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US Commercial Spent Nuclear Fuel Assembly Characteristics: 1968-2013

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ABSTRACT

Activities related to management of spent nuclear fuel (SNF) are increasing in the US and many other countries. Over 240,000 SNF assemblies have been discharged from US commercial reactors since the late 1960s. The enrichment and burnup of SNF have changed significantly over the past 40 years, and fuel assembly designs have also evolved. Understanding the general characteristics of SNF helps regulators and other stakeholders form overall strategies towards the final disposal of US SNF. This report documents a survey of all US commercial SNF assemblies in the GC-859 database and provides reference SNF source terms (e.g., nuclide inventories, decay heat, and neutron/photon emission) at various cooling times up to 200 years after fuel discharge. This study reviews the distribution and evolution of fuel parameters of all SNF assemblies discharged over the past 40 years. Assemblies were categorized into three groups based on discharge year, and the median burnups and enrichments of each group were used to establish representative cases. An extended burnup case was created for boiling water reactor (BWR) fuels, and another was created for the pressurized water reactor (PWR) fuels. Two additional cases were developed to represent the eight mixed oxide (MOX) fuel assemblies in the database. Burnup calculations were performed for each representative case. Realistic parameters for fuel design and operations were used to model the SNF and to provide reference fuel characteristics representative of the current inventory. Burnup calculations were performed using the ORIGEN code, which is part of the SCALE nuclear modeling and simulation code system. Results include total activity, decay heat, photon emission, neutron flux, gamma heat, and plutonium content, as well as concentrations for 115 significant nuclides. These quantities are important in the design, regulation, and operations of SNF storage, transportation, and disposal systems.

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LIST OF ACRONYMS

BWR	boiling water reactor
DOE	US Department of Energy
DPA	displacements per atom
EFPD	effective full power day
EIA	US Energy Information Administration
EOL	end of life
Gd	gadolinium
GE	General Electric
GUI	graphical user interface
GWd	gigawatt days
ID	identification
LWR	light water reactor
MOX	mixed oxide fuel
MT	metric ton
MTHM	metric ton of heavy metal
MTU	metric ton of uranium
NEI	Nuclear Energy Institute
NFST	Nuclear Fuels Storage and Transportation Planning Project
NRC	US Nuclear Regulatory Commission
PWR	pressurized water reactor
SNF	spent nuclear fuel
UO_2	uranium dioxide
W	Westinghouse
wt%	weight percent

1 INTRODUCTION

Activities related to management of spent nuclear fuel (SNF) are increasing in the US and many other countries. Storage of SNF is an important issue for the US nuclear industry and its regulators, as there is currently no decision on final disposal of SNF in the US. Since the late 1960s, over 240,000 SNF assemblies have been discharged from US commercial reactors. The enrichment and burnup of the SNF have changed significantly over the past 40 years, and fuel assembly designs have evolved, as well. It is important to examine the variations of the SNF parameters and identify the general characteristics, which can help the SNF regulators and other stakeholders develop SNF management strategies.

The GC-859 database [1], which is maintained by the US Energy Information Administration (EIA), documents information on every SNF assembly discharged from US commercial reactors from 1968 to 2013. This database provides a basis for evaluating the general characteristics of US SNF. An SNF assembly contains hundreds of nuclides in varying concentrations as determined by the assembly's initial enrichment, burnup, cooling time, and the relevant reactor operation conditions. Nuclide concentrations and their associated radiological properties are important input parameters for the design and safety evaluation of SNF storage, transportation, and disposal systems. The goal of this study is twofold: (1) summarize the general US SNF characteristics by surveying the GC-859 database and (2) provide calculated reference solutions to SNF source terms based on these typical characteristics.

This study surveys the GC-859 database, generates statistics on distributions of SNF parameters such as burnup and initial enrichment, and identifies the general trends of these parameters for all boiling water reactor (BWR) and pressurized water reactor (PWR) SNF assemblies documented in the database. Because these parameters have evolved over time, the SNF assemblies are divided into three groups based on the discharge year. BWR and PWR assemblies are grouped separately, with three groups for BWR assemblies and three groups for PWR assemblies. The median burnups and median initial enrichments for the assemblies in each group are used to represent the fuels in that group. The GC-859 database also contains information on eight mixed oxide (MOX) fuel assemblies which were discharged from two different PWRs. Two groups have been established to represent these MOX assemblies. Additionally, an extended burnup case with a burnup of 72 gigawatt days (GWd) per metric ton of uranium (MTU) and an enrichment of 5 weight percent (wt%) ^{235}U is also included for BWR and PWR fuel. Although this burnup exceeds what can typically be achieved for an assembly with 5 wt% enrichment, it represents the upper bound for burnup of US fuel assemblies.

This study also provides calculated reference solutions to SNF source terms using the representative SNF parameters identified in the first part. The source terms, including isotopic inventories, activities, decay heat, etc., were calculated in this work using the well-validated ORIGEN code [2] from the SCALE nuclear analysis code package [3]. In generating the reference solutions, calculations for PWRs were performed based on a Westinghouse (W) 17 × 17 assembly design, and the General Electric (GE) 8 × 8 design was used for BWR calculations. W 14 × 14 and W 17 × 17 assembly designs were used for the MOX calculations. Studies were also conducted to quantify the sensitivities of the SNF source terms to burnup, cooling time, and initial enrichment of the fuel.

Specifically, the reference solutions