869E-10	1.125E-08
U	9.718E-01	9.718E-01	9.718E-01	9.718E-01	9.719E-01	9.719E-01	9.722E-01
Np	2.263E-04	2.271E-04	2.281E-04	2.292E-04	2.311E-04	2.349E-04	8.697E-04
Pu	7.045E-03	6.990E-03	6.939E-03	6.893E-03	6.831E-03	6.746E-03	6.115E-03
Am	2.549E-04	3.085E-04	3.570E-04	4.007E-04	4.585E-04	5.370E-04	1.912E-04
Cm	2.889E-06	2.685E-06	2.496E-06	2.322E-06	2.083E-06	1.741E-06	8.419E-08
Cf	7.594E-15	7.528E-15	7.441E-15	7.356E-15	7.239E-15	7.071E-15	1.064E-15
TOTAL	9.794E-01	9.794E-01	9.794E-01	9.794E-01	9.794E-01	9.794E-01	9.794E-01

TABLE F.6.c. Actinide Inventory by Element at 25 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He	6.634E-07	7.265E-07	7.921E-07	8.599E-07	9.650E-07	1.148E-06	2.200E-05
Pb	1.965E-11	3.099E-11	4.368E-11	5.719E-11	7.819E-11	1.135E-10	1.271E-09
Bi	1.228E-15	1.455E-15	1.631E-15	1.772E-15	1.943E-15	2.185E-15	1.176E-11
Ra	2.499E-13	3.411E-13	4.427E-13	5.563E-13	7.515E-13	1.150E-12	2.406E-09
Ac	3.963E-14	5.069E-14	6.177E-14	7.287E-14	8.953E-14	1.174E-13	5.804E-12
Th	4.761E-09	5.810E-09	6.865E-09	7.927E-09	9.534E-09	1.225E-08	7.385E-07
Pa	3.370E-10	3.544E-10	3.717E-10	3.891E-10	4.151E-10	4.584E-10	8.921E-09
U	9.656E-01	9.656E-01	9.656E-01	9.656E-01	9.656E-01	9.656E-01	9.660E-01
Np	3.062E-04	3.072E-04	3.085E-04	3.099E-04	3.124E-04	3.173E-04	1.138E-03
Pu	7.963E-03	7.891E-03	7.825E-03	7.766E-03	7.686E-03	7.575E-03	6.785E-03
Am	3.463E-04	4.159E-04	4.787E-04	5.355E-04	6.104E-04	7.121E-04	2.646E-04
Cm	8.479E-06	7.883E-06	7.332E-06	6.821E-06	6.125E-06	5.126E-06	3.058E-07
Cf	7.776E-14	7.695E-14	7.595E-14	7.500E-14	7.372E-14	7.188E-14	1.101E-14
TOTAL	9.743E-01	9.743E-01	9.743E-01	9.743E-01	9.743E-01	9.743E-01	9.743E-01

TABLE F.6.d. Actinide Inventory by Element at 30 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He	9.838E-07	1.076E-06	1.170E-06	1.266E-06	1.412E-06	1.661E-06	2.633E-05
Pb	2.769E-11	4.410E-11	6.255E-11	8.226E-11	1.130E-10	1.647E-10	1.680E-09
Bi	1.789E-15	2.126E-15	2.387E-15	2.594E-15	2.840E-15	3.180E-15	1.429E-11
Ra	2.718E-13	3.636E-13	4.625E-13	5.706E-13	7.540E-13	1.126E-12	2.657E-09
Ac	3.989E-14	5.074E-14	6.145E-14	7.205E-14	8.772E-14	1.133E-13	4.536E-12
Th	4.517E-09	5.527E-09	6.547E-09	7.577E-09	9.142E-09	1.180E-08	8.228E-07
Pa	3.368E-10	3.502E-10	3.636E-10	3.770E-10	3.971E-10	4.306E-10	6.986E-09
U	9.595E-01	9.595E-01	9.595E-01	9.595E-01	9.595E-01	9.595E-01	9.600E-01
Np	3.874E-04	3.886E-04	3.901E-04	3.918E-04	3.947E-04	4.003E-04	1.359E-03
Pu	8.771E-03	8.686E-03	8.610E-03	8.540E-03	8.446E-03	8.317E-03	7.390E-03
Am	4.329E-04	5.144E-04	5.880E-04	6.545E-04	7.423E-04	8.616E-04	3.374E-04
Cm	1.996E-05	1.857E-05	1.728E-05	1.608E-05	1.445E-05	1.211E-05	8.518E-07
Bk	3.196E-15	6.568E-16	1.350E-16	2.774E-17	2.585E-18	4.948E-20	4.260E-28
Cf	5.091E-13	5.029E-13	4.958E-13	4.891E-13	4.802E-13	4.675E-13	7.283E-14
TOTAL	9.691E-01	9.691E-01	9.691E-01	9.691E-01	9.691E-01	9.691E-01	9.691E-01

TABLE F.6.e. Actinide Inventory by Element at 35 MWd/kgM, g/gU

Element	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
He	1.358E-06	1.490E-06	1.623E-06	1.757E-06	1.957E-06	2.291E-06	3.087E-05
Pb	3.689E-11	5.923E-11	8.445E-11	1.115E-10	1.536E-10	2.247E-10	2.172E-09
Bi	2.461E-15	2.933E-15	3.296E-15	3.584E-15	3.924E-15	4.382E-15	1.683E-11
Ra	3.004E-13	3.945E-13	4.918E-13	5.956E-13	7.685E-13	1.117E-12	2.969E-09
Ac	3.941E-14	4.992E-14	6.019E-14	7.024E-14	8.492E-14	1.085E-13	3.513E-12
Th	4.271E-09	5.243E-09	6.228E-09	7.227E-09	8.753E-09	1.137E-08	9.217E-07
Pa	3.321E-10	3.423E-10	3.525E-10	3.627E-10	3.781E-10	4.037E-10	5.428E-09
U	9.535E-01	9.535E-01	9.535E-01	9.535E-01	9.535E-01	9.536E-01	9.541E-01
Np	4.680E-04	4.694E-04	4.711E-04	4.730E-04	4.763E-04	4.828E-04	1.583E-03
Pu	9.459E-03	9.363E-03	9.275E-03	9.195E-03	9.088E-03	8.940E-03	7.884E-03
Am	5.334E-04	6.273E-04	7.122E-04	7.888E-04	8.901E-04	1.027E-03	4.247E-04
Cm	4.003E-05	3.725E-05	3.468E-05	3.230E-05	2.904E-05	2.438E-05	1.963E-06
Bk	1.529E-14	3.142E-15	6.457E-16	1.327E-16	1.236E-17	2.368E-19	2.732E-27
Cf	2.464E-12	2.430E-12	2.393E-12	2.358E-12	2.313E-12	2.249E-12	3.555E-13
TOTAL	9.640E-01	9.640E-01	9.640E-01	9.640E-01	9.640E-01	9.640E-01	9.640E-01

TABLE F.7.a. Fuel Activation Product Inventory by Isotope at 15 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	4.972E-09	4.972E-09	4.972E-09	4.972E-09	4.972E-09	4.972E-09	4.972E-09
H 2	1.988E-12	1.988E-12	1.988E-12	1.988E-12	1.988E-12	1.988E-12	1.988E-12
H 3	5.872E-16	5.249E-16	4.691E-16	4.193E-16	3.543E-16	2.676E-16	0.00
He 3	2.519E-16	3.142E-16	3.700E-16	4.198E-16	4.848E-16	5.715E-16	8.391E-16
He 4	1.057E-06	1.057E-06	1.057E-06	1.057E-06	1.057E-06	1.057E-06	1.057E-06
Li 6	4.926E-15	4.926E-15	4.926E-15	4.926E-15	4.926E-15	4.926E-15	4.926E-15
Be 9	4.506E-11	4.506E-11	4.506E-11	4.506E-11	4.506E-11	4.506E-11	4.506E-11
Be 10	1.319E-11	1.319E-11	1.319E-11	1.319E-11	1.319E-11	1.319E-11	1.318E-11
B 11	6.426E-09	6.426E-09	6.426E-09	6.426E-09	6.426E-09	6.426E-09	6.426E-09
C 12	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05
C 13	3.577E-06	3.577E-06	3.577E-06	3.577E-06	3.577E-06	3.577E-06	3.577E-06
C 14	6.743E-08	6.741E-08	6.740E-08	6.738E-08	6.736E-08	6.732E-08	5.979E-08
N 14	2.703E-05	2.703E-05	2.703E-05	2.703E-05	2.703E-05	2.703E-05	2.703E-05
N 15	1.103E-07	1.103E-07	1.103E-07	1.103E-07	1.103E-07	1.103E-07	1.103E-07
O 16	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01
O 17	5.427E-05	5.427E-05	5.427E-05	5.427E-05	5.427E-05	5.427E-05	5.427E-05
O 18	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04
F 19	5.700E-06	5.700E-06	5.700E-06	5.700E-06	5.700E-06	5.700E-06	5.700E-06
Ne 20	8.294E-11	8.294E-11	8.294E-11	8.294E-11	8.294E-11	8.294E-11	8.294E-11
Ne 21	1.916E-15	1.916E-15	1.916E-15	1.916E-15	1.916E-15	1.916E-15	1.916E-15
Ne 22	2.559E-15	2.559E-15	2.559E-15	2.559E-15	2.559E-15	2.559E-15	2.559E-15
Na 23	2.071E-16	2.071E-16	2.071E-16	2.071E-16	2.071E-16	2.071E-16	2.071E-16
Mg 24	9.226E-11	9.226E-11	9.226E-11	9.226E-11	9.226E-11	9.226E-11	9.226E-11
Mg 25	9.706E-11	9.706E-11	9.706E-11	9.706E-11	9.706E-11	9.706E-11	9.706E-11
Mg 26	4.431E-11	4.431E-11	4.431E-11	4.431E-11	4.431E-11	4.431E-11	4.431E-11
Al 27	4.539E-05	4.539E-05	4.539E-05	4.539E-05	4.539E-05	4.539E-05	4.539E-05
Si 28	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05
Si 29	2.194E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06	2.194E-06
Si 30	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06
P 31	2.010E-10	2.010E-10	2.010E-10	2.010E-10	2.010E-10	2.010E-10	2.010E-10
S 32	8.222E-11	8.222E-11	8.222E-11	8.222E-11	8.222E-11	8.222E-11	8.222E-11
S 33	2.314E-14	2.314E-14	2.314E-14	2.314E-14	2.314E-14	2.314E-14	2.314E-14
S 34	5.599E-12	5.599E-12	5.599E-12	5.599E-12	5.599E-12	5.599E-12	5.599E-12
S 36	6.624E-14	8.295E-14	9.967E-14	1.164E-13	1.415E-13	1.832E-13	8.364E-12
Cl 35	4.073E-06	4.073E-06	4.073E-06	4.073E-06	4.073E-06	4.073E-06	4.073E-06
Cl 36	1.910E-07	1.910E-07	1.910E-07	1.910E-07	1.910E-07	1.910E-07	1.906E-07
Cl 37	1.442E-06	1.442E-06	1.442E-06	1.442E-06	1.442E-06	1.442E-06	1.442E-06
Ar 36	3.418E-12	4.281E-12	5.144E-12	6.007E-12	7.302E-12	9.459E-12	4.319E-10
Ar 38	7.187E-10	7.187E-10	7.187E-10	7.187E-10	7.187E-10	7.187E-10	7.187E-10
Ar 39	1.775E-11	1.766E-11	1.757E-11	1.748E-11	1.735E-11	1.713E-11	1.371E-12

TABLE F.7.a. Fuel Activation Product Inventory by Isotope at 15 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ar 40	2.490E-11	2.490E-11	2.490E-11	2.490E-11	2.490E-11	2.490E-11	2.490E-11
K 39	3.740E-13	4.653E-13	5.561E-13	6.464E-13	7.810E-13	1.003E-12	1.676E-11
K 40	7.134E-09	7.134E-09	7.134E-09	7.134E-09	7.134E-09	7.134E-09	7.134E-09
K 41	1.181E-10	1.184E-10	1.187E-10	1.191E-10	1.196E-10	1.204E-10	2.792E-10
Ca 40	4.386E-05	4.386E-05	4.386E-05	4.386E-05	4.386E-05	4.386E-05	4.386E-05
Ca 41	1.903E-08	1.903E-08	1.903E-08	1.903E-08	1.902E-08	1.902E-08	1.886E-08
Ca 42	3.071E-07	3.071E-07	3.071E-07	3.071E-07	3.071E-07	3.071E-07	3.071E-07
Ca 43	6.301E-08	6.301E-08	6.301E-08	6.301E-08	6.301E-08	6.301E-08	6.301E-08
Ca 44	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06
Ca 45	1.834E-14	8.204E-16	3.670E-17	1.641E-18	1.553E-20	6.572E-24	0.00
Ca 46	1.821E-09	1.821E-09	1.821E-09	1.821E-09	1.821E-09	1.821E-09	1.821E-09
Ca 48	1.031E-07	1.031E-07	1.031E-07	1.031E-07	1.031E-07	1.031E-07	1.031E-07
Sc 45	1.147E-09	1.147E-09	1.147E-09	1.147E-09	1.147E-09	1.147E-09	1.147E-09
Ti 46	1.162E-11	1.162E-11	1.162E-11	1.162E-11	1.162E-11	1.162E-11	1.162E-11
Ti 47	1.388E-12	1.388E-12	1.388E-12	1.388E-12	1.388E-12	1.388E-12	1.388E-12
Ti 48	1.458E-15	1.458E-15	1.458E-15	1.458E-15	1.458E-15	1.458E-15	1.458E-15
Ti 49	1.224E-10	1.224E-10	1.224E-10	1.224E-10	1.224E-10	1.224E-10	1.224E-10
Ti 50	1.547E-13	1.547E-13	1.547E-13	1.547E-13	1.547E-13	1.547E-13	1.547E-13
V 51	2.632E-11	2.632E-11	2.632E-11	2.632E-11	2.632E-11	2.632E-11	2.632E-11
Cr 52	6.771E-14	6.771E-14	6.771E-14	6.771E-14	6.771E-14	6.771E-14	6.771E-14
Cr 53	5.154E-11	5.154E-11	5.154E-11	5.154E-11	5.154E-11	5.154E-11	5.154E-11
Cr 54	7.832E-10	7.847E-10	7.850E-10	7.851E-10	7.851E-10	7.851E-10	7.851E-10
Mn 54	1.856E-12	3.672E-13	7.264E-14	1.437E-14	1.265E-15	2.202E-17	0.00
Mn 55	7.385E-09	7.829E-09	8.090E-09	8.242E-09	8.362E-09	8.434E-09	8.460E-09
Fe 54	3.302E-06	3.302E-06	3.302E-06	3.302E-06	3.302E-06	3.302E-06	3.302E-06
Fe 55	1.075E-09	6.305E-10	3.699E-10	2.170E-10	9.754E-11	2.572E-11	0.00
Fe 56	5.405E-05	5.405E-05	5.405E-05	5.405E-05	5.405E-05	5.405E-05	5.405E-05
Fe 57	1.460E-06	1.460E-06	1.460E-06	1.460E-06	1.460E-06	1.460E-06	1.460E-06
Fe 58	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07	1.846E-07
Co 59	1.235E-09	1.237E-09	1.239E-09	1.241E-09	1.243E-09	1.248E-09	2.106E-09
Co 60	3.224E-11	2.478E-11	1.905E-11	1.464E-11	9.869E-12	5.113E-12	0.00
Ni 58	1.903E-05	1.903E-05	1.903E-05	1.903E-05	1.903E-05	1.903E-05	1.903E-05
Ni 59	1.015E-07	1.015E-07	1.015E-07	1.015E-07	1.015E-07	1.015E-07	1.006E-07
Ni 60	7.553E-06	7.553E-06	7.553E-06	7.553E-06	7.553E-06	7.553E-06	7.553E-06
Ni 61	3.555E-07	3.555E-07	3.555E-07	3.555E-07	3.555E-07	3.555E-07	3.555E-07
Ni 62	1.061E-06	1.061E-06	1.061E-06	1.061E-06	1.061E-06	1.061E-06	1.061E-06
Ni 63	1.529E-08	1.506E-08	1.484E-08	1.462E-08	1.429E-08	1.376E-08	8.552E-12
Ni 64	2.812E-07	2.812E-07	2.812E-07	2.812E-07	2.812E-07	2.812E-07	2.812E-07
Cu 63	9.393E-10	1.168E-09	1.393E-09	1.615E-09	1.942E-09	2.470E-09	1.622E-08
Cu 65	4.844E-10	4.844E-10	4.844E-10	4.844E-10	4.844E-10	4.844E-10	4.844E-10
Zn 64	1.625E-13	1.625E-13	1.625E-13	1.625E-13	1.625E-13	1.625E-13	1.625E-13

TABLE F.7.a. Fuel Activation Product Inventory by Isotope at 15 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Zn 66	6.655E-13	6.655E-13	6.655E-13	6.655E-13	6.655E-13	6.655E-13	6.655E-13
Zn 67	2.288E-16	2.288E-16	2.288E-16	2.288E-16	2.288E-16	2.288E-16	2.288E-16
Ru104	6.300E-16	6.300E-16	6.300E-16	6.300E-16	6.300E-16	6.300E-16	6.300E-16
Pd104	1.391E-13	1.391E-13	1.391E-13	1.391E-13	1.391E-13	1.391E-13	1.391E-13
Pd105	5.223E-16	5.223E-16	5.223E-16	5.223E-16	5.223E-16	5.223E-16	5.223E-16
Pd106	2.944E-12	2.944E-12	2.944E-12	2.944E-12	2.944E-12	2.944E-12	2.944E-12
Pd107	1.365E-13	1.365E-13	1.365E-13	1.365E-13	1.365E-13	1.365E-13	1.365E-13
Pd108	9.938E-10	1.020E-09	1.045E-09	1.070E-09	1.107E-09	1.168E-09	3.351E-09
Pd110	5.769E-10	5.769E-10	5.769E-10	5.769E-10	5.769E-10	5.769E-10	5.769E-10
Ag107	5.232E-07	5.232E-07	5.232E-07	5.232E-07	5.232E-07	5.232E-07	5.232E-07
Ag108m	2.593E-09	2.565E-09	2.537E-09	2.510E-09	2.469E-09	2.403E-09	1.143E-11
Ag109	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.341E-07	3.341E-07
Ag110m	5.123E-12	6.754E-13	8.903E-14	1.174E-14	5.617E-16	3.543E-18	0.00
Cd108	3.850E-08	3.850E-08	3.850E-08	3.851E-08	3.851E-08	3.852E-08	3.872E-08
Cd109	1.089E-12	3.657E-13	1.228E-13	4.124E-14	8.024E-15	5.243E-16	0.00
Cd110	1.992E-07	1.992E-07	1.992E-07	1.992E-07	1.992E-07	1.992E-07	1.992E-07
Cd111	2.914E-09	2.914E-09	2.914E-09	2.914E-09	2.914E-09	2.914E-09	2.914E-09
Cd112	4.235E-11	4.235E-11	4.235E-11	4.235E-11	4.235E-11	4.235E-11	4.235E-11
Cd113	6.300E-15	6.300E-15	6.300E-15	6.300E-15	6.300E-15	6.300E-15	6.300E-15
Cd114	7.499E-14	7.499E-14	7.499E-14	7.499E-14	7.499E-14	7.499E-14	7.499E-14
TOTAL	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01

TABLE F.7.b. Fuel Activation Product Inventory by Isotope at 20 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	6.740E-09	6.740E-09	6.740E-09	6.740E-09	6.740E-09	6.740E-09	6.740E-09
H 2	3.656E-12	3.656E-12	3.656E-12	3.656E-12	3.656E-12	3.656E-12	3.656E-12
H 3	1.369E-15	1.224E-15	1.094E-15	9.777E-16	8.262E-16	6.240E-16	0.00
He 3	5.783E-16	7.237E-16	8.536E-16	9.698E-16	1.121E-15	1.324E-15	1.948E-15
He 4	1.433E-06	1.433E-06	1.433E-06	1.433E-06	1.433E-06	1.433E-06	1.433E-06
Li 6	8.250E-15	8.250E-15	8.250E-15	8.250E-15	8.250E-15	8.250E-15	8.250E-15
Be 9	6.111E-11	6.111E-11	6.111E-11	6.111E-11	6.111E-11	6.111E-11	6.111E-11
Be 10	2.371E-11	2.371E-11	2.371E-11	2.371E-11	2.371E-11	2.371E-11	2.370E-11
B 11	8.713E-09	8.713E-09	8.713E-09	8.713E-09	8.713E-09	8.713E-09	8.713E-09
C 12	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05
C 13	4.794E-06	4.794E-06	4.794E-06	4.794E-06	4.794E-06	4.794E-06	4.794E-06
C 14	9.143E-08	9.141E-08	9.139E-08	9.137E-08	9.133E-08	9.128E-08	8.107E-08
N 14	2.700E-05	2.700E-05	2.700E-05	2.700E-05	2.700E-05	2.700E-05	2.701E-05
N 15	1.116E-07	1.116E-07	1.116E-07	1.116E-07	1.116E-07	1.116E-07	1.116E-07
O 16	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01
O 17	5.428E-05	5.428E-05	5.428E-05	5.428E-05	5.428E-05	5.428E-05	5.428E-05
O 18	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04
F 19	5.700E-06	5.700E-06	5.700E-06	5.700E-06	5.700E-06	5.700E-06	5.700E-06
Ne 20	1.125E-10	1.125E-10	1.125E-10	1.125E-10	1.125E-10	1.125E-10	1.125E-10
Ne 21	3.525E-15	3.525E-15	3.525E-15	3.525E-15	3.525E-15	3.525E-15	3.525E-15
Ne 22	4.709E-15	4.709E-15	4.709E-15	4.709E-15	4.709E-15	4.709E-15	4.709E-15
Na 23	3.812E-16	3.812E-16	3.812E-16	3.812E-16	3.812E-16	3.812E-16	3.812E-16
Mg 24	1.251E-10	1.251E-10	1.251E-10	1.251E-10	1.251E-10	1.251E-10	1.251E-10
Mg 25	1.316E-10	1.316E-10	1.316E-10	1.316E-10	1.316E-10	1.316E-10	1.316E-10
Mg 26	6.015E-11	6.015E-11	6.015E-11	6.015E-11	6.015E-11	6.015E-11	6.015E-11
Al 27	4.538E-05	4.538E-05	4.538E-05	4.538E-05	4.538E-05	4.538E-05	4.538E-05
Si 28	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05
Si 29	2.197E-06	2.197E-06	2.197E-06	2.197E-06	2.197E-06	2.197E-06	2.197E-06
Si 30	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06
P 31	2.727E-10	2.727E-10	2.727E-10	2.727E-10	2.727E-10	2.727E-10	2.727E-10
S 32	1.106E-10	1.106E-10	1.106E-10	1.106E-10	1.106E-10	1.106E-10	1.106E-10
S 33	4.235E-14	4.235E-14	4.235E-14	4.235E-14	4.235E-14	4.235E-14	4.235E-14
S 34	7.596E-12	7.596E-12	7.596E-12	7.596E-12	7.596E-12	7.596E-12	7.596E-12
S 36	8.881E-14	1.113E-13	1.337E-13	1.562E-13	1.898E-13	2.460E-13	1.123E-11
Cl 35	4.009E-06	4.009E-06	4.009E-06	4.009E-06	4.009E-06	4.009E-06	4.009E-06
Cl 36	2.566E-07	2.566E-07	2.566E-07	2.566E-07	2.566E-07	2.566E-07	2.560E-07
Cl 37	1.442E-06	1.442E-06	1.442E-06	1.442E-06	1.442E-06	1.442E-06	1.442E-06
Ar 36	4.582E-12	5.742E-12	6.901E-12	8.060E-12	9.799E-12	1.270E-11	5.800E-10
Ar 38	9.749E-10	9.749E-10	9.749E-10	9.749E-10	9.749E-10	9.749E-10	9.749E-10
Ar 39	2.194E-11	2.182E-11	2.171E-11	2.160E-11	2.143E-11	2.116E-11	1.694E-12
Ar 40	4.410E-11	4.410E-11	4.410E-11	4.410E-11	4.410E-11	4.410E-11	4.410E-11

TABLE F.7.b. Fuel Activation Product Inventory by Isotope at 20 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
K 39	4.646E-13	5.773E-13	6.895E-13	8.011E-13	9.675E-13	1.242E-12	2.071E-11
K 40	9.613E-09	9.613E-09	9.613E-09	9.613E-09	9.613E-09	9.613E-09	9.613E-09
K 41	2.156E-10	2.160E-10	2.165E-10	2.169E-10	2.176E-10	2.187E-10	4.342E-10
Ca 40	4.385E-05	4.385E-05	4.385E-05	4.385E-05	4.385E-05	4.385E-05	4.385E-05
Ca 41	2.580E-08	2.580E-08	2.580E-08	2.580E-08	2.580E-08	2.580E-08	2.559E-08
Ca 42	3.070E-07	3.070E-07	3.070E-07	3.070E-07	3.070E-07	3.070E-07	3.070E-07
Ca 43	6.293E-08	6.293E-08	6.293E-08	6.293E-08	6.293E-08	6.293E-08	6.293E-08
Ca 44	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06
Ca 45	2.552E-14	1.142E-15	5.106E-17	2.284E-18	2.161E-20	9.143E-24	0.00
Ca 46	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09
Ca 48	1.031E-07	1.031E-07	1.031E-07	1.031E-07	1.031E-07	1.031E-07	1.031E-07
Sc 45	1.551E-09	1.551E-09	1.551E-09	1.551E-09	1.551E-09	1.551E-09	1.551E-09
Ti 46	2.135E-11	2.135E-11	2.135E-11	2.135E-11	2.135E-11	2.135E-11	2.135E-11
Ti 47	1.892E-12	1.892E-12	1.892E-12	1.892E-12	1.892E-12	1.892E-12	1.892E-12
Ti 48	2.687E-15	2.687E-15	2.687E-15	2.687E-15	2.687E-15	2.687E-15	2.687E-15
Ti 49	1.659E-10	1.659E-10	1.659E-10	1.659E-10	1.659E-10	1.659E-10	1.659E-10
Ti 50	2.845E-13	2.845E-13	2.845E-13	2.845E-13	2.845E-13	2.845E-13	2.845E-13
V 51	3.565E-11	3.565E-11	3.565E-11	3.565E-11	3.565E-11	3.565E-11	3.565E-11
Cr 52	1.244E-13	1.244E-13	1.244E-13	1.244E-13	1.244E-13	1.244E-13	1.244E-13
Cr 53	6.963E-11	6.963E-11	6.963E-11	6.963E-11	6.963E-11	6.963E-11	6.963E-11
Cr 54	1.062E-09	1.064E-09	1.064E-09	1.064E-09	1.064E-09	1.064E-09	1.064E-09
Mn 54	2.554E-12	5.053E-13	9.998E-14	1.978E-14	1.740E-15	3.030E-17	0.00
Mn 55	9.996E-09	1.060E-08	1.096E-08	1.116E-08	1.133E-08	1.143E-08	1.146E-08
Fe 54	3.299E-06	3.299E-06	3.299E-06	3.299E-06	3.299E-06	3.299E-06	3.299E-06
Fe 55	1.465E-09	8.595E-10	5.043E-10	2.959E-10	1.330E-10	3.506E-11	0.00
Fe 56	5.399E-05	5.399E-05	5.399E-05	5.399E-05	5.399E-05	5.399E-05	5.399E-05
Fe 57	1.519E-06	1.519E-06	1.519E-06	1.519E-06	1.519E-06	1.519E-06	1.519E-06
Fe 58	1.869E-07	1.869E-07	1.869E-07	1.869E-07	1.869E-07	1.869E-07	1.869E-07
Co 59	2.000E-09	2.003E-09	2.005E-09	2.007E-09	2.011E-09	2.017E-09	3.152E-09
Co 60	5.504E-11	4.231E-11	3.252E-11	2.500E-11	1.685E-11	8.728E-12	0.00
Ni 58	1.899E-05	1.899E-05	1.899E-05	1.899E-05	1.899E-05	1.899E-05	1.899E-05
Ni 59	1.343E-07	1.343E-07	1.343E-07	1.343E-07	1.343E-07	1.343E-07	1.331E-07
Ni 60	7.550E-06	7.550E-06	7.550E-06	7.550E-06	7.550E-06	7.550E-06	7.550E-06
Ni 61	3.634E-07	3.634E-07	3.634E-07	3.634E-07	3.634E-07	3.634E-07	3.634E-07
Ni 62	1.055E-06	1.055E-06	1.055E-06	1.055E-06	1.055E-06	1.055E-06	1.055E-06
Ni 63	2.061E-08	2.030E-08	1.999E-08	1.970E-08	1.925E-08	1.854E-08	1.152E-11
Ni 64	2.812E-07	2.812E-07	2.812E-07	2.812E-07	2.812E-07	2.812E-07	2.812E-07
Cu 63	1.263E-09	1.571E-09	1.875E-09	2.174E-09	2.614E-09	3.326E-09	2.186E-08
Cu 65	6.567E-10	6.567E-10	6.567E-10	6.567E-10	6.567E-10	6.567E-10	6.567E-10
Zn 64	2.990E-13	2.990E-13	2.990E-13	2.990E-13	2.990E-13	2.990E-13	2.990E-13
Zn 66	1.224E-12	1.224E-12	1.224E-12	1.224E-12	1.224E-12	1.224E-12	1.224E-12

TABLE F.7.b. Fuel Activation Product Inventory by Isotope at 20 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Zn 67	5.703E-16	5.703E-16	5.703E-16	5.703E-16	5.703E-16	5.703E-16	5.703E-16
Ru104	8.426E-16	8.426E-16	8.426E-16	8.426E-16	8.426E-16	8.426E-16	8.426E-16
Pd104	1.858E-13	1.858E-13	1.858E-13	1.858E-13	1.858E-13	1.858E-13	1.858E-13
Pd105	9.465E-16	9.465E-16	9.465E-16	9.465E-16	9.465E-16	9.465E-16	9.465E-16
Pd106	3.929E-12	3.929E-12	3.929E-12	3.929E-12	3.929E-12	3.929E-12	3.929E-12
Pd107	1.840E-13	1.840E-13	1.840E-13	1.840E-13	1.840E-13	1.840E-13	1.839E-13
Pd108	1.312E-09	1.346E-09	1.380E-09	1.414E-09	1.464E-09	1.545E-09	4.467E-09
Pd110	7.246E-10	7.246E-10	7.246E-10	7.246E-10	7.246E-10	7.246E-10	7.246E-10
Ag107	5.091E-07	5.091E-07	5.091E-07	5.091E-07	5.091E-07	5.091E-07	5.091E-07
Ag108m	3.471E-09	3.433E-09	3.396E-09	3.359E-09	3.304E-09	3.215E-09	1.529E-11
Ag109	2.825E-07	2.825E-07	2.825E-07	2.825E-07	2.825E-07	2.825E-07	2.825E-07
Ag110m	6.151E-12	8.109E-13	1.069E-13	1.409E-14	6.744E-16	4.255E-18	0.00
Cd108	5.149E-08	5.150E-08	5.150E-08	5.150E-08	5.151E-08	5.152E-08	5.179E-08
Cd109	1.904E-12	6.395E-13	2.147E-13	7.211E-14	1.403E-14	9.169E-16	0.00
Cd110	2.488E-07	2.488E-07	2.488E-07	2.488E-07	2.488E-07	2.488E-07	2.488E-07
Cd111	5.044E-09	5.044E-09	5.044E-09	5.044E-09	5.044E-09	5.044E-09	5.044E-09
Cd112	1.008E-10	1.008E-10	1.008E-10	1.008E-10	1.008E-10	1.008E-10	1.008E-10
Cd113	1.524E-14	1.524E-14	1.524E-14	1.524E-14	1.524E-14	1.524E-14	1.524E-14
Cd114	2.505E-13	2.505E-13	2.505E-13	2.505E-13	2.505E-13	2.505E-13	2.505E-13
TOTAL	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01

TABLE F.7.c. Fuel Activation Product Inventory by Isotope at 25 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	8.584E-09	8.584E-09	8.584E-09	8.584E-09	8.584E-09	8.584E-09	8.584E-09
H 2	5.934E-12	5.934E-12	5.934E-12	5.934E-12	5.934E-12	5.934E-12	5.934E-12
H 3	2.645E-15	2.364E-15	2.113E-15	1.889E-15	1.596E-15	1.205E-15	0.00
He 3	1.106E-15	1.387E-15	1.638E-15	1.862E-15	2.155E-15	2.545E-15	3.751E-15
He 4	1.827E-06	1.827E-06	1.827E-06	1.827E-06	1.827E-06	1.827E-06	1.827E-06
Li 6	1.221E-14	1.221E-14	1.221E-14	1.221E-14	1.221E-14	1.221E-14	1.221E-14
Be 9	7.785E-11	7.785E-11	7.785E-11	7.785E-11	7.785E-11	7.785E-11	7.785E-11
Be 10	3.795E-11	3.795E-11	3.795E-11	3.795E-11	3.795E-11	3.795E-11	3.793E-11
B 11	1.110E-08	1.110E-08	1.110E-08	1.110E-08	1.110E-08	1.110E-08	1.110E-08
C 12	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05
C 13	6.065E-06	6.065E-06	6.065E-06	6.065E-06	6.065E-06	6.065E-06	6.065E-06
C 14	1.165E-07	1.164E-07	1.164E-07	1.164E-07	1.163E-07	1.163E-07	1.033E-07
N 14	2.698E-05	2.698E-05	2.698E-05	2.698E-05	2.698E-05	2.698E-05	2.699E-05
N 15	1.130E-07	1.130E-07	1.130E-07	1.130E-07	1.130E-07	1.130E-07	1.130E-07
O 16	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01
O 17	5.428E-05	5.428E-05	5.428E-05	5.428E-05	5.428E-05	5.428E-05	5.428E-05
O 18	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04
F 19	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06
Ne 20	1.434E-10	1.434E-10	1.434E-10	1.434E-10	1.434E-10	1.434E-10	1.434E-10
Ne 21	5.722E-15	5.722E-15	5.722E-15	5.722E-15	5.722E-15	5.722E-15	5.722E-15
Ne 22	7.648E-15	7.648E-15	7.648E-15	7.648E-15	7.648E-15	7.648E-15	7.648E-15
Na 23	6.194E-16	6.194E-16	6.194E-16	6.194E-16	6.194E-16	6.194E-16	6.194E-16
Mg 24	1.595E-10	1.595E-10	1.595E-10	1.595E-10	1.595E-10	1.595E-10	1.595E-10
Mg 25	1.678E-10	1.678E-10	1.678E-10	1.678E-10	1.678E-10	1.678E-10	1.678E-10
Mg 26	7.670E-11	7.670E-11	7.670E-11	7.670E-11	7.670E-11	7.670E-11	7.670E-11
Al 27	4.538E-05	4.538E-05	4.538E-05	4.538E-05	4.538E-05	4.538E-05	4.538E-05
Si 28	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05
Si 29	2.200E-06	2.200E-06	2.200E-06	2.200E-06	2.200E-06	2.200E-06	2.200E-06
Si 30	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06
P 31	3.475E-10	3.475E-10	3.475E-10	3.475E-10	3.475E-10	3.475E-10	3.475E-10
S 32	1.398E-10	1.398E-10	1.398E-10	1.398E-10	1.398E-10	1.398E-10	1.398E-10
S 33	6.841E-14	6.841E-14	6.841E-14	6.841E-14	6.841E-14	6.841E-14	6.841E-14
S 34	9.683E-12	9.683E-12	9.683E-12	9.683E-12	9.683E-12	9.683E-12	9.683E-12
S 36	1.119E-13	1.402E-13	1.685E-13	1.968E-13	2.393E-13	3.101E-13	1.417E-11
Cl 35	3.942E-06	3.942E-06	3.942E-06	3.942E-06	3.942E-06	3.942E-06	3.942E-06
Cl 36	3.236E-07	3.236E-07	3.236E-07	3.236E-07	3.236E-07	3.236E-07	3.229E-07
Cl 37	1.444E-06	1.444E-06	1.444E-06	1.444E-06	1.444E-06	1.444E-06	1.444E-06
Ar 36	5.771E-12	7.233E-12	8.695E-12	1.016E-11	1.235E-11	1.601E-11	7.316E-10
Ar 38	1.243E-09	1.243E-09	1.243E-09	1.243E-09	1.243E-09	1.243E-09	1.243E-09
Ar 39	2.548E-11	2.535E-11	2.522E-11	2.509E-11	2.489E-11	2.457E-11	1.967E-12
Ar 40	6.944E-11	6.944E-11	6.944E-11	6.944E-11	6.944E-11	6.944E-11	6.944E-11

TABLE F.7.c. Fuel Activation Product Inventory by Isotope at 25 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
K 39	5.427E-13	6.736E-13	8.039E-13	9.335E-13	1.127E-12	1.445E-12	2.405E-11
K 40	1.217E-08	1.217E-08	1.217E-08	1.217E-08	1.217E-08	1.217E-08	1.217E-08
K 41	3.478E-10	3.483E-10	3.489E-10	3.495E-10	3.503E-10	3.517E-10	6.263E-10
Ca 40	4.384E-05	4.384E-05	4.384E-05	4.384E-05	4.384E-05	4.384E-05	4.384E-05
Ca 41	3.288E-08	3.288E-08	3.288E-08	3.288E-08	3.288E-08	3.288E-08	3.260E-08
Ca 42	3.069E-07	3.069E-07	3.069E-07	3.069E-07	3.069E-07	3.069E-07	3.069E-07
Ca 43	6.283E-08	6.283E-08	6.283E-08	6.283E-08	6.283E-08	6.283E-08	6.283E-08
Ca 44	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06	1.040E-06
Ca 45	3.305E-14	1.478E-15	6.613E-17	2.958E-18	2.798E-20	1.184E-23	0.00
Ca 46	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09
Ca 48	1.030E-07	1.030E-07	1.030E-07	1.030E-07	1.030E-07	1.030E-07	1.030E-07
SC 45	1.969E-09	1.969E-09	1.969E-09	1.969E-09	1.969E-09	1.969E-09	1.969E-09
Ti 46	3.458E-11	3.458E-11	3.458E-11	3.458E-11	3.458E-11	3.458E-11	3.458E-11
Ti 47	2.428E-12	2.428E-12	2.428E-12	2.428E-12	2.428E-12	2.428E-12	2.428E-12
Ti 48	4.375E-15	4.375E-15	4.375E-15	4.375E-15	4.375E-15	4.375E-15	4.375E-15
Ti 49	2.113E-10	2.113E-10	2.113E-10	2.113E-10	2.113E-10	2.113E-10	2.113E-10
Ti 50	4.618E-13	4.618E-13	4.618E-13	4.618E-13	4.618E-13	4.618E-13	4.618E-13
V 51	4.537E-11	4.537E-11	4.537E-11	4.537E-11	4.537E-11	4.537E-11	4.537E-11
Cr 52	2.018E-13	2.018E-13	2.018E-13	2.018E-13	2.018E-13	2.018E-13	2.018E-13
Cr 53	8.836E-11	8.836E-11	8.836E-11	8.836E-11	8.836E-11	8.836E-11	8.836E-11
Cr 54	1.352E-09	1.355E-09	1.355E-09	1.355E-09	1.355E-09	1.355E-09	1.355E-09
Mn 54	3.288E-12	6.506E-13	1.287E-13	2.546E-14	2.241E-15	3.901E-17	0.00
Mn 55	1.271E-08	1.349E-08	1.394E-08	1.421E-08	1.442E-08	1.454E-08	1.459E-08
Fe 54	3.295E-06	3.295E-06	3.295E-06	3.295E-06	3.295E-06	3.295E-06	3.295E-06
Fe 55	1.874E-09	1.100E-09	6.452E-10	3.785E-10	1.701E-10	4.486E-11	0.00
Fe 56	5.393E-05	5.393E-05	5.393E-05	5.393E-05	5.393E-05	5.393E-05	5.393E-05
Fe 57	1.580E-06	1.580E-06	1.580E-06	1.580E-06	1.580E-06	1.580E-06	1.580E-06
Fe 58	1.892E-07	1.892E-07	1.892E-07	1.892E-07	1.892E-07	1.892E-07	1.892E-07
Co 59	2.911E-09	2.914E-09	2.917E-09	2.920E-09	2.924E-09	2.932E-09	4.341E-09
Co 60	8.733E-11	6.713E-11	5.160E-11	3.967E-11	2.673E-11	1.385E-11	0.00
Ni 58	1.895E-05	1.895E-05	1.895E-05	1.895E-05	1.895E-05	1.895E-05	1.895E-05
Ni 59	1.668E-07	1.668E-07	1.668E-07	1.668E-07	1.668E-07	1.667E-07	1.653E-07
Ni 60	7.549E-06	7.549E-06	7.549E-06	7.549E-06	7.549E-06	7.549E-06	7.549E-06
Ni 61	3.717E-07	3.717E-07	3.717E-07	3.717E-07	3.717E-07	3.717E-07	3.717E-07
Ni 62	1.050E-06	1.050E-06	1.050E-06	1.050E-06	1.050E-06	1.050E-06	1.050E-06
Ni 63	2.608E-08	2.569E-08	2.530E-08	2.492E-08	2.437E-08	2.346E-08	1.458E-11
Ni 64	2.813E-07	2.813E-07	2.813E-07	2.813E-07	2.813E-07	2.813E-07	2.813E-07
Cu 63	1.595E-09	1.985E-09	2.369E-09	2.748E-09	3.305E-09	4.205E-09	2.766E-08
Cu 65	8.364E-10	8.364E-10	8.364E-10	8.364E-10	8.364E-10	8.364E-10	8.364E-10
Zn 64	4.839E-13	4.839E-13	4.839E-13	4.839E-13	4.839E-13	4.839E-13	4.839E-13
Zn 66	1.986E-12	1.986E-12	1.986E-12	1.986E-12	1.986E-12	1.986E-12	1.986E-12

TABLE F.7.c. Fuel Activation Product Inventory by Isotope at 25 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Zn 67	1.180E-15	1.180E-15	1.180E-15	1.180E-15	1.180E-15	1.180E-15	1.180E-15
Ru104	1.058E-15	1.058E-15	1.058E-15	1.058E-15	1.058E-15	1.058E-15	1.058E-15
Pd104	2.332E-13	2.332E-13	2.332E-13	2.332E-13	2.332E-13	2.332E-13	2.332E-13
Pd105	1.513E-15	1.513E-15	1.513E-15	1.513E-15	1.513E-15	1.513E-15	1.513E-15
Pd106	4.925E-12	4.925E-12	4.925E-12	4.925E-12	4.925E-12	4.925E-12	4.925E-12
Pd107	2.328E-13	2.328E-13	2.328E-13	2.328E-13	2.328E-13	2.328E-13	2.328E-13
Pd108	1.625E-09	1.668E-09	1.711E-09	1.753E-09	1.816E-09	1.918E-09	5.590E-09
Pd110	8.542E-10	8.542E-10	8.542E-10	8.542E-10	8.542E-10	8.542E-10	8.542E-10
Ag107	4.948E-07	4.948E-07	4.948E-07	4.948E-07	4.948E-07	4.948E-07	4.948E-07
Ag108m	4.362E-09	4.314E-09	4.267E-09	4.221E-09	4.153E-09	4.041E-09	1.922E-11
Ag109	2.372E-07	2.372E-07	2.372E-07	2.372E-07	2.372E-07	2.372E-07	2.372E-07
Ag110m	6.865E-12	9.049E-13	1.193E-13	1.572E-14	7.526E-16	4.748E-18	0.00
Cd108	6.467E-08	6.467E-08	6.468E-08	6.468E-08	6.469E-08	6.470E-08	6.505E-08
Cd109	2.926E-12	9.826E-13	3.300E-13	1.108E-13	2.156E-14	1.409E-15	0.00
Cd110	2.917E-07	2.917E-07	2.917E-07	2.917E-07	2.917E-07	2.917E-07	2.917E-07
Cd111	7.697E-09	7.697E-09	7.697E-09	7.697E-09	7.697E-09	7.697E-09	7.697E-09
Cd112	1.988E-10	1.988E-10	1.988E-10	1.988E-10	1.988E-10	1.988E-10	1.988E-10
Cd113	3.141E-14	3.141E-14	3.141E-14	3.141E-14	3.141E-14	3.141E-14	3.141E-14
Cd114	6.528E-13	6.528E-13	6.528E-13	6.528E-13	6.528E-13	6.528E-13	6.528E-13
TOTAL	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01

TABLE F.7.d. Fuel Activation Product Inventory by Isotope at 30 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	1.052E-08	1.052E-08	1.052E-08	1.052E-08	1.052E-08	1.052E-08	1.052E-08
H 2	8.918E-12	8.918E-12	8.918E-12	8.918E-12	8.918E-12	8.918E-12	8.918E-12
H 3	4.549E-15	4.066E-15	3.634E-15	3.248E-15	2.745E-15	2.073E-15	0.00
He 3	1.887E-15	2.370E-15	2.802E-15	3.188E-15	3.691E-15	4.363E-15	6.436E-15
He 4	2.240E-06	2.240E-06	2.240E-06	2.240E-06	2.240E-06	2.240E-06	2.240E-06
Li 6	1.675E-14	1.675E-14	1.675E-14	1.675E-14	1.675E-14	1.675E-14	1.675E-14
Be 9	9.544E-11	9.544E-11	9.544E-11	9.544E-11	9.544E-11	9.544E-11	9.544E-11
Be 10	5.651E-11	5.651E-11	5.651E-11	5.651E-11	5.651E-11	5.651E-11	5.648E-11
B 10	1.747E-16	2.237E-16	2.726E-16	3.216E-16	3.950E-16	5.174E-16	2.450E-14
B 11	1.360E-08	1.360E-08	1.360E-08	1.360E-08	1.360E-08	1.360E-08	1.360E-08
C 12	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05
C 13	7.399E-06	7.399E-06	7.399E-06	7.399E-06	7.399E-06	7.399E-06	7.399E-06
C 14	1.428E-07	1.427E-07	1.427E-07	1.427E-07	1.426E-07	1.425E-07	1.266E-07
N 14	2.695E-05	2.695E-05	2.695E-05	2.695E-05	2.695E-05	2.695E-05	2.697E-05
N 15	1.144E-07	1.144E-07	1.144E-07	1.144E-07	1.144E-07	1.144E-07	1.144E-07
O 16	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01
O 17	5.429E-05	5.429E-05	5.429E-05	5.429E-05	5.429E-05	5.429E-05	5.429E-05
O 18	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04
F 19	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06
Ne 20	1.758E-10	1.758E-10	1.758E-10	1.758E-10	1.758E-10	1.758E-10	1.758E-10
Ne 21	8.601E-15	8.601E-15	8.601E-15	8.601E-15	8.601E-15	8.601E-15	8.601E-15
Ne 22	1.150E-14	1.150E-14	1.150E-14	1.150E-14	1.150E-14	1.150E-14	1.150E-14
Na 23	9.316E-16	9.316E-16	9.316E-16	9.316E-16	9.316E-16	9.316E-16	9.316E-16
Mg 24	1.955E-10	1.955E-10	1.955E-10	1.955E-10	1.955E-10	1.955E-10	1.955E-10
Mg 25	2.057E-10	2.057E-10	2.057E-10	2.057E-10	2.057E-10	2.057E-10	2.057E-10
Mg 26	9.411E-11	9.411E-11	9.411E-11	9.411E-11	9.411E-11	9.411E-11	9.411E-11
Al 27	4.537E-05	4.537E-05	4.537E-05	4.537E-05	4.537E-05	4.537E-05	4.537E-05
Si 28	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05
Si 29	2.202E-06	2.202E-06	2.202E-06	2.202E-06	2.202E-06	2.202E-06	2.202E-06
Si 30	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06
P 31	4.261E-10	4.261E-10	4.261E-10	4.261E-10	4.261E-10	4.261E-10	4.261E-10
S 32	1.700E-10	1.700E-10	1.700E-10	1.700E-10	1.700E-10	1.700E-10	1.700E-10
S 33	1.023E-13	1.023E-13	1.023E-13	1.023E-13	1.023E-13	1.023E-13	1.023E-13
S 34	1.188E-11	1.188E-11	1.188E-11	1.188E-11	1.188E-11	1.188E-11	1.188E-11
S 36	1.355E-13	1.699E-13	2.042E-13	2.386E-13	2.901E-13	3.759E-13	1.719E-11
Cl 35	3.874E-06	3.874E-06	3.874E-06	3.874E-06	3.874E-06	3.874E-06	3.874E-06
Cl 36	3.925E-07	3.925E-07	3.925E-07	3.925E-07	3.925E-07	3.925E-07	3.916E-07
Cl 37	1.445E-06	1.445E-06	1.445E-06	1.445E-06	1.445E-06	1.445E-06	1.445E-06
Ar 36	6.989E-12	8.763E-12	1.054E-11	1.231E-11	1.497E-11	1.940E-11	8.874E-10
Ar 38	1.524E-09	1.524E-09	1.524E-09	1.524E-09	1.524E-09	1.524E-09	1.524E-09
Ar 39	2.848E-11	2.833E-11	2.819E-11	2.804E-11	2.783E-11	2.747E-11	2.199E-12

TABLE F.7.d. Fuel Activation Product Inventory by Isotope at 30 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ar 40	1.016E-10	1.016E-10	1.016E-10	1.016E-10	1.016E-10	1.016E-10	1.016E-10
K 39	6.101E-13	7.565E-13	9.021E-13	1.047E-12	1.263E-12	1.619E-12	2.689E-11
K 40	1.481E-08	1.481E-08	1.481E-08	1.481E-08	1.481E-08	1.481E-08	1.481E-08
K 41	5.196E-10	5.203E-10	5.210E-10	5.217E-10	5.227E-10	5.244E-10	8.610E-10
Ca 40	4.383E-05	4.383E-05	4.383E-05	4.383E-05	4.383E-05	4.383E-05	4.383E-05
Ca 41	4.031E-08	4.031E-08	4.031E-08	4.031E-08	4.031E-08	4.031E-08	3.997E-08
Ca 42	3.068E-07	3.068E-07	3.068E-07	3.068E-07	3.068E-07	3.068E-07	3.068E-07
Ca 43	6.274E-08	6.274E-08	6.274E-08	6.274E-08	6.274E-08	6.274E-08	6.274E-08
Ca 44	1.039E-06	1.039E-06	1.039E-06	1.039E-06	1.039E-06	1.039E-06	1.039E-06
Ca 45	4.134E-14	1.849E-15	8.271E-17	3.700E-18	3.500E-20	1.481E-23	0.00
Ca 46	1.819E-09	1.819E-09	1.819E-09	1.819E-09	1.819E-09	1.819E-09	1.819E-09
Ca 48	1.030E-07	1.030E-07	1.030E-07	1.030E-07	1.030E-07	1.030E-07	1.030E-07
Sc 45	2.404E-09	2.404E-09	2.404E-09	2.404E-09	2.404E-09	2.404E-09	2.404E-09
Ti 46	5.184E-11	5.184E-11	5.184E-11	5.184E-11	5.184E-11	5.184E-11	5.184E-11
Ti 47	3.005E-12	3.005E-12	3.005E-12	3.005E-12	3.005E-12	3.005E-12	3.005E-12
Ti 48	6.602E-15	6.602E-15	6.602E-15	6.602E-15	6.602E-15	6.602E-15	6.602E-15
Ti 49	2.589E-10	2.589E-10	2.589E-10	2.589E-10	2.589E-10	2.589E-10	2.589E-10
Ti 50	6.940E-13	6.940E-13	6.940E-13	6.940E-13	6.940E-13	6.940E-13	6.940E-13
V 51	5.555E-11	5.555E-11	5.555E-11	5.555E-11	5.555E-11	5.555E-11	5.555E-11
Cr 52	3.030E-13	3.030E-13	3.030E-13	3.030E-13	3.030E-13	3.030E-13	3.030E-13
Cr 53	1.079E-10	1.079E-10	1.079E-10	1.079E-10	1.079E-10	1.079E-10	1.079E-10
Cr 54	1.656E-09	1.660E-09	1.660E-09	1.661E-09	1.661E-09	1.661E-09	1.661E-09
Mn 54	4.078E-12	8.067E-13	1.596E-13	3.158E-14	2.779E-15	4.837E-17	0.00
Mn 55	1.555E-08	1.651E-08	1.707E-08	1.739E-08	1.765E-08	1.780E-08	1.786E-08
Fe 54	3.292E-06	3.292E-06	3.292E-06	3.292E-06	3.292E-06	3.292E-06	3.292E-06
Fe 55	2.308E-09	1.354E-09	7.944E-10	4.661E-10	2.095E-10	5.524E-11	0.00
Fe 56	5.387E-05	5.387E-05	5.387E-05	5.387E-05	5.387E-05	5.387E-05	5.387E-05
Fe 57	1.645E-06	1.645E-06	1.645E-06	1.645E-06	1.645E-06	1.645E-06	1.645E-06
Fe 58	1.916E-07	1.916E-07	1.916E-07	1.916E-07	1.916E-07	1.916E-07	1.916E-07
Co 59	3.962E-09	3.965E-09	3.969E-09	3.972E-09	3.977E-09	3.986E-09	5.669E-09
Co 60	1.315E-10	1.011E-10	7.771E-11	5.973E-11	4.026E-11	2.086E-11	0.00
Ni 58	1.890E-05	1.890E-05	1.890E-05	1.890E-05	1.890E-05	1.890E-05	1.890E-05
Ni 59	1.991E-07	1.991E-07	1.991E-07	1.990E-07	1.990E-07	1.990E-07	1.974E-07
Ni 60	7.549E-06	7.549E-06	7.549E-06	7.549E-06	7.549E-06	7.549E-06	7.549E-06
Ni 61	3.804E-07	3.804E-07	3.804E-07	3.804E-07	3.804E-07	3.804E-07	3.804E-07
Ni 62	1.044E-06	1.044E-06	1.044E-06	1.044E-06	1.044E-06	1.044E-06	1.044E-06
Ni 63	3.174E-08	3.126E-08	3.080E-08	3.034E-08	2.966E-08	2.856E-08	1.775E-11
Ni 64	2.814E-07	2.814E-07	2.814E-07	2.814E-07	2.814E-07	2.814E-07	2.814E-07
Cu 63	1.938E-09	2.412E-09	2.880E-09	3.341E-09	4.018E-09	5.115E-09	3.366E-08
Cu 65	1.025E-09	1.025E-09	1.025E-09	1.025E-09	1.025E-09	1.025E-09	1.025E-09
Zn 64	7.252E-13	7.252E-13	7.252E-13	7.252E-13	7.252E-13	7.252E-13	7.252E-13

TABLE F.7.d. Fuel Activation Product Inventory by Isotope at 30 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Zn 66	2.985E-12	2.985E-12	2.985E-12	2.985E-12	2.985E-12	2.985E-12	2.985E-12
Zn 67	2.172E-15	2.172E-15	2.172E-15	2.172E-15	2.172E-15	2.172E-15	2.172E-15
Ru104	1.278E-15	1.278E-15	1.278E-15	1.278E-15	1.278E-15	1.278E-15	1.278E-15
Pd104	2.813E-13	2.813E-13	2.813E-13	2.813E-13	2.813E-13	2.813E-13	2.813E-13
Pd105	2.237E-15	2.237E-15	2.237E-15	2.237E-15	2.237E-15	2.237E-15	2.237E-15
Pd106	5.936E-12	5.936E-12	5.936E-12	5.936E-12	5.936E-12	5.936E-12	5.936E-12
Pd107	2.833E-13	2.833E-13	2.833E-13	2.833E-13	2.833E-13	2.833E-13	2.833E-13
Pd108	1.934E-09	1.986E-09	2.038E-09	2.089E-09	2.164E-09	2.288E-09	6.725E-09
Pd110	9.676E-10	9.676E-10	9.676E-10	9.676E-10	9.676E-10	9.676E-10	9.676E-10
Ag107	4.801E-07	4.801E-07	4.801E-07	4.801E-07	4.801E-07	4.801E-07	4.801E-07
Ag108m	5.271E-09	5.213E-09	5.157E-09	5.101E-09	5.018E-09	4.883E-09	2.322E-11
Ag109	1.974E-07	1.974E-07	1.974E-07	1.974E-07	1.974E-07	1.974E-07	1.974E-07
Ag110m	7.336E-12	9.671E-13	1.275E-13	1.680E-14	8.043E-16	5.074E-18	0.00
Cd108	7.809E-08	7.810E-08	7.810E-08	7.811E-08	7.811E-08	7.813E-08	7.855E-08
Cd109	4.160E-12	1.397E-12	4.691E-13	1.575E-13	3.065E-14	2.003E-15	0.00
Cd110	3.284E-07	3.284E-07	3.284E-07	3.284E-07	3.284E-07	3.284E-07	3.284E-07
Cd111	1.085E-08	1.085E-08	1.085E-08	1.085E-08	1.085E-08	1.085E-08	1.085E-08
Cd112	3.486E-10	3.486E-10	3.486E-10	3.486E-10	3.486E-10	3.486E-10	3.486E-10
Cd113	5.509E-14	5.509E-14	5.509E-14	5.509E-14	5.509E-14	5.509E-14	5.509E-14
Cd114	1.427E-12	1.427E-12	1.427E-12	1.427E-12	1.427E-12	1.427E-12	1.427E-12
In115	2.728E-16	2.728E-16	2.728E-16	2.728E-16	2.728E-16	2.728E-16	2.728E-16
Sn116	1.386E-16	1.386E-16	1.386E-16	1.386E-16	1.386E-16	1.386E-16	1.386E-16
TOTAL	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01

TABLE F.7.e. Fuel Activation Product Inventory by Isotope at 35 MWd/kgM, g/gU

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	1.255E-08	1.255E-08	1.255E-08	1.255E-08	1.255E-08	1.255E-08	1.255E-08
H 2	1.271E-11	1.271E-11	1.271E-11	1.271E-11	1.271E-11	1.271E-11	1.271E-11
H 3	7.221E-15	6.454E-15	5.769E-15	5.156E-15	4.357E-15	3.291E-15	0.00
He 3	2.979E-15	3.745E-15	4.431E-15	5.043E-15	5.843E-15	6.909E-15	1.020E-14
He 4	2.674E-06	2.674E-06	2.674E-06	2.674E-06	2.674E-06	2.674E-06	2.674E-06
Li 6	2.182E-14	2.182E-14	2.182E-14	2.182E-14	2.182E-14	2.182E-14	2.182E-14
Be 9	1.139E-10	1.139E-10	1.139E-10	1.139E-10	1.139E-10	1.139E-10	1.139E-10
Be 10	7.999E-11	7.999E-11	7.999E-11	7.999E-11	7.999E-11	7.999E-11	7.996E-11
B 10	2.415E-16	3.108E-16	3.801E-16	4.494E-16	5.534E-16	7.266E-16	3.468E-14
B 11	1.623E-08	1.623E-08	1.623E-08	1.623E-08	1.623E-08	1.623E-08	1.623E-08
C 12	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05	1.344E-05
C 13	8.803E-06	8.803E-06	8.803E-06	8.803E-06	8.803E-06	8.803E-06	8.803E-06
C 14	1.704E-07	1.703E-07	1.703E-07	1.703E-07	1.702E-07	1.701E-07	1.511E-07
N 14	2.692E-05	2.693E-05	2.693E-05	2.693E-05	2.693E-05	2.693E-05	2.694E-05
N 15	1.159E-07	1.159E-07	1.159E-07	1.159E-07	1.159E-07	1.159E-07	1.159E-07
O 16	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01	1.341E-01
O 17	5.429E-05	5.429E-05	5.429E-05	5.429E-05	5.429E-05	5.429E-05	5.429E-05
O 18	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04	3.084E-04
F 19	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06	5.699E-06
Ne 20	2.099E-10	2.099E-10	2.099E-10	2.099E-10	2.099E-10	2.099E-10	2.099E-10
Ne 21	1.226E-14	1.226E-14	1.226E-14	1.226E-14	1.226E-14	1.226E-14	1.226E-14
Ne 22	1.639E-14	1.639E-14	1.639E-14	1.639E-14	1.639E-14	1.639E-14	1.639E-14
Na 23	1.329E-15	1.329E-15	1.329E-15	1.329E-15	1.329E-15	1.329E-15	1.329E-15
Mg 24	2.334E-10	2.334E-10	2.334E-10	2.334E-10	2.334E-10	2.334E-10	2.334E-10
Mg 25	2.456E-10	2.456E-10	2.456E-10	2.456E-10	2.456E-10	2.456E-10	2.456E-10
Mg 26	1.125E-10	1.125E-10	1.125E-10	1.125E-10	1.125E-10	1.125E-10	1.125E-10
Al 27	4.537E-05	4.537E-05	4.537E-05	4.537E-05	4.537E-05	4.537E-05	4.537E-05
Si 28	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05	4.172E-05
Si 29	2.205E-06	2.205E-06	2.205E-06	2.205E-06	2.205E-06	2.205E-06	2.205E-06
Si 30	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06	1.503E-06
P 31	5.088E-10	5.088E-10	5.088E-10	5.088E-10	5.088E-10	5.088E-10	5.088E-10
S 32	2.011E-10	2.011E-10	2.011E-10	2.011E-10	2.011E-10	2.011E-10	2.011E-10
S 33	1.449E-13	1.449E-13	1.449E-13	1.449E-13	1.449E-13	1.449E-13	1.449E-13
S 34	1.419E-11	1.419E-11	1.419E-11	1.419E-11	1.419E-11	1.419E-11	1.419E-11
S 36	1.598E-13	2.003E-13	2.409E-13	2.814E-13	3.422E-13	4.436E-13	2.029E-11
Cl 35	3.803E-06	3.803E-06	3.803E-06	3.803E-06	3.803E-06	3.803E-06	3.803E-06
Cl 36	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.634E-07	4.624E-07
Cl 37	1.448E-06	1.448E-06	1.448E-06	1.448E-06	1.448E-06	1.448E-06	1.448E-06
Ar 36	8.239E-12	1.033E-11	1.243E-11	1.452E-11	1.766E-11	2.289E-11	1.048E-09
Ar 38	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09	1.820E-09
Ar 39	3.102E-11	3.086E-11	3.070E-11	3.054E-11	3.031E-11	2.992E-11	2.395E-12

TABLE F.7.e. Fuel Activation Product Inventory by Isotope at 35 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ar 40	1.414E-10	1.414E-10	1.414E-10	1.414E-10	1.414E-10	1.414E-10	1.414E-10
K 39	6.683E-13	8.277E-13	9.863E-13	1.144E-12	1.379E-12	1.767E-12	2.929E-11
K 40	1.755E-08	1.755E-08	1.755E-08	1.755E-08	1.755E-08	1.755E-08	1.755E-08
K 41	7.362E-10	7.370E-10	7.378E-10	7.386E-10	7.399E-10	7.419E-10	1.144E-09
Ca 40	4.382E-05	4.382E-05	4.382E-05	4.382E-05	4.382E-05	4.382E-05	4.382E-05
Ca 41	4.813E-08	4.812E-08	4.812E-08	4.812E-08	4.812E-08	4.812E-08	4.772E-08
Ca 42	3.067E-07	3.067E-07	3.067E-07	3.067E-07	3.067E-07	3.067E-07	3.067E-07
Ca 43	6.264E-08	6.264E-08	6.264E-08	6.264E-08	6.264E-08	6.264E-08	6.264E-08
Ca 44	1.039E-06	1.039E-06	1.039E-06	1.039E-06	1.039E-06	1.039E-06	1.039E-06
Ca 45	5.026E-14	2.248E-15	1.006E-16	4.498E-18	4.255E-20	1.801E-23	0.00
Ca 46	1.819E-09	1.819E-09	1.819E-09	1.819E-09	1.819E-09	1.819E-09	1.819E-09
Ca 48	1.029E-07	1.029E-07	1.029E-07	1.029E-07	1.029E-07	1.029E-07	1.029E-07
Sc 45	2.859E-09	2.859E-09	2.859E-09	2.859E-09	2.859E-09	2.859E-09	2.859E-09
Ti 46	7.365E-11	7.365E-11	7.365E-11	7.365E-11	7.365E-11	7.365E-11	7.365E-11
Ti 47	3.631E-12	3.631E-12	3.631E-12	3.631E-12	3.631E-12	3.631E-12	3.631E-12
Ti 48	9.458E-15	9.458E-15	9.458E-15	9.458E-15	9.458E-15	9.458E-15	9.458E-15
Ti 49	3.089E-10	3.089E-10	3.089E-10	3.089E-10	3.089E-10	3.089E-10	3.089E-10
Ti 50	9.888E-13	9.888E-13	9.888E-13	9.888E-13	9.888E-13	9.888E-13	9.888E-13
V 51	6.622E-11	6.622E-11	6.622E-11	6.622E-11	6.622E-11	6.622E-11	6.622E-11
Cr 52	4.313E-13	4.313E-13	4.313E-13	4.313E-13	4.313E-13	4.313E-13	4.313E-13
Cr 53	1.282E-10	1.282E-10	1.282E-10	1.282E-10	1.282E-10	1.282E-10	1.282E-10
Cr 54	1.976E-09	1.980E-09	1.981E-09	1.981E-09	1.981E-09	1.981E-09	1.981E-09
Mn 54	4.921E-12	9.735E-13	1.926E-13	3.810E-14	3.353E-15	5.838E-17	0.00
Mn 55	1.853E-08	1.967E-08	2.034E-08	2.074E-08	2.104E-08	2.123E-08	2.129E-08
Fe 54	3.288E-06	3.288E-06	3.288E-06	3.288E-06	3.288E-06	3.288E-06	3.288E-06
Fe 55	2.766E-09	1.623E-09	9.523E-10	5.587E-10	2.511E-10	6.622E-11	0.00
Fe 56	5.380E-05	5.380E-05	5.380E-05	5.380E-05	5.380E-05	5.380E-05	5.380E-05
Fe 57	1.712E-06	1.712E-06	1.712E-06	1.712E-06	1.712E-06	1.712E-06	1.712E-06
Fe 58	1.941E-07	1.941E-07	1.941E-07	1.941E-07	1.941E-07	1.941E-07	1.941E-07
Co 59	5.144E-09	5.148E-09	5.152E-09	5.156E-09	5.162E-09	5.172E-09	7.126E-09
Co 60	1.900E-10	1.460E-10	1.123E-10	8.629E-11	5.816E-11	3.013E-11	0.00
Ni 58	1.886E-05	1.886E-05	1.886E-05	1.886E-05	1.886E-05	1.886E-05	1.886E-05
Ni 59	2.311E-07	2.311E-07	2.311E-07	2.311E-07	2.311E-07	2.311E-07	2.291E-07
Ni 60	7.551E-06	7.551E-06	7.551E-06	7.551E-06	7.551E-06	7.551E-06	7.551E-06
Ni 61	3.895E-07	3.895E-07	3.895E-07	3.895E-07	3.895E-07	3.895E-07	3.895E-07
Ni 62	1.038E-06	1.038E-06	1.038E-06	1.038E-06	1.038E-06	1.038E-06	1.038E-06
Ni 63	3.760E-08	3.704E-08	3.649E-08	3.594E-08	3.514E-08	3.384E-08	2.103E-11
Ni 64	2.816E-07	2.816E-07	2.816E-07	2.816E-07	2.816E-07	2.816E-07	2.816E-07
Cu 63	2.291E-09	2.854E-09	3.408E-09	3.953E-09	4.757E-09	6.056E-09	3.987E-08
Cu 65	1.223E-09	1.223E-09	1.223E-09	1.223E-09	1.223E-09	1.223E-09	1.223E-09
Zn 64	1.030E-12	1.030E-12	1.030E-12	1.030E-12	1.030E-12	1.030E-12	1.030E-12

TABLE F.7.e. Fuel Activation Product Inventory by Isotope at 35 MWd/kgM, g/gU (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Zn 66	4.253E-12	4.253E-12	4.253E-12	4.253E-12	4.253E-12	4.253E-12	4.253E-12
Zn 67	3.691E-15	3.691E-15	3.691E-15	3.691E-15	3.691E-15	3.691E-15	3.691E-15
Ru104	1.502E-15	1.502E-15	1.502E-15	1.502E-15	1.502E-15	1.502E-15	1.502E-15
Pd104	3.303E-13	3.303E-13	3.303E-13	3.303E-13	3.303E-13	3.303E-13	3.303E-13
Pd105	3.134E-15	3.134E-15	3.134E-15	3.134E-15	3.134E-15	3.134E-15	3.134E-15
Pd106	6.962E-12	6.962E-12	6.962E-12	6.962E-12	6.962E-12	6.962E-12	6.962E-12
Pd107	3.356E-13	3.356E-13	3.356E-13	3.356E-13	3.356E-13	3.356E-13	3.356E-13
Pd108	2.238E-09	2.299E-09	2.360E-09	2.420E-09	2.509E-09	2.654E-09	7.871E-09
Pd110	1.066E-09	1.066E-09	1.066E-09	1.066E-09	1.066E-09	1.066E-09	1.066E-09
Ag107	4.652E-07	4.652E-07	4.652E-07	4.652E-07	4.652E-07	4.652E-07	4.652E-07
Ag108m	6.197E-09	6.130E-09	6.064E-09	5.998E-09	5.900E-09	5.742E-09	2.730E-11
Ag109	1.628E-07	1.628E-07	1.628E-07	1.628E-07	1.628E-07	1.628E-07	1.628E-07
Ag110m	7.580E-12	9.992E-13	1.317E-13	1.736E-14	8.310E-16	5.244E-18	0.00
Cd108	9.176E-08	9.177E-08	9.177E-08	9.178E-08	9.179E-08	9.180E-08	9.230E-08
Cd109	5.595E-12	1.879E-12	6.309E-13	2.119E-13	4.123E-14	2.694E-15	0.00
Cd110	3.594E-07	3.594E-07	3.594E-07	3.594E-07	3.594E-07	3.594E-07	3.594E-07
Cd111	1.449E-08	1.449E-08	1.449E-08	1.449E-08	1.449E-08	1.449E-08	1.449E-08
Cd112	5.637E-10	5.637E-10	5.637E-10	5.637E-10	5.637E-10	5.637E-10	5.637E-10
Cd113	8.908E-14	8.908E-14	8.908E-14	8.908E-14	8.908E-14	8.908E-14	8.908E-14
Cd114	2.789E-12	2.789E-12	2.789E-12	2.789E-12	2.789E-12	2.789E-12	2.789E-12
In115	6.046E-16	6.046E-16	6.046E-16	6.046E-16	6.046E-16	6.046E-16	6.046E-16
Sn116	3.578E-16	3.578E-16	3.578E-16	3.578E-16	3.578E-16	3.578E-16	3.578E-16
TOTAL	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01	1.347E-01

TABLE F.8.a. Cladding Activation Product Inventory by Isotope at 15 MWd/kgM, g/gZr

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	1.402E-05	1.402E-05	1.402E-05	1.402E-05	1.402E-05	1.402E-05	1.402E-05
H 2	1.539E-08	1.539E-08	1.539E-08	1.539E-08	1.539E-08	1.539E-08	1.539E-08
H 3	1.162E-14	1.038E-14	9.279E-15	8.294E-15	7.009E-15	5.294E-15	0.00
He 3	5.014E-15	6.247E-15	7.350E-15	8.335E-15	9.621E-15	1.134E-14	1.663E-14
He 4	4.107E-08	4.107E-08	4.107E-08	4.107E-08	4.107E-08	4.107E-08	4.107E-08
Li 6	4.962E-14	4.962E-14	4.962E-14	4.962E-14	4.962E-14	4.962E-14	4.962E-14
Be 9	4.539E-10	4.539E-10	4.539E-10	4.539E-10	4.539E-10	4.539E-10	4.539E-10
Be 10	1.172E-11	1.172E-11	1.172E-11	1.172E-11	1.172E-11	1.172E-11	1.172E-11
B 11	7.088E-09	7.088E-09	7.088E-09	7.088E-09	7.088E-09	7.088E-09	7.088E-09
C 12	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04
C 13	1.678E-06	1.678E-06	1.678E-06	1.678E-06	1.678E-06	1.678E-06	1.678E-06
C 14	6.225E-08	6.223E-08	6.222E-08	6.220E-08	6.218E-08	6.214E-08	5.519E-08
N 14	2.981E-05	2.981E-05	2.981E-05	2.981E-05	2.981E-05	2.981E-05	2.982E-05
N 15	1.202E-07	1.202E-07	1.202E-07	1.202E-07	1.202E-07	1.202E-07	1.202E-07
O 16	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03
O 17	5.075E-07	5.075E-07	5.075E-07	5.075E-07	5.075E-07	5.075E-07	5.075E-07
O 18	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06
F 19	1.151E-12	1.151E-12	1.151E-12	1.151E-12	1.151E-12	1.151E-12	1.151E-12
Ne 22	4.509E-15	4.509E-15	4.509E-15	4.509E-15	4.509E-15	4.509E-15	4.509E-15
Mg 24	8.129E-11	8.129E-11	8.129E-11	8.129E-11	8.129E-11	8.129E-11	8.129E-11
Mg 25	1.710E-10	1.710E-10	1.710E-10	1.710E-10	1.710E-10	1.710E-10	1.710E-10
Mg 26	7.808E-11	7.808E-11	7.808E-11	7.808E-11	7.808E-11	7.808E-11	7.808E-11
Al 27	3.999E-05	3.999E-05	3.999E-05	3.999E-05	3.999E-05	3.999E-05	3.999E-05
Si 28	7.350E-05	7.350E-05	7.350E-05	7.350E-05	7.350E-05	7.350E-05	7.350E-05
Si 29	3.867E-06	3.867E-06	3.867E-06	3.867E-06	3.867E-06	3.867E-06	3.867E-06
Si 30	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06
P 31	3.542E-10	3.542E-10	3.542E-10	3.542E-10	3.542E-10	3.542E-10	3.542E-10
S 32	3.475E-14	3.475E-14	3.475E-14	3.475E-14	3.475E-14	3.475E-14	3.477E-14
Ti 47	8.913E-11	8.913E-11	8.913E-11	8.913E-11	8.913E-11	8.913E-11	8.913E-11
Ti 48	9.914E-14	9.914E-14	9.914E-14	9.914E-14	9.914E-14	9.914E-14	9.914E-14
Ti 49	2.427E-10	2.427E-10	2.427E-10	2.427E-10	2.427E-10	2.427E-10	2.427E-10
Ti 50	9.725E-10	9.725E-10	9.725E-10	9.725E-10	9.725E-10	9.725E-10	9.725E-10
V 50	3.551E-09	3.551E-09	3.551E-09	3.551E-09	3.551E-09	3.551E-09	3.551E-09
V 51	7.154E-07	7.154E-07	7.154E-07	7.154E-07	7.154E-07	7.154E-07	7.154E-07
Cr 50	4.108E-05	4.108E-05	4.108E-05	4.108E-05	4.108E-05	4.108E-05	4.108E-05
Cr 52	8.338E-04	8.338E-04	8.338E-04	8.338E-04	8.338E-04	8.338E-04	8.338E-04
Cr 53	9.811E-05	9.811E-05	9.811E-05	9.811E-05	9.811E-05	9.811E-05	9.811E-05
Cr 54	2.643E-05	2.643E-05	2.643E-05	2.643E-05	2.643E-05	2.643E-05	2.643E-05
Mn 54	6.291E-11	1.245E-11	2.462E-12	4.872E-13	4.287E-14	7.463E-16	0.00
Mn 55	2.518E-07	2.664E-07	2.749E-07	2.799E-07	2.838E-07	2.862E-07	2.870E-07
Fe 54	1.119E-04	1.119E-04	1.119E-04	1.119E-04	1.119E-04	1.119E-04	1.119E-04

TABLE F.8.a. Cladding Activation Product Inventory by Isotope at 15 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Fe 55	3.520E-08	2.065E-08	1.212E-08	7.110E-09	3.195E-09	8.426E-10	0.00
Fe 56	1.832E-03	1.832E-03	1.832E-03	1.832E-03	1.832E-03	1.832E-03	1.832E-03
Fe 57	4.948E-05	4.948E-05	4.948E-05	4.948E-05	4.948E-05	4.948E-05	4.948E-05
Fe 58	6.135E-06	6.135E-06	6.135E-06	6.135E-06	6.135E-06	6.135E-06	6.135E-06
Co 59	8.475E-09	8.475E-09	8.475E-09	8.475E-09	8.475E-09	8.475E-09	8.475E-09
Co 60	8.466E-11	6.507E-11	5.002E-11	3.845E-11	2.591E-11	1.343E-11	0.00
Ni 60	1.326E-10	1.522E-10	1.673E-10	1.788E-10	1.914E-10	2.039E-10	2.173E-10
Ni 61	2.138E-13	2.138E-13	2.138E-13	2.138E-13	2.138E-13	2.138E-13	2.138E-13
Sr 87	5.980E-09	5.980E-09	5.980E-09	5.980E-09	5.980E-09	5.980E-09	5.980E-09
Sr 88	5.596E-07	5.596E-07	5.596E-07	5.596E-07	5.596E-07	5.596E-07	5.596E-07
Sr 90	8.806E-12	8.396E-12	8.006E-12	7.634E-12	7.108E-12	6.310E-12	4.674E-22
Y 89	4.259E-08	4.259E-08	4.259E-08	4.259E-08	4.259E-08	4.259E-08	4.259E-08
Y 90	2.208E-15	2.106E-15	2.008E-15	1.914E-15	1.782E-15	1.582E-15	1.172E-25
Zr 90	4.975E-01	4.975E-01	4.975E-01	4.975E-01	4.975E-01	4.975E-01	4.975E-01
Zr 91	1.092E-01	1.092E-01	1.092E-01	1.092E-01	1.092E-01	1.092E-01	1.092E-01
Zr 92	1.691E-01	1.691E-01	1.691E-01	1.691E-01	1.691E-01	1.691E-01	1.691E-01
Zr 93	1.061E-04	1.061E-04	1.061E-04	1.061E-04	1.061E-04	1.061E-04	1.061E-04
Zr 94	1.756E-01	1.756E-01	1.756E-01	1.756E-01	1.756E-01	1.756E-01	1.756E-01
Zr 96	2.880E-02	2.880E-02	2.880E-02	2.880E-02	2.880E-02	2.880E-02	2.880E-02
Nb 93	8.391E-11	1.220E-10	1.656E-10	2.144E-10	2.960E-10	4.512E-10	4.727E-08
Nb 93m	2.965E-10	3.546E-10	4.071E-10	4.545E-10	5.172E-10	6.025E-10	8.960E-10
Nb 94	1.348E-14	1.348E-14	1.348E-14	1.348E-14	1.348E-14	1.347E-14	1.303E-14
Mo 95	3.889E-05	3.889E-05	3.889E-05	3.889E-05	3.889E-05	3.889E-05	3.889E-05
Mo 96	7.770E-07	7.770E-07	7.770E-07	7.770E-07	7.770E-07	7.770E-07	7.770E-07
Mo 97	5.900E-05	5.900E-05	5.900E-05	5.900E-05	5.900E-05	5.900E-05	5.900E-05
Mo 98	2.376E-07	2.376E-07	2.376E-07	2.376E-07	2.376E-07	2.376E-07	2.376E-07
Mo100	8.460E-15	8.460E-15	8.460E-15	8.460E-15	8.460E-15	8.460E-15	8.460E-15
Tc 99	2.662E-11	2.662E-11	2.662E-11	2.662E-11	2.662E-11	2.662E-11	2.654E-11
Ru100	7.051E-13	7.051E-13	7.051E-13	7.051E-13	7.051E-13	7.051E-13	7.051E-13
Ru101	1.279E-15	1.279E-15	1.279E-15	1.279E-15	1.279E-15	1.279E-15	1.279E-15
Cd111	6.208E-12	6.208E-12	6.208E-12	6.208E-12	6.208E-12	6.208E-12	6.208E-12
Cd112	5.344E-11	5.344E-11	5.344E-11	5.344E-11	5.344E-11	5.344E-11	5.344E-11
Cd113	3.377E-13	3.377E-13	3.377E-13	3.377E-13	3.377E-13	3.377E-13	3.377E-13
Cd114	3.878E-09	3.878E-09	3.878E-09	3.878E-09	3.878E-09	3.878E-09	3.878E-09
Cd116	3.873E-11	3.873E-11	3.873E-11	3.873E-11	3.873E-11	3.873E-11	3.873E-11
In113	1.167E-06	1.167E-06	1.167E-06	1.167E-06	1.167E-06	1.167E-06	1.167E-06
In115	2.509E-11	2.509E-11	2.509E-11	2.509E-11	2.509E-11	2.509E-11	2.509E-11
Sn112	1.402E-04	1.402E-04	1.402E-04	1.402E-04	1.402E-04	1.402E-04	1.402E-04
Sn113	2.071E-13	2.546E-15	3.129E-17	3.845E-19	5.255E-22	8.798E-27	0.00
Sn114	9.648E-05	9.648E-05	9.648E-05	9.648E-05	9.648E-05	9.648E-05	9.648E-05
Sn115	5.241E-05	5.241E-05	5.241E-05	5.241E-05	5.241E-05	5.241E-05	5.241E-05

TABLE F.8.a. Cladding Activation Product Inventory by Isotope at 15 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Sn116	2.141E-03	2.141E-03	2.141E-03	2.141E-03	2.141E-03	2.141E-03	2.141E-03
Sn117	1.150E-03	1.150E-03	1.150E-03	1.150E-03	1.150E-03	1.150E-03	1.150E-03
Sn118	3.614E-03	3.614E-03	3.614E-03	3.614E-03	3.614E-03	3.614E-03	3.614E-03
Sn119	1.305E-03	1.305E-03	1.305E-03	1.305E-03	1.305E-03	1.305E-03	1.305E-03
Sn119m	3.751E-09	4.749E-10	6.014E-11	7.615E-12	3.431E-13	1.958E-15	0.00
Sn120	4.911E-03	4.911E-03	4.911E-03	4.911E-03	4.911E-03	4.911E-03	4.911E-03
Sn121m	1.751E-08	1.703E-08	1.656E-08	1.611E-08	1.545E-08	1.442E-08	1.800E-14
Sn122	7.083E-04	7.083E-04	7.083E-04	7.083E-04	7.083E-04	7.083E-04	7.083E-04
Sn123	3.899E-13	7.735E-15	1.535E-16	3.045E-18	8.514E-21	4.720E-25	0.00
Sn124	8.729E-04	8.729E-04	8.729E-04	8.729E-04	8.729E-04	8.729E-04	8.729E-04
Sb121	3.243E-06	3.244E-06	3.244E-06	3.245E-06	3.245E-06	3.246E-06	3.261E-06
Sb123	3.431E-07	3.431E-07	3.431E-07	3.431E-07	3.431E-07	3.431E-07	3.431E-07
Sb125	5.777E-07	3.502E-07	2.123E-07	1.287E-07	6.075E-08	1.738E-08	0.00
Te122	1.006E-07	1.006E-07	1.006E-07	1.006E-07	1.006E-07	1.006E-07	1.006E-07
Te123	8.704E-10	8.704E-10	8.704E-10	8.704E-10	8.704E-10	8.704E-10	8.704E-10
Te124	5.474E-09	5.474E-09	5.474E-09	5.474E-09	5.474E-09	5.474E-09	5.474E-09
Te125	3.424E-06	3.655E-06	3.795E-06	3.879E-06	3.948E-06	3.992E-06	4.010E-06
Te125m	8.080E-09	4.900E-09	2.970E-09	1.801E-09	8.498E-10	2.432E-10	0.00
Te126	1.820E-08	1.820E-08	1.820E-08	1.820E-08	1.820E-08	1.820E-08	1.820E-08
Te128	2.495E-14	2.495E-14	2.495E-14	2.495E-14	2.495E-14	2.495E-14	2.495E-14
I127	3.125E-11	3.125E-11	3.125E-11	3.125E-11	3.125E-11	3.125E-11	3.125E-11
Xe128	3.903E-13	3.903E-13	3.903E-13	3.903E-13	3.903E-13	3.903E-13	3.903E-13
Lu175	2.971E-08	2.971E-08	2.971E-08	2.971E-08	2.971E-08	2.971E-08	2.971E-08
Lu176	6.353E-10	6.353E-10	6.353E-10	6.353E-10	6.353E-10	6.353E-10	6.353E-10
Hf174	5.231E-08	5.231E-08	5.231E-08	5.231E-08	5.231E-08	5.231E-08	5.231E-08
Hf176	2.235E-06	2.235E-06	2.235E-06	2.235E-06	2.235E-06	2.235E-06	2.235E-06
Hf177	1.141E-06	1.141E-06	1.141E-06	1.141E-06	1.141E-06	1.141E-06	1.141E-06
Hf178	1.430E-05	1.430E-05	1.430E-05	1.430E-05	1.430E-05	1.430E-05	1.430E-05
Hf179	1.537E-05	1.537E-05	1.537E-05	1.537E-05	1.537E-05	1.537E-05	1.537E-05
Hf180	2.152E-05	2.152E-05	2.152E-05	2.152E-05	2.152E-05	2.152E-05	2.152E-05
Hf182	9.731E-10	9.731E-10	9.731E-10	9.731E-10	9.731E-10	9.731E-10	9.730E-10
Ta181	4.438E-07	4.438E-07	4.438E-07	4.438E-07	4.438E-07	4.438E-07	4.438E-07
Ta182	1.061E-14	1.635E-16	3.563E-17	3.406E-17	3.404E-17	3.404E-17	3.404E-17
W182	2.475E-08	2.475E-08	2.475E-08	2.475E-08	2.475E-08	2.475E-08	2.475E-08
W183	2.060E-08	2.060E-08	2.060E-08	2.060E-08	2.060E-08	2.060E-08	2.060E-08
W184	6.612E-10	6.612E-10	6.612E-10	6.612E-10	6.612E-10	6.612E-10	6.612E-10
W186	3.786E-15	3.786E-15	3.786E-15	3.786E-15	3.786E-15	3.786E-15	3.786E-15
Re185	7.970E-13	7.970E-13	7.970E-13	7.970E-13	7.970E-13	7.970E-13	7.970E-13
Os186	5.587E-14	5.587E-14	5.587E-14	5.587E-14	5.587E-14	5.587E-14	5.587E-14
TOTAL	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

TABLE F.8.b. Cladding Activation Product Inventory by Isotope at 20 MWd/kgM, g/gZr

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	1.402E-05	1.402E-05	1.402E-05	1.402E-05	1.402E-05	1.402E-05	1.402E-05
H 2	1.938E-08	1.938E-08	1.938E-08	1.938E-08	1.938E-08	1.938E-08	1.938E-08
H 3	2.315E-14	2.069E-14	1.850E-14	1.653E-14	1.397E-14	1.055E-14	1.360E-38
He 3	9.806E-15	1.226E-14	1.446E-14	1.643E-14	1.899E-14	2.241E-14	3.296E-14
He 4	5.570E-08	5.570E-08	5.570E-08	5.570E-08	5.570E-08	5.570E-08	5.570E-08
Li 6	8.310E-14	8.310E-14	8.310E-14	8.310E-14	8.310E-14	8.310E-14	8.310E-14
Be 9	6.156E-10	6.156E-10	6.156E-10	6.156E-10	6.156E-10	6.156E-10	6.156E-10
Be 10	1.596E-11	1.596E-11	1.596E-11	1.596E-11	1.596E-11	1.595E-11	1.595E-11
B 11	9.610E-09	9.610E-09	9.610E-09	9.610E-09	9.610E-09	9.610E-09	9.610E-09
C 12	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04
C 13	1.690E-06	1.690E-06	1.690E-06	1.690E-06	1.690E-06	1.690E-06	1.690E-06
C 14	8.440E-08	8.438E-08	8.436E-08	8.433E-08	8.430E-08	8.425E-08	7.483E-08
N 14	2.978E-05	2.978E-05	2.978E-05	2.978E-05	2.978E-05	2.978E-05	2.979E-05
N 15	1.211E-07	1.211E-07	1.211E-07	1.211E-07	1.211E-07	1.211E-07	1.211E-07
O 16	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03
O 17	5.075E-07	5.075E-07	5.075E-07	5.075E-07	5.075E-07	5.075E-07	5.075E-07
O 18	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06
F 19	1.561E-12	1.561E-12	1.561E-12	1.561E-12	1.561E-12	1.561E-12	1.561E-12
Ne 22	8.296E-15	8.296E-15	8.296E-15	8.296E-15	8.296E-15	8.296E-15	8.296E-15
Mg 24	1.102E-10	1.102E-10	1.102E-10	1.102E-10	1.102E-10	1.102E-10	1.102E-10
Mg 25	2.319E-10	2.319E-10	2.319E-10	2.319E-10	2.319E-10	2.319E-10	2.319E-10
Mg 26	1.060E-10	1.060E-10	1.060E-10	1.060E-10	1.060E-10	1.060E-10	1.060E-10
Al 27	3.999E-05	3.999E-05	3.999E-05	3.999E-05	3.999E-05	3.999E-05	3.999E-05
Si 28	7.350E-05	7.350E-05	7.350E-05	7.350E-05	7.350E-05	7.350E-05	7.350E-05
Si 29	3.871E-06	3.871E-06	3.871E-06	3.871E-06	3.871E-06	3.871E-06	3.871E-06
Si 30	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06
P 31	4.805E-10	4.805E-10	4.805E-10	4.805E-10	4.805E-10	4.805E-10	4.805E-10
S 32	6.393E-14	6.393E-14	6.393E-14	6.393E-14	6.393E-14	6.393E-14	6.396E-14
Ca 44	1.489E-15	1.489E-15	1.489E-15	1.489E-15	1.489E-15	1.489E-15	1.489E-15
Ti 47	1.205E-10	1.205E-10	1.205E-10	1.205E-10	1.205E-10	1.205E-10	1.205E-10
Ti 48	1.818E-13	1.818E-13	1.818E-13	1.818E-13	1.818E-13	1.818E-13	1.818E-13
Ti 49	3.288E-10	3.288E-10	3.288E-10	3.288E-10	3.288E-10	3.288E-10	3.288E-10
Ti 50	1.323E-09	1.323E-09	1.323E-09	1.323E-09	1.323E-09	1.323E-09	1.323E-09
V 50	4.731E-09	4.731E-09	4.731E-09	4.731E-09	4.731E-09	4.731E-09	4.731E-09
V 51	9.667E-07	9.667E-07	9.667E-07	9.667E-07	9.667E-07	9.667E-07	9.667E-07
Cr 50	4.083E-05	4.083E-05	4.083E-05	4.083E-05	4.083E-05	4.083E-05	4.083E-05
Cr 52	8.327E-04	8.327E-04	8.327E-04	8.327E-04	8.327E-04	8.327E-04	8.327E-04
Cr 53	9.859E-05	9.859E-05	9.859E-05	9.859E-05	9.859E-05	9.859E-05	9.859E-05
Cr 54	2.713E-05	2.713E-05	2.713E-05	2.713E-05	2.713E-05	2.713E-05	2.713E-05
Mn 54	8.658E-11	1.713E-11	3.389E-12	6.705E-13	5.900E-14	1.027E-15	0.00
Mn 55	3.410E-07	3.609E-07	3.725E-07	3.793E-07	3.846E-07	3.879E-07	3.890E-07

TABLE F.8.b. Cladding Activation Product Inventory by Isotope at 20 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Fe 54	1.118E-04	1.118E-04	1.118E-04	1.118E-04	1.118E-04	1.118E-04	1.118E-04
Fe 55	4.798E-08	2.815E-08	1.652E-08	9.692E-09	4.356E-09	1.149E-09	0.00
Fe 56	1.830E-03	1.830E-03	1.830E-03	1.830E-03	1.830E-03	1.830E-03	1.830E-03
Fe 57	5.148E-05	5.148E-05	5.148E-05	5.148E-05	5.148E-05	5.148E-05	5.148E-05
Fe 58	6.181E-06	6.181E-06	6.181E-06	6.181E-06	6.181E-06	6.181E-06	6.181E-06
Co 59	1.143E-08	1.143E-08	1.143E-08	1.143E-08	1.143E-08	1.143E-08	1.143E-08
Co 60	1.555E-10	1.195E-10	9.190E-11	7.064E-11	4.761E-11	2.466E-11	0.00
Ni 60	2.426E-10	2.786E-10	3.063E-10	3.275E-10	3.505E-10	3.735E-10	3.982E-10
Ni 61	5.329E-13	5.329E-13	5.329E-13	5.329E-13	5.329E-13	5.329E-13	5.329E-13
Sr 87	8.041E-09	8.041E-09	8.041E-09	8.041E-09	8.041E-09	8.041E-09	8.041E-09
Sr 88	7.589E-07	7.589E-07	7.589E-07	7.589E-07	7.589E-07	7.589E-07	7.589E-07
Sr 90	1.618E-11	1.543E-11	1.471E-11	1.403E-11	1.306E-11	1.160E-11	8.591E-22
Y 89	5.777E-08	5.777E-08	5.777E-08	5.777E-08	5.777E-08	5.777E-08	5.777E-08
Y 90	4.059E-15	3.870E-15	3.690E-15	3.518E-15	3.276E-15	2.908E-15	2.154E-25
Zr 90	4.974E-01	4.974E-01	4.974E-01	4.974E-01	4.974E-01	4.974E-01	4.974E-01
Zr 91	1.091E-01	1.091E-01	1.091E-01	1.091E-01	1.091E-01	1.091E-01	1.091E-01
Zr 92	1.692E-01	1.692E-01	1.692E-01	1.692E-01	1.692E-01	1.692E-01	1.692E-01
Zr 93	1.437E-04	1.437E-04	1.437E-04	1.437E-04	1.437E-04	1.437E-04	1.436E-04
Zr 94	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01
Zr 96	2.878E-02	2.878E-02	2.878E-02	2.878E-02	2.878E-02	2.878E-02	2.878E-02
Nb 93	1.132E-10	1.646E-10	2.237E-10	2.896E-10	4.000E-10	6.100E-10	6.400E-08
Nb 93m	4.006E-10	4.794E-10	5.506E-10	6.148E-10	6.997E-10	8.153E-10	1.213E-09
Nb 94	2.481E-14	2.481E-14	2.480E-14	2.480E-14	2.480E-14	2.480E-14	2.398E-14
Mo 95	5.238E-05	5.238E-05	5.238E-05	5.238E-05	5.238E-05	5.238E-05	5.238E-05
Mo 96	1.422E-06	1.422E-06	1.422E-06	1.422E-06	1.422E-06	1.422E-06	1.422E-06
Mo 97	7.989E-05	7.989E-05	7.989E-05	7.989E-05	7.989E-05	7.989E-05	7.989E-05
Mo 98	4.366E-07	4.366E-07	4.366E-07	4.366E-07	4.366E-07	4.366E-07	4.366E-07
Mo100	2.906E-14	2.906E-14	2.906E-14	2.906E-14	2.906E-14	2.906E-14	2.906E-14
Tc 99	6.577E-11	6.577E-11	6.577E-11	6.577E-11	6.577E-11	6.576E-11	6.555E-11
Ru 99	1.480E-15	1.908E-15	2.336E-15	2.764E-15	3.406E-15	4.476E-15	2.139E-13
Ru100	2.365E-12	2.365E-12	2.365E-12	2.365E-12	2.365E-12	2.365E-12	2.365E-12
Ru101	5.817E-15	5.817E-15	5.817E-15	5.817E-15	5.817E-15	5.817E-15	5.817E-15
Cd111	8.361E-12	8.361E-12	8.361E-12	8.361E-12	8.361E-12	8.361E-12	8.361E-12
Cd112	7.175E-11	7.175E-11	7.175E-11	7.175E-11	7.175E-11	7.175E-11	7.175E-11
Cd113	3.399E-13	3.399E-13	3.399E-13	3.399E-13	3.399E-13	3.399E-13	3.399E-13
Cd114	6.915E-09	6.915E-09	6.915E-09	6.915E-09	6.915E-09	6.915E-09	6.915E-09
Cd116	5.259E-11	5.259E-11	5.259E-11	5.259E-11	5.259E-11	5.259E-11	5.259E-11
In113	1.548E-06	1.548E-06	1.548E-06	1.548E-06	1.548E-06	1.548E-06	1.548E-06
In115	2.732E-11	2.732E-11	2.732E-11	2.732E-11	2.732E-11	2.732E-11	2.732E-11
Sn112	1.398E-04	1.398E-04	1.398E-04	1.398E-04	1.398E-04	1.398E-04	1.398E-04
Sn113	2.886E-13	3.547E-15	4.359E-17	5.358E-19	7.375E-22	1.235E-26	0.00

TABLE F.8.b. Cladding Activation Product Inventory by Isotope at 20 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Sn114	9.652E-05	9.652E-05	9.652E-05	9.652E-05	9.652E-05	9.652E-05	9.652E-05
Sn115	5.146E-05	5.146E-05	5.146E-05	5.146E-05	5.146E-05	5.146E-05	5.146E-05
Sn116	2.137E-03	2.137E-03	2.137E-03	2.137E-03	2.137E-03	2.137E-03	2.137E-03
Sn117	1.152E-03	1.152E-03	1.152E-03	1.152E-03	1.152E-03	1.152E-03	1.152E-03
Sn118	3.612E-03	3.612E-03	3.612E-03	3.612E-03	3.612E-03	3.612E-03	3.612E-03
Sn119	1.309E-03	1.309E-03	1.309E-03	1.309E-03	1.309E-03	1.309E-03	1.309E-03
Sn119m	5.188E-09	6.569E-10	8.318E-11	1.053E-11	4.746E-13	2.708E-15	0.00
Sn120	4.911E-03	4.911E-03	4.911E-03	4.911E-03	4.911E-03	4.911E-03	4.911E-03
Sn121m	2.375E-08	2.310E-08	2.247E-08	2.186E-08	2.097E-08	1.956E-08	2.443E-14
Sn122	7.082E-04	7.082E-04	7.082E-04	7.082E-04	7.082E-04	7.082E-04	7.082E-04
Sn123	5.440E-13	1.079E-14	2.141E-16	4.248E-18	1.188E-20	6.585E-25	0.00
Sn124	8.715E-04	8.715E-04	8.715E-04	8.715E-04	8.715E-04	8.715E-04	8.715E-04
Sb121	4.351E-06	4.352E-06	4.352E-06	4.353E-06	4.354E-06	4.355E-06	4.375E-06
Sb123	4.629E-07	4.629E-07	4.629E-07	4.629E-07	4.629E-07	4.629E-07	4.629E-07
Sb125	7.859E-07	4.764E-07	2.888E-07	1.751E-07	8.265E-08	2.365E-08	0.00
Te122	1.830E-07	1.830E-07	1.830E-07	1.830E-07	1.830E-07	1.830E-07	1.830E-07
Te123	1.927E-09	1.927E-09	1.927E-09	1.927E-09	1.927E-09	1.927E-09	1.927E-09
Te124	1.052E-08	1.052E-08	1.052E-08	1.052E-08	1.052E-08	1.052E-08	1.052E-08
Te125	4.629E-06	4.943E-06	5.133E-06	5.248E-06	5.342E-06	5.402E-06	5.426E-06
Te125m	1.099E-08	6.666E-09	4.041E-09	2.450E-09	1.156E-09	3.308E-10	0.00
Te126	3.342E-08	3.342E-08	3.342E-08	3.342E-08	3.342E-08	3.342E-08	3.342E-08
Te128	8.405E-14	8.405E-14	8.405E-14	8.405E-14	8.405E-14	8.405E-14	8.405E-14
I127	7.751E-11	7.751E-11	7.751E-11	7.751E-11	7.751E-11	7.751E-11	7.751E-11
Xe128	1.314E-12	1.314E-12	1.314E-12	1.314E-12	1.314E-12	1.314E-12	1.314E-12
Xe129	2.781E-15	2.781E-15	2.781E-15	2.781E-15	2.781E-15	2.781E-15	2.781E-15
Yb172	1.546E-15	1.546E-15	1.546E-15	1.546E-15	1.546E-15	1.546E-15	1.546E-15
Lu175	3.546E-08	3.546E-08	3.546E-08	3.546E-08	3.546E-08	3.546E-08	3.546E-08
Lu176	8.888E-10	8.888E-10	8.888E-10	8.888E-10	8.888E-10	8.888E-10	8.888E-10
Hf174	4.385E-08	4.385E-08	4.385E-08	4.385E-08	4.385E-08	4.385E-08	4.385E-08
Hf176	2.059E-06	2.059E-06	2.059E-06	2.059E-06	2.059E-06	2.059E-06	2.059E-06
Hf177	6.065E-07	6.065E-07	6.065E-07	6.065E-07	6.065E-07	6.065E-07	6.065E-07
Hf178	1.205E-05	1.205E-05	1.205E-05	1.205E-05	1.205E-05	1.205E-05	1.205E-05
Hf179	1.712E-05	1.712E-05	1.712E-05	1.712E-05	1.712E-05	1.712E-05	1.712E-05
Hf180	2.257E-05	2.257E-05	2.257E-05	2.257E-05	2.257E-05	2.257E-05	2.257E-05
Hf182	1.818E-09	1.818E-09	1.818E-09	1.818E-09	1.818E-09	1.818E-09	1.818E-09
Ta181	5.950E-07	5.950E-07	5.950E-07	5.950E-07	5.950E-07	5.950E-07	5.950E-07
Ta182	1.660E-14	2.661E-16	6.607E-17	6.362E-17	6.359E-17	6.360E-17	6.359E-17
W182	3.817E-08	3.817E-08	3.817E-08	3.817E-08	3.817E-08	3.817E-08	3.817E-08
W183	4.407E-08	4.407E-08	4.407E-08	4.407E-08	4.407E-08	4.407E-08	4.407E-08
W184	1.931E-09	1.931E-09	1.931E-09	1.931E-09	1.931E-09	1.931E-09	1.931E-09
W186	1.976E-14	1.976E-14	1.976E-14	1.976E-14	1.976E-14	1.976E-14	1.976E-14

TABLE F.8.b. Cladding Activation Product Inventory by Isotope at 20 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Re185	3.107E-12	3.107E-12	3.107E-12	3.107E-12	3.107E-12	3.107E-12	3.107E-12
Os186	2.944E-13	2.944E-13	2.944E-13	2.944E-13	2.944E-13	2.944E-13	2.944E-13
TOTAL	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

TABLE F.8.c. Cladding Activation Product Inventory by Isotope at 25 MWd/kgM, g/gZr

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	1.403E-05	1.403E-05	1.403E-05	1.403E-05	1.403E-05	1.403E-05	1.403E-05
H 2	2.356E-08	2.356E-08	2.356E-08	2.356E-08	2.356E-08	2.356E-08	2.356E-08
H 3	4.073E-14	3.640E-14	3.254E-14	2.908E-14	2.457E-14	1.856E-14	2.393E-38
He 3	1.705E-14	2.138E-14	2.524E-14	2.870E-14	3.320E-14	3.922E-14	5.778E-14
He 4	7.097E-08	7.097E-08	7.097E-08	7.097E-08	7.097E-08	7.097E-08	7.097E-08
Li 6	1.230E-13	1.230E-13	1.230E-13	1.230E-13	1.230E-13	1.230E-13	1.230E-13
Be 9	7.843E-10	7.843E-10	7.843E-10	7.843E-10	7.843E-10	7.843E-10	7.843E-10
Be 10	2.041E-11	2.041E-11	2.041E-11	2.041E-11	2.041E-11	2.041E-11	2.040E-11
B 11	1.224E-08	1.224E-08	1.224E-08	1.224E-08	1.224E-08	1.224E-08	1.224E-08
C 12	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04
C 13	1.702E-06	1.702E-06	1.702E-06	1.702E-06	1.702E-06	1.702E-06	1.702E-06
C 14	1.075E-07	1.075E-07	1.074E-07	1.074E-07	1.074E-07	1.073E-07	9.532E-08
N 14	2.976E-05	2.976E-05	2.976E-05	2.976E-05	2.976E-05	2.976E-05	2.977E-05
N 15	1.220E-07	1.220E-07	1.220E-07	1.220E-07	1.220E-07	1.220E-07	1.220E-07
O 16	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03
O 17	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07
O 18	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06
F 19	1.989E-12	1.989E-12	1.989E-12	1.989E-12	1.989E-12	1.989E-12	1.989E-12
Ne 22	1.347E-14	1.347E-14	1.347E-14	1.347E-14	1.347E-14	1.347E-14	1.347E-14
Na 23	1.091E-15	1.091E-15	1.091E-15	1.091E-15	1.091E-15	1.091E-15	1.091E-15
Mg 24	1.405E-10	1.405E-10	1.405E-10	1.405E-10	1.405E-10	1.405E-10	1.405E-10
Mg 25	2.956E-10	2.956E-10	2.956E-10	2.956E-10	2.956E-10	2.956E-10	2.956E-10
Mg 26	1.352E-10	1.352E-10	1.352E-10	1.352E-10	1.352E-10	1.352E-10	1.352E-10
Al 27	3.998E-05	3.998E-05	3.998E-05	3.998E-05	3.998E-05	3.998E-05	3.998E-05
Si 28	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05
Si 29	3.876E-06	3.876E-06	3.876E-06	3.876E-06	3.876E-06	3.876E-06	3.876E-06
Si 30	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06	2.648E-06
P 31	6.123E-10	6.123E-10	6.123E-10	6.123E-10	6.123E-10	6.123E-10	6.123E-10
S 32	1.038E-13	1.038E-13	1.038E-13	1.038E-13	1.038E-13	1.038E-13	1.039E-13
Ca 44	2.412E-15	2.412E-15	2.412E-15	2.412E-15	2.412E-15	2.412E-15	2.412E-15
Ti 47	1.530E-10	1.530E-10	1.530E-10	1.530E-10	1.530E-10	1.530E-10	1.530E-10
Ti 48	2.943E-13	2.943E-13	2.943E-13	2.943E-13	2.943E-13	2.943E-13	2.943E-13
Ti 49	4.186E-10	4.186E-10	4.186E-10	4.186E-10	4.186E-10	4.186E-10	4.186E-10
Ti 50	1.690E-09	1.690E-09	1.690E-09	1.690E-09	1.690E-09	1.690E-09	1.690E-09
V 50	5.918E-09	5.918E-09	5.918E-09	5.918E-09	5.918E-09	5.918E-09	5.918E-09
V 51	1.227E-06	1.227E-06	1.227E-06	1.227E-06	1.227E-06	1.227E-06	1.227E-06
Cr 50	4.057E-05	4.057E-05	4.057E-05	4.057E-05	4.057E-05	4.057E-05	4.057E-05
Cr 52	8.315E-04	8.315E-04	8.315E-04	8.315E-04	8.315E-04	8.315E-04	8.315E-04
Cr 53	9.910E-05	9.910E-05	9.910E-05	9.910E-05	9.910E-05	9.910E-05	9.910E-05
Cr 54	2.786E-05	2.786E-05	2.786E-05	2.786E-05	2.786E-05	2.786E-05	2.786E-05
Mn 54	1.115E-10	2.205E-11	4.363E-12	8.631E-13	7.595E-14	1.322E-15	0.00

TABLE F.8.c. Cladding Activation Product Inventory by Isotope at 25 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Mn 55	4.339E-07	4.593E-07	4.742E-07	4.829E-07	4.897E-07	4.938E-07	4.953E-07
Fe 54	1.117E-04	1.117E-04	1.117E-04	1.117E-04	1.117E-04	1.117E-04	1.117E-04
Fe 55	6.139E-08	3.602E-08	2.113E-08	1.240E-08	5.573E-09	1.470E-09	0.00
Fe 56	1.828E-03	1.828E-03	1.828E-03	1.828E-03	1.828E-03	1.828E-03	1.828E-03
Fe 57	5.356E-05	5.356E-05	5.356E-05	5.356E-05	5.356E-05	5.356E-05	5.356E-05
Fe 58	6.231E-06	6.231E-06	6.231E-06	6.231E-06	6.231E-06	6.231E-06	6.231E-06
Co 59	1.449E-08	1.449E-08	1.449E-08	1.449E-08	1.449E-08	1.449E-08	1.449E-08
Co 60	2.520E-10	1.937E-10	1.489E-10	1.144E-10	7.713E-11	3.996E-11	0.00
Ni 60	3.919E-10	4.502E-10	4.950E-10	5.294E-10	5.667E-10	6.039E-10	6.439E-10
Ni 61	1.101E-12	1.101E-12	1.101E-12	1.101E-12	1.101E-12	1.101E-12	1.101E-12
Ni 62	1.268E-15	1.268E-15	1.268E-15	1.268E-15	1.268E-15	1.268E-15	1.268E-15
Sr 87	1.015E-08	1.015E-08	1.015E-08	1.015E-08	1.015E-08	1.015E-08	1.015E-08
Sr 88	9.668E-07	9.668E-07	9.668E-07	9.668E-07	9.668E-07	9.668E-07	9.668E-07
Sr 90	2.625E-11	2.503E-11	2.387E-11	2.276E-11	2.119E-11	1.881E-11	1.393E-21
Y 89	7.362E-08	7.362E-08	7.362E-08	7.362E-08	7.362E-08	7.362E-08	7.362E-08
Y 90	6.583E-15	6.277E-15	5.985E-15	5.707E-15	5.314E-15	4.718E-15	3.494E-25
Zr 90	4.974E-01	4.974E-01	4.974E-01	4.974E-01	4.974E-01	4.974E-01	4.974E-01
Zr 91	1.091E-01	1.091E-01	1.091E-01	1.091E-01	1.091E-01	1.091E-01	1.091E-01
Zr 92	1.693E-01	1.693E-01	1.693E-01	1.693E-01	1.693E-01	1.693E-01	1.693E-01
Zr 93	1.828E-04	1.828E-04	1.828E-04	1.828E-04	1.828E-04	1.828E-04	1.827E-04
Zr 94	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01
Zr 96	2.876E-02	2.876E-02	2.876E-02	2.876E-02	2.876E-02	2.876E-02	2.876E-02
Nb 93	1.434E-10	2.088E-10	2.838E-10	3.676E-10	5.080E-10	7.749E-10	8.140E-08
Nb 93m	5.087E-10	6.090E-10	6.996E-10	7.813E-10	8.894E-10	1.037E-09	1.543E-09
Nb 94	4.010E-14	4.010E-14	4.010E-14	4.009E-14	4.009E-14	4.008E-14	3.876E-14
Mo 95	6.625E-05	6.625E-05	6.625E-05	6.625E-05	6.625E-05	6.625E-05	6.625E-05
Mo 96	2.296E-06	2.296E-06	2.296E-06	2.296E-06	2.296E-06	2.296E-06	2.296E-06
Mo 97	1.016E-04	1.016E-04	1.016E-04	1.016E-04	1.016E-04	1.016E-04	1.016E-04
Mo 98	7.078E-07	7.078E-07	7.078E-07	7.078E-07	7.078E-07	7.078E-07	7.078E-07
Mo100	7.744E-14	7.744E-14	7.744E-14	7.744E-14	7.744E-14	7.744E-14	7.744E-14
Tc 99	1.347E-10	1.347E-10	1.347E-10	1.347E-10	1.347E-10	1.347E-10	1.342E-10
Ru 99	3.023E-15	3.899E-15	4.775E-15	5.652E-15	6.966E-15	9.157E-15	4.379E-13
Ru100	6.180E-12	6.180E-12	6.180E-12	6.180E-12	6.180E-12	6.180E-12	6.180E-12
Ru101	1.936E-14	1.936E-14	1.936E-14	1.936E-14	1.936E-14	1.936E-14	1.936E-14
Cd111	1.058E-11	1.058E-11	1.058E-11	1.058E-11	1.058E-11	1.058E-11	1.058E-11
Cd112	9.047E-11	9.047E-11	9.047E-11	9.047E-11	9.047E-11	9.047E-11	9.047E-11
Cd113	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13	3.424E-13
Cd114	1.094E-08	1.094E-08	1.094E-08	1.094E-08	1.094E-08	1.094E-08	1.094E-08
Cd116	6.710E-11	6.710E-11	6.710E-11	6.710E-11	6.710E-11	6.710E-11	6.710E-11
In113	1.928E-06	1.928E-06	1.928E-06	1.928E-06	1.928E-06	1.928E-06	1.928E-06

TABLE F.8.c. Cladding Activation Product Inventory by Isotope at 25 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
In115	2.885E-11	2.885E-11	2.885E-11	2.885E-11	2.885E-11	2.885E-11	2.885E-11
Sn112	1.393E-04	1.393E-04	1.393E-04	1.393E-04	1.393E-04	1.393E-04	1.393E-04
Sn113	3.732E-13	4.586E-15	5.636E-17	6.927E-19	9.404E-22	1.574E-26	0.00
Sn114	9.658E-05	9.658E-05	9.658E-05	9.658E-05	9.658E-05	9.658E-05	9.658E-05
Sn115	5.048E-05	5.048E-05	5.048E-05	5.048E-05	5.048E-05	5.048E-05	5.048E-05
Sn116	2.132E-03	2.132E-03	2.132E-03	2.132E-03	2.132E-03	2.132E-03	2.132E-03
Sn117	1.154E-03	1.154E-03	1.154E-03	1.154E-03	1.154E-03	1.154E-03	1.154E-03
Sn118	3.610E-03	3.610E-03	3.610E-03	3.610E-03	3.610E-03	3.610E-03	3.610E-03
Sn119	1.314E-03	1.314E-03	1.314E-03	1.314E-03	1.314E-03	1.314E-03	1.314E-03
Sn119m	6.699E-09	8.483E-10	1.074E-10	1.360E-11	6.129E-13	3.496E-15	0.00
Sn120	4.912E-03	4.912E-03	4.912E-03	4.912E-03	4.912E-03	4.912E-03	4.912E-03
Sn121m	3.028E-08	2.945E-08	2.864E-08	2.786E-08	2.672E-08	2.493E-08	3.114E-14
Sn122	7.081E-04	7.081E-04	7.081E-04	7.081E-04	7.081E-04	7.081E-04	7.081E-04
Sn123	7.051E-13	1.399E-14	2.775E-16	5.506E-18	1.537E-20	8.522E-25	0.00
Sn124	8.700E-04	8.700E-04	8.700E-04	8.700E-04	8.700E-04	8.700E-04	8.700E-04
Sb121	5.481E-06	5.482E-06	5.483E-06	5.484E-06	5.485E-06	5.487E-06	5.512E-06
Sb123	5.867E-07	5.867E-07	5.867E-07	5.867E-07	5.867E-07	5.867E-07	5.867E-07
Sb125	1.003E-06	6.083E-07	3.688E-07	2.236E-07	1.055E-07	3.020E-08	0.00
Te122	2.935E-07	2.935E-07	2.935E-07	2.935E-07	2.935E-07	2.935E-07	2.935E-07
Te123	3.563E-09	3.563E-09	3.563E-09	3.563E-09	3.563E-09	3.563E-09	3.563E-09
Te123m	1.718E-15	2.497E-17	3.630E-19	5.269E-21	1.494E-23	3.807E-28	0.00
Te124	1.794E-08	1.794E-08	1.794E-08	1.794E-08	1.794E-08	1.794E-08	1.794E-08
Te125	5.879E-06	6.280E-06	6.523E-06	6.670E-06	6.790E-06	6.866E-06	6.897E-06
Te125m	1.404E-08	8.511E-09	5.160E-09	3.128E-09	1.476E-09	4.224E-10	0.00
Te126	5.414E-08	5.414E-08	5.414E-08	5.414E-08	5.414E-08	5.414E-08	5.414E-08
Te128	2.205E-13	2.205E-13	2.205E-13	2.205E-13	2.205E-13	2.205E-13	2.205E-13
I127	1.594E-10	1.594E-10	1.594E-10	1.594E-10	1.594E-10	1.594E-10	1.594E-10
Xe128	3.447E-12	3.447E-12	3.447E-12	3.447E-12	3.447E-12	3.447E-12	3.447E-12
Xe129	9.257E-15	9.257E-15	9.257E-15	9.257E-15	9.257E-15	9.257E-15	9.257E-15
Yb172	2.307E-15	2.307E-15	2.307E-15	2.307E-15	2.307E-15	2.307E-15	2.307E-15
Yb173	1.642E-15	1.642E-15	1.642E-15	1.642E-15	1.642E-15	1.642E-15	1.642E-15
Lu175	3.956E-08	3.956E-08	3.956E-08	3.956E-08	3.956E-08	3.956E-08	3.956E-08
Lu176	1.101E-09	1.101E-09	1.101E-09	1.101E-09	1.101E-09	1.101E-09	1.101E-09
Hf174	3.648E-08	3.648E-08	3.648E-08	3.648E-08	3.648E-08	3.648E-08	3.648E-08
Hf176	1.890E-06	1.890E-06	1.890E-06	1.890E-06	1.890E-06	1.890E-06	1.890E-06
Hf177	3.628E-07	3.628E-07	3.628E-07	3.628E-07	3.628E-07	3.628E-07	3.628E-07
Hf178	9.895E-06	9.895E-06	9.895E-06	9.895E-06	9.895E-06	9.895E-06	9.895E-06
Hf179	1.831E-05	1.831E-05	1.831E-05	1.831E-05	1.831E-05	1.831E-05	1.831E-05
Hf180	2.377E-05	2.377E-05	2.377E-05	2.377E-05	2.377E-05	2.377E-05	2.377E-05
Hf182	3.006E-09	3.006E-09	3.006E-09	3.006E-09	3.006E-09	3.006E-09	3.006E-09

TABLE F.8.c. Cladding Activation Product Inventory by Isotope at 25 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ta181	7.514E-07	7.514E-07	7.514E-07	7.514E-07	7.514E-07	7.514E-07	7.514E-07
Ta182	2.312E-14	3.868E-16	1.086E-16	1.052E-16	1.052E-16	1.052E-16	1.052E-16
W182	5.257E-08	5.257E-08	5.257E-08	5.257E-08	5.257E-08	5.257E-08	5.257E-08
W183	7.896E-08	7.896E-08	7.896E-08	7.896E-08	7.896E-08	7.896E-08	7.896E-08
W184	4.446E-09	4.446E-09	4.446E-09	4.446E-09	4.446E-09	4.446E-09	4.446E-09
W186	7.158E-14	7.158E-14	7.158E-14	7.158E-14	7.158E-14	7.158E-14	7.158E-14
Re185	8.955E-12	8.955E-12	8.955E-12	8.955E-12	8.955E-12	8.955E-12	8.955E-12
Re187	3.220E-15	3.220E-15	3.220E-15	3.220E-15	3.220E-15	3.220E-15	3.220E-15
Os186	1.077E-12	1.077E-12	1.077E-12	1.077E-12	1.077E-12	1.077E-12	1.077E-12
TOTAL	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

TABLE F.8.d. Cladding Activation Product Inventory by Isotope at 30 MWd/kgM, g/gZr

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	1.404E-05	1.404E-05	1.404E-05	1.404E-05	1.404E-05	1.404E-05	1.404E-05
H 2	2.794E-08	2.794E-08	2.794E-08	2.794E-08	2.794E-08	2.794E-08	2.794E-08
H 3	6.587E-14	5.887E-14	5.262E-14	4.703E-14	3.974E-14	3.002E-14	3.868E-38
He 3	2.734E-14	3.434E-14	4.059E-14	4.618E-14	5.347E-14	6.319E-14	9.321E-14
He 4	8.702E-08	8.702E-08	8.702E-08	8.702E-08	8.702E-08	8.702E-08	8.702E-08
Li 6	1.688E-13	1.688E-13	1.688E-13	1.688E-13	1.688E-13	1.688E-13	1.688E-13
Be 9	9.614E-10	9.614E-10	9.614E-10	9.614E-10	9.614E-10	9.614E-10	9.614E-10
Be 10	2.512E-11	2.512E-11	2.512E-11	2.512E-11	2.512E-11	2.512E-11	2.511E-11
B 11	1.500E-08	1.500E-08	1.500E-08	1.500E-08	1.500E-08	1.500E-08	1.500E-08
C 12	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04
C 13	1.715E-06	1.715E-06	1.715E-06	1.715E-06	1.715E-06	1.715E-06	1.715E-06
C 14	1.318E-07	1.317E-07	1.317E-07	1.317E-07	1.316E-07	1.315E-07	1.168E-07
N 14	2.973E-05	2.973E-05	2.973E-05	2.973E-05	2.973E-05	2.973E-05	2.974E-05
N 15	1.230E-07	1.230E-07	1.230E-07	1.230E-07	1.230E-07	1.230E-07	1.230E-07
O 16	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03
O 17	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07	5.076E-07
O 18	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06
F 19	2.439E-12	2.439E-12	2.439E-12	2.439E-12	2.439E-12	2.439E-12	2.439E-12
Ne 22	2.025E-14	2.025E-14	2.025E-14	2.025E-14	2.025E-14	2.025E-14	2.025E-14
Na 23	1.642E-15	1.642E-15	1.642E-15	1.642E-15	1.642E-15	1.642E-15	1.642E-15
Mg 24	1.723E-10	1.723E-10	1.723E-10	1.723E-10	1.723E-10	1.723E-10	1.723E-10
Mg 25	3.624E-10	3.624E-10	3.624E-10	3.624E-10	3.624E-10	3.624E-10	3.624E-10
Mg 26	1.658E-10	1.658E-10	1.658E-10	1.658E-10	1.658E-10	1.658E-10	1.658E-10
Al 27	3.998E-05	3.998E-05	3.998E-05	3.998E-05	3.998E-05	3.998E-05	3.998E-05
Si 28	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05
Si 29	3.881E-06	3.881E-06	3.881E-06	3.881E-06	3.881E-06	3.881E-06	3.881E-06
Si 30	2.649E-06	2.649E-06	2.649E-06	2.649E-06	2.649E-06	2.649E-06	2.649E-06
P 31	7.509E-10	7.509E-10	7.509E-10	7.509E-10	7.509E-10	7.509E-10	7.509E-10
S 32	1.561E-13	1.561E-13	1.561E-13	1.561E-13	1.561E-13	1.561E-13	1.561E-13
Ca 44	3.617E-15	3.617E-15	3.617E-15	3.617E-15	3.617E-15	3.617E-15	3.617E-15
Ca 46	1.456E-15	1.456E-15	1.456E-15	1.456E-15	1.456E-15	1.456E-15	1.456E-15
Ti 47	1.869E-10	1.869E-10	1.869E-10	1.869E-10	1.869E-10	1.869E-10	1.869E-10
Ti 48	4.409E-13	4.409E-13	4.409E-13	4.409E-13	4.409E-13	4.409E-13	4.409E-13
Ti 49	5.126E-10	5.126E-10	5.126E-10	5.126E-10	5.126E-10	5.126E-10	5.126E-10
Ti 50	2.078E-09	2.078E-09	2.078E-09	2.078E-09	2.078E-09	2.078E-09	2.078E-09
V 50	7.116E-09	7.116E-09	7.116E-09	7.116E-09	7.116E-09	7.116E-09	7.116E-09
V 51	1.498E-06	1.498E-06	1.498E-06	1.498E-06	1.498E-06	1.498E-06	1.498E-06
Cr 50	4.030E-05	4.030E-05	4.030E-05	4.030E-05	4.030E-05	4.030E-05	4.030E-05
Cr 52	8.302E-04	8.302E-04	8.302E-04	8.302E-04	8.302E-04	8.302E-04	8.302E-04
Cr 53	9.962E-05	9.962E-05	9.962E-05	9.962E-05	9.962E-05	9.962E-05	9.962E-05

TABLE F.8.d. Cladding Activation Product Inventory by Isotope at 30 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cr 54	2.864E-05	2.864E-05	2.864E-05	2.864E-05	2.864E-05	2.864E-05	2.864E-05
Mn 54	1.382E-10	2.735E-11	5.410E-12	1.070E-12	9.419E-14	1.640E-15	0.00
Mn 55	5.312E-07	5.624E-07	5.808E-07	5.915E-07	5.999E-07	6.050E-07	6.068E-07
Fe 54	1.116E-04	1.116E-04	1.116E-04	1.116E-04	1.116E-04	1.116E-04	1.116E-04
Fe 55	7.559E-08	4.435E-08	2.602E-08	1.527E-08	6.862E-09	1.809E-09	0.00
Fe 56	1.826E-03	1.826E-03	1.826E-03	1.826E-03	1.826E-03	1.826E-03	1.826E-03
Fe 57	5.575E-05	5.575E-05	5.575E-05	5.575E-05	5.575E-05	5.575E-05	5.575E-05
Fe 58	6.286E-06	6.286E-06	6.286E-06	6.286E-06	6.286E-06	6.286E-06	6.286E-06
Co 59	1.767E-08	1.767E-08	1.767E-08	1.767E-08	1.767E-08	1.767E-08	1.767E-08
Co 60	3.779E-10	2.905E-10	2.233E-10	1.717E-10	1.157E-10	5.993E-11	0.00
Ni 60	5.858E-10	6.733E-10	7.405E-10	7.921E-10	8.481E-10	9.038E-10	9.638E-10
Ni 61	2.026E-12	2.026E-12	2.026E-12	2.026E-12	2.026E-12	2.026E-12	2.026E-12
Ni 62	2.863E-15	2.863E-15	2.863E-15	2.863E-15	2.863E-15	2.863E-15	2.863E-15
Sr 87	1.233E-08	1.233E-08	1.233E-08	1.233E-08	1.233E-08	1.233E-08	1.233E-08
Sr 88	1.185E-06	1.185E-06	1.185E-06	1.185E-06	1.185E-06	1.185E-06	1.185E-06
Sr 90	3.943E-11	3.759E-11	3.585E-11	3.418E-11	3.182E-11	2.825E-11	2.093E-21
Y 89	9.028E-08	9.028E-08	9.028E-08	9.028E-08	9.028E-08	9.028E-08	9.028E-08
Y 90	9.887E-15	9.427E-15	8.989E-15	8.571E-15	7.981E-15	7.085E-15	5.248E-25
Zr 90	4.973E-01	4.973E-01	4.973E-01	4.973E-01	4.973E-01	4.973E-01	4.973E-01
Zr 91	1.090E-01	1.090E-01	1.090E-01	1.090E-01	1.090E-01	1.090E-01	1.090E-01
Zr 92	1.694E-01	1.694E-01	1.694E-01	1.694E-01	1.694E-01	1.694E-01	1.694E-01
Zr 93	2.237E-04	2.237E-04	2.237E-04	2.237E-04	2.237E-04	2.237E-04	2.236E-04
Zr 94	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01
Zr 96	2.873E-02	2.873E-02	2.873E-02	2.873E-02	2.873E-02	2.873E-02	2.873E-02
Nb 93	1.749E-10	2.547E-10	3.465E-10	4.490E-10	6.206E-10	9.470E-10	9.961E-08
Nb 93m	6.214E-10	7.442E-10	8.552E-10	9.553E-10	1.088E-09	1.268E-09	1.888E-09
Nb 94	6.004E-14	6.003E-14	6.003E-14	6.002E-14	6.002E-14	6.001E-14	5.803E-14
Mo 95	8.062E-05	8.062E-05	8.062E-05	8.062E-05	8.062E-05	8.062E-05	8.062E-05
Mo 96	3.431E-06	3.431E-06	3.431E-06	3.431E-06	3.431E-06	3.431E-06	3.431E-06
Mo 97	1.244E-04	1.244E-04	1.244E-04	1.244E-04	1.244E-04	1.244E-04	1.244E-04
Mo 98	1.062E-06	1.062E-06	1.062E-06	1.062E-06	1.062E-06	1.062E-06	1.062E-06
Mo100	1.775E-13	1.775E-13	1.775E-13	1.775E-13	1.775E-13	1.775E-13	1.775E-13
Tc 99	2.455E-10	2.455E-10	2.455E-10	2.455E-10	2.455E-10	2.455E-10	2.447E-10
Ru 99	5.496E-15	7.094E-15	8.691E-15	1.029E-14	1.269E-14	1.668E-14	7.984E-13
Ru100	1.383E-11	1.383E-11	1.383E-11	1.383E-11	1.383E-11	1.383E-11	1.383E-11
Ru101	5.310E-14	5.310E-14	5.310E-14	5.310E-14	5.310E-14	5.310E-14	5.310E-14
Cd111	1.287E-11	1.287E-11	1.287E-11	1.287E-11	1.287E-11	1.287E-11	1.287E-11
Cd112	1.097E-10	1.097E-10	1.097E-10	1.097E-10	1.097E-10	1.097E-10	1.097E-10
Cd113	3.446E-13	3.446E-13	3.446E-13	3.446E-13	3.446E-13	3.446E-13	3.446E-13
Cd114	1.605E-08	1.605E-08	1.605E-08	1.605E-08	1.605E-08	1.605E-08	1.605E-08
Cd116	8.237E-11	8.237E-11	8.237E-11	8.237E-11	8.237E-11	8.237E-11	8.237E-11

TABLE F.8.d. Cladding Activation Product Inventory by Isotope at 30 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
In113	2.308E-06	2.308E-06	2.308E-06	2.308E-06	2.308E-06	2.308E-06	2.308E-06
In115	3.026E-11	3.026E-11	3.026E-11	3.026E-11	3.026E-11	3.026E-11	3.026E-11
Sn112	1.388E-04	1.388E-04	1.388E-04	1.388E-04	1.388E-04	1.388E-04	1.388E-04
Sn113	4.670E-13	5.739E-15	7.054E-17	8.668E-19	1.182E-21	1.979E-26	0.00
Sn114	9.665E-05	9.665E-05	9.665E-05	9.665E-05	9.665E-05	9.665E-05	9.665E-05
Sn115	4.947E-05	4.947E-05	4.947E-05	4.947E-05	4.947E-05	4.947E-05	4.947E-05
Sn116	2.127E-03	2.127E-03	2.127E-03	2.127E-03	2.127E-03	2.127E-03	2.127E-03
Sn117	1.156E-03	1.156E-03	1.156E-03	1.156E-03	1.156E-03	1.156E-03	1.156E-03
Sn118	3.607E-03	3.607E-03	3.607E-03	3.607E-03	3.607E-03	3.607E-03	3.607E-03
Sn119	1.318E-03	1.318E-03	1.318E-03	1.318E-03	1.318E-03	1.318E-03	1.318E-03
Sn119m	8.343E-09	1.056E-09	1.338E-10	1.694E-11	7.633E-13	4.355E-15	0.00
Sn120	4.912E-03	4.912E-03	4.912E-03	4.912E-03	4.912E-03	4.912E-03	4.912E-03
Sn121m	3.714E-08	3.612E-08	3.513E-08	3.417E-08	3.278E-08	3.058E-08	3.819E-14
Sn122	7.080E-04	7.080E-04	7.080E-04	7.080E-04	7.080E-04	7.080E-04	7.080E-04
Sn123	8.838E-13	1.753E-14	3.479E-16	6.902E-18	1.932E-20	1.071E-24	0.00
Sn124	8.684E-04	8.684E-04	8.684E-04	8.684E-04	8.684E-04	8.684E-04	8.684E-04
Sb121	6.641E-06	6.642E-06	6.643E-06	6.644E-06	6.645E-06	6.647E-06	6.678E-06
Sb123	7.152E-07	7.152E-07	7.152E-07	7.152E-07	7.152E-07	7.152E-07	7.152E-07
Sb125	1.233E-06	7.474E-07	4.531E-07	2.747E-07	1.297E-07	3.710E-08	0.00
Te122	4.356E-07	4.356E-07	4.356E-07	4.356E-07	4.356E-07	4.356E-07	4.356E-07
Te123	5.904E-09	5.904E-09	5.904E-09	5.904E-09	5.904E-09	5.904E-09	5.904E-09
Te123m	3.190E-15	4.638E-17	6.743E-19	9.806E-21	1.409E-23	3.591E-28	0.00
Te124	2.840E-08	2.840E-08	2.840E-08	2.840E-08	2.840E-08	2.840E-08	2.840E-08
Te125	7.184E-06	7.677E-06	7.975E-06	8.156E-06	8.303E-06	8.397E-06	8.434E-06
Te125m	1.725E-08	1.046E-08	6.340E-09	3.843E-09	1.814E-09	5.190E-10	0.00
Te128	4.958E-13	4.958E-13	4.958E-13	4.958E-13	4.958E-13	4.958E-13	4.958E-13
I127	2.917E-10	2.917E-10	2.917E-10	2.917E-10	2.917E-10	2.917E-10	2.917E-10
Xe128	7.746E-12	7.746E-12	7.746E-12	7.746E-12	7.746E-12	7.746E-12	7.746E-12
Xe129	2.540E-14	2.540E-14	2.540E-14	2.540E-14	2.540E-14	2.540E-14	2.540E-14
Yb172	3.179E-15	3.179E-15	3.179E-15	3.179E-15	3.179E-15	3.179E-15	3.179E-15
Yb173	2.447E-15	2.447E-15	2.447E-15	2.447E-15	2.447E-15	2.447E-15	2.447E-15
Lu175	4.222E-08	4.222E-08	4.222E-08	4.222E-08	4.222E-08	4.222E-08	4.222E-08
Lu176	1.263E-09	1.263E-09	1.263E-09	1.263E-09	1.263E-09	1.263E-09	1.263E-09
Hf174	3.007E-08	3.007E-08	3.007E-08	3.007E-08	3.007E-08	3.007E-08	3.007E-08
Hf176	1.727E-06	1.727E-06	1.727E-06	1.727E-06	1.727E-06	1.727E-06	1.727E-06
Hf177	2.500E-07	2.500E-07	2.500E-07	2.500E-07	2.500E-07	2.500E-07	2.500E-07
Hf178	7.976E-06	7.976E-06	7.976E-06	7.976E-06	7.976E-06	7.976E-06	7.976E-06
Hf179	1.898E-05	1.898E-05	1.898E-05	1.898E-05	1.898E-05	1.898E-05	1.898E-05
Hf180	2.510E-05	2.510E-05	2.510E-05	2.510E-05	2.510E-05	2.510E-05	2.510E-05
Hf182	4.620E-09	4.620E-09	4.620E-09	4.620E-09	4.620E-09	4.620E-09	4.620E-09
Ta181	9.152E-07	9.152E-07	9.152E-07	9.152E-07	9.152E-07	9.152E-07	9.152E-07

TABLE F.8.d. Cladding Activation Product Inventory by Isotope at 30 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Ta182	3.027E-14	5.301E-16	1.661E-16	1.617E-16	1.616E-16	1.616E-16	1.616E-16
W182	6.762E-08	6.762E-08	6.762E-08	6.762E-08	6.762E-08	6.762E-08	6.762E-08
W183	1.271E-07	1.271E-07	1.271E-07	1.271E-07	1.271E-07	1.271E-07	1.271E-07
W184	8.838E-09	8.838E-09	8.838E-09	8.838E-09	8.838E-09	8.838E-09	8.838E-09
W186	2.068E-13	2.068E-13	2.068E-13	2.068E-13	2.068E-13	2.068E-13	2.068E-13
Re185	2.144E-11	2.144E-11	2.144E-11	2.144E-11	2.144E-11	2.144E-11	2.144E-11
Re187	1.148E-14	1.148E-14	1.148E-14	1.148E-14	1.148E-14	1.148E-14	1.148E-14
Os186	3.145E-12	3.145E-12	3.145E-12	3.145E-12	3.145E-12	3.145E-12	3.145E-12
TOTAL	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

TABLE F.8.e. Cladding Activation Product Inventory by Isotope at 35 MWd/kgM, g/gZr

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
H 1	1.405E-05	1.405E-05	1.405E-05	1.405E-05	1.405E-05	1.405E-05	1.405E-05
H 2	3.255E-08	3.255E-08	3.255E-08	3.255E-08	3.255E-08	3.255E-08	3.255E-08
H 3	1.001E-13	8.951E-14	8.001E-14	7.151E-14	6.043E-14	4.564E-14	5.888E-38
He 3	4.133E-14	5.196E-14	6.146E-14	6.996E-14	8.104E-14	9.583E-14	1.415E-13
He 4	1.039E-07	1.039E-07	1.039E-07	1.039E-07	1.039E-07	1.039E-07	1.039E-07
Li 6	2.198E-13	2.198E-13	2.198E-13	2.198E-13	2.198E-13	2.198E-13	2.198E-13
Be 9	1.148E-09	1.148E-09	1.148E-09	1.148E-09	1.148E-09	1.148E-09	1.148E-09
Be 10	3.011E-11	3.011E-11	3.011E-11	3.011E-11	3.011E-11	3.011E-11	3.010E-11
B 11	1.790E-08	1.790E-08	1.790E-08	1.790E-08	1.790E-08	1.790E-08	1.790E-08
C 12	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04	1.354E-04
C 13	1.728E-06	1.728E-06	1.728E-06	1.728E-06	1.728E-06	1.728E-06	1.728E-06
C 14	1.572E-07	1.572E-07	1.572E-07	1.571E-07	1.571E-07	1.570E-07	1.394E-07
N 14	2.970E-05	2.970E-05	2.970E-05	2.970E-05	2.970E-05	2.970E-05	2.971E-05
N 15	1.241E-07	1.241E-07	1.241E-07	1.241E-07	1.241E-07	1.241E-07	1.241E-07
O 16	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03	1.254E-03
O 17	5.077E-07	5.077E-07	5.077E-07	5.077E-07	5.077E-07	5.077E-07	5.077E-07
O 18	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06	2.884E-06
F 19	2.912E-12	2.912E-12	2.912E-12	2.912E-12	2.912E-12	2.912E-12	2.912E-12
Ne 21	1.202E-15	1.202E-15	1.202E-15	1.202E-15	1.202E-15	1.202E-15	1.202E-15
Ne 22	2.887E-14	2.887E-14	2.887E-14	2.887E-14	2.887E-14	2.887E-14	2.887E-14
Na 23	2.341E-15	2.341E-15	2.341E-15	2.341E-15	2.341E-15	2.341E-15	2.341E-15
Mg 24	2.056E-10	2.056E-10	2.056E-10	2.056E-10	2.056E-10	2.056E-10	2.056E-10
Mg 25	4.327E-10	4.327E-10	4.327E-10	4.327E-10	4.327E-10	4.327E-10	4.327E-10
Mg 26	1.982E-10	1.982E-10	1.982E-10	1.982E-10	1.982E-10	1.982E-10	1.982E-10
Al 27	3.997E-05	3.997E-05	3.997E-05	3.997E-05	3.997E-05	3.997E-05	3.997E-05
Si 28	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05	7.349E-05
Si 29	3.886E-06	3.886E-06	3.886E-06	3.886E-06	3.886E-06	3.886E-06	3.886E-06
Si 30	2.649E-06	2.649E-06	2.649E-06	2.649E-06	2.649E-06	2.649E-06	2.649E-06
P 31	8.965E-10	8.965E-10	8.965E-10	8.965E-10	8.965E-10	8.965E-10	8.965E-10
S 32	2.225E-13	2.225E-13	2.225E-13	2.225E-13	2.225E-13	2.225E-13	2.226E-13
Ca 44	5.142E-15	5.142E-15	5.142E-15	5.142E-15	5.142E-15	5.142E-15	5.142E-15
Ca 46	2.074E-15	2.074E-15	2.074E-15	2.074E-15	2.074E-15	2.074E-15	2.074E-15
Ti 47	2.223E-10	2.223E-10	2.223E-10	2.223E-10	2.223E-10	2.223E-10	2.223E-10
Ti 48	6.261E-13	6.261E-13	6.261E-13	6.261E-13	6.261E-13	6.261E-13	6.261E-13
Ti 49	6.113E-10	6.113E-10	6.113E-10	6.113E-10	6.113E-10	6.113E-10	6.113E-10
Ti 50	2.488E-09	2.488E-09	2.488E-09	2.488E-09	2.488E-09	2.488E-09	2.488E-09
V 50	8.324E-09	8.324E-09	8.324E-09	8.324E-09	8.324E-09	8.324E-09	8.324E-09
V 51	1.781E-06	1.781E-06	1.781E-06	1.781E-06	1.781E-06	1.781E-06	1.781E-06
Cr 50	4.002E-05	4.002E-05	4.002E-05	4.002E-05	4.002E-05	4.002E-05	4.002E-05
Cr 52	8.289E-04	8.289E-04	8.289E-04	8.289E-04	8.289E-04	8.289E-04	8.289E-04
Cr 53	1.002E-04	1.002E-04	1.002E-04	1.002E-04	1.002E-04	1.002E-04	1.002E-04

TABLE F.8.e. Cladding Activation Product Inventory by Isotope at 35 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cr 54	2.946E-05	2.946E-05	2.946E-05	2.946E-05	2.946E-05	2.946E-05	2.946E-05
Mn 54	1.668E-10	3.300E-11	6.529E-12	1.292E-12	1.137E-13	1.979E-15	0.00
Mn 55	6.332E-07	6.706E-07	6.926E-07	7.055E-07	7.156E-07	7.216E-07	7.238E-07
Fe 54	1.115E-04	1.115E-04	1.115E-04	1.115E-04	1.115E-04	1.115E-04	1.115E-04
Fe 55	9.062E-08	5.317E-08	3.120E-08	1.830E-08	8.227E-09	2.169E-09	0.00
Fe 56	1.824E-03	1.824E-03	1.824E-03	1.824E-03	1.824E-03	1.824E-03	1.824E-03
Fe 57	5.804E-05	5.804E-05	5.804E-05	5.804E-05	5.804E-05	5.804E-05	5.804E-05
Fe 58	6.346E-06	6.346E-06	6.346E-06	6.346E-06	6.346E-06	6.346E-06	6.346E-06
Co 59	2.098E-08	2.098E-08	2.098E-08	2.098E-08	2.098E-08	2.098E-08	2.098E-08
Co 60	5.372E-10	4.130E-10	3.174E-10	2.440E-10	1.645E-10	8.520E-11	0.00
Ni 60	8.302E-10	9.544E-10	1.050E-09	1.123E-09	1.203E-09	1.282E-09	1.367E-09
Ni 61	3.441E-12	3.441E-12	3.441E-12	3.441E-12	3.441E-12	3.441E-12	3.441E-12
Ni 62	5.812E-15	5.812E-15	5.812E-15	5.812E-15	5.812E-15	5.812E-15	5.812E-15
Sr 87	1.458E-08	1.458E-08	1.458E-08	1.458E-08	1.458E-08	1.458E-08	1.458E-08
Sr 88	1.415E-06	1.415E-06	1.415E-06	1.415E-06	1.415E-06	1.415E-06	1.415E-06
Sr 90	5.615E-11	5.354E-11	5.105E-11	4.868E-11	4.532E-11	4.024E-11	2.980E-21
Y 89	1.078E-07	1.078E-07	1.078E-07	1.078E-07	1.078E-07	1.078E-07	1.078E-07
Y 90	1.408E-14	1.343E-14	1.280E-14	1.221E-14	1.137E-14	1.009E-14	7.474E-25
Zr 90	4.973E-01	4.973E-01	4.973E-01	4.973E-01	4.973E-01	4.973E-01	4.973E-01
Zr 91	1.089E-01	1.089E-01	1.089E-01	1.089E-01	1.089E-01	1.089E-01	1.089E-01
Zr 92	1.695E-01	1.695E-01	1.695E-01	1.695E-01	1.695E-01	1.695E-01	1.695E-01
Zr 93	2.665E-04	2.665E-04	2.665E-04	2.665E-04	2.665E-04	2.665E-04	2.664E-04
Zr 94	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01	1.755E-01
Zr 96	2.871E-02	2.871E-02	2.871E-02	2.871E-02	2.871E-02	2.871E-02	2.871E-02
Nb 93	2.076E-10	3.026E-10	4.118E-10	5.339E-10	7.382E-10	1.127E-09	1.187E-07
Nb 93m	7.391E-10	8.856E-10	1.018E-09	1.137E-09	1.295E-09	1.510E-09	2.249E-09
Nb 94	8.514E-14	8.513E-14	8.513E-14	8.512E-14	8.511E-14	8.510E-14	8.230E-14
Mo 95	9.548E-05	9.548E-05	9.548E-05	9.548E-05	9.548E-05	9.548E-05	9.548E-05
Mo 96	4.858E-06	4.858E-06	4.858E-06	4.858E-06	4.858E-06	4.858E-06	4.858E-06
Mo 97	1.482E-04	1.482E-04	1.482E-04	1.482E-04	1.482E-04	1.482E-04	1.482E-04
Mo 98	1.512E-06	1.512E-06	1.512E-06	1.512E-06	1.512E-06	1.512E-06	1.512E-06
Mo100	3.652E-13	3.652E-13	3.652E-13	3.652E-13	3.652E-13	3.652E-13	3.652E-13
Tc 98	1.838E-15	1.838E-15	1.838E-15	1.838E-15	1.838E-15	1.838E-15	1.838E-15
Tc 99	4.131E-10	4.131E-10	4.131E-10	4.131E-10	4.131E-10	4.131E-10	4.117E-10
Ru 99	9.222E-15	1.191E-14	1.460E-14	1.729E-14	2.132E-14	2.804E-14	1.343E-12
Ru100	2.783E-11	2.783E-11	2.783E-11	2.783E-11	2.783E-11	2.783E-11	2.783E-11
Ru101	1.275E-13	1.275E-13	1.275E-13	1.275E-13	1.275E-13	1.275E-13	1.275E-13
Ru102	1.858E-15	1.858E-15	1.858E-15	1.858E-15	1.858E-15	1.858E-15	1.858E-15
Cd111	1.524E-11	1.524E-11	1.524E-11	1.524E-11	1.524E-11	1.524E-11	1.524E-11
Cd112	1.295E-10	1.295E-10	1.295E-10	1.295E-10	1.295E-10	1.295E-10	1.295E-10
Cd113	3.470E-13	3.470E-13	3.470E-13	3.470E-13	3.470E-13	3.470E-13	3.470E-13

TABLE F.8.e. Cladding Activation Product Inventory by Isotope at 35 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Cd114	2.235E-08	2.235E-08	2.235E-08	2.235E-08	2.235E-08	2.235E-08	2.235E-08
Cd116	9.847E-11	9.847E-11	9.847E-11	9.847E-11	9.847E-11	9.847E-11	9.847E-11
In113	2.688E-06	2.688E-06	2.688E-06	2.688E-06	2.688E-06	2.688E-06	2.688E-06
In115	3.191E-11	3.191E-11	3.191E-11	3.191E-11	3.191E-11	3.191E-11	3.191E-11
Sn112	1.384E-04	1.384E-04	1.384E-04	1.384E-04	1.384E-04	1.384E-04	1.384E-04
Sn113	5.673E-13	6.972E-15	8.568E-17	1.053E-18	1.421E-21	2.379E-26	0.00
Sn114	9.675E-05	9.675E-05	9.675E-05	9.675E-05	9.675E-05	9.675E-05	9.675E-05
Sn115	4.843E-05	4.843E-05	4.843E-05	4.843E-05	4.843E-05	4.843E-05	4.843E-05
Sn116	2.122E-03	2.122E-03	2.122E-03	2.122E-03	2.122E-03	2.122E-03	2.122E-03
Sn117	1.158E-03	1.158E-03	1.158E-03	1.158E-03	1.158E-03	1.158E-03	1.158E-03
Sn118	3.605E-03	3.605E-03	3.605E-03	3.605E-03	3.605E-03	3.605E-03	3.605E-03
Sn119	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03	1.323E-03
Sn119m	1.010E-08	1.280E-09	1.620E-10	2.052E-11	9.245E-13	5.272E-15	0.00
Sn120	4.913E-03	4.913E-03	4.913E-03	4.913E-03	4.913E-03	4.913E-03	4.913E-03
Sn121m	4.435E-08	4.314E-08	4.196E-08	4.081E-08	3.915E-08	3.653E-08	4.562E-14
Sn122	7.078E-04	7.078E-04	7.078E-04	7.078E-04	7.078E-04	7.078E-04	7.078E-04
Sn123	1.076E-12	2.135E-14	4.236E-16	8.404E-18	2.351E-20	1.304E-24	0.00
Sn124	8.668E-04	8.668E-04	8.668E-04	8.668E-04	8.668E-04	8.668E-04	8.668E-04
Sb121	7.830E-06	7.831E-06	7.832E-06	7.834E-06	7.835E-06	7.838E-06	7.874E-06
Sb123	8.487E-07	8.487E-07	8.487E-07	8.487E-07	8.487E-07	8.487E-07	8.487E-07
Sb125	1.475E-06	8.940E-07	5.420E-07	3.286E-07	1.551E-07	4.438E-08	0.00
Te122	6.127E-07	6.127E-07	6.127E-07	6.127E-07	6.127E-07	6.127E-07	6.127E-07
Te123	9.087E-09	9.087E-09	9.087E-09	9.087E-09	9.087E-09	9.087E-09	9.087E-09
Te123m	5.450E-15	7.924E-17	1.152E-18	1.676E-20	2.395E-23	6.104E-28	0.00
Te124	4.271E-08	4.271E-08	4.271E-08	4.271E-08	4.271E-08	4.271E-08	4.271E-08
Te125	8.547E-06	9.136E-06	9.493E-06	9.709E-06	9.885E-06	9.997E-06	1.004E-05
Te125m	2.063E-08	1.251E-08	7.583E-09	4.597E-09	2.169E-09	6.208E-10	0.00
Te126	1.154E-07	1.154E-07	1.154E-07	1.154E-07	1.154E-07	1.154E-07	1.154E-07
Te128	1.002E-12	1.002E-12	1.002E-12	1.002E-12	1.002E-12	1.002E-12	1.002E-12
I127	4.930E-10	4.930E-10	4.930E-10	4.930E-10	4.930E-10	4.930E-10	4.930E-10
Xe128	1.564E-11	1.564E-11	1.564E-11	1.564E-11	1.564E-11	1.564E-11	1.564E-11
Xe129	6.096E-14	6.096E-14	6.096E-14	6.096E-14	6.096E-14	6.096E-14	6.096E-14
Xe130	2.483E-15	2.483E-15	2.483E-15	2.483E-15	2.483E-15	2.483E-15	2.483E-15
Yb172	4.140E-15	4.140E-15	4.140E-15	4.140E-15	4.140E-15	4.140E-15	4.140E-15
Yb173	3.365E-15	3.365E-15	3.365E-15	3.365E-15	3.365E-15	3.365E-15	3.365E-15
Lu175	4.359E-08	4.359E-08	4.359E-08	4.359E-08	4.359E-08	4.359E-08	4.359E-08
Lu176	1.374E-09	1.374E-09	1.374E-09	1.374E-09	1.374E-09	1.374E-09	1.374E-09
Hf174	2.454E-08	2.454E-08	2.454E-08	2.454E-08	2.454E-08	2.454E-08	2.454E-08
Hf176	1.572E-06	1.572E-06	1.572E-06	1.572E-06	1.572E-06	1.572E-06	1.572E-06
Hf177	1.947E-07	1.947E-07	1.947E-07	1.947E-07	1.947E-07	1.947E-07	1.947E-07
Hf178	6.341E-06	6.341E-06	6.341E-06	6.341E-06	6.341E-06	6.341E-06	6.341E-06

TABLE F.8.e. Cladding Activation Product Inventory by Isotope at 35 MWd/kgM, g/gZr (contd)

Isotope	6 Years	8 Years	10 Years	12 Years	15 Years	20 Years	1000 Years
Hf179	1.918E-05	1.918E-05	1.918E-05	1.918E-05	1.918E-05	1.918E-05	1.918E-05
Hf180	2.651E-05	2.651E-05	2.651E-05	2.651E-05	2.651E-05	2.651E-05	2.651E-05
Hf182	6.758E-09	6.758E-09	6.758E-09	6.758E-09	6.758E-09	6.758E-09	6.757E-09
Ta181	1.087E-06	1.087E-06	1.087E-06	1.087E-06	1.087E-06	1.087E-06	1.087E-06
Ta182	3.782E-14	6.965E-16	2.420E-16	2.365E-16	2.364E-16	2.364E-16	2.364E-16
W182	8.301E-08	8.301E-08	8.301E-08	8.301E-08	8.301E-08	8.301E-08	8.301E-08
W183	1.900E-07	1.900E-07	1.900E-07	1.900E-07	1.900E-07	1.900E-07	1.900E-07
W184	1.589E-08	1.589E-08	1.589E-08	1.589E-08	1.589E-08	1.589E-08	1.589E-08
W186	5.106E-13	5.106E-13	5.106E-13	5.106E-13	5.106E-13	5.106E-13	5.106E-13
Re185	4.521E-11	4.521E-11	4.521E-11	4.521E-11	4.521E-11	4.521E-11	4.521E-11
Re187	3.402E-14	3.402E-14	3.402E-14	3.402E-14	3.402E-14	3.402E-14	3.402E-14
Os186	7.855E-12	7.855E-12	7.855E-12	7.855E-12	7.855E-12	7.855E-12	7.855E-12
Os188	1.832E-15	1.832E-15	1.832E-15	1.832E-15	1.832E-15	1.832E-15	1.832E-15
TOTAL	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00	1.000E+00

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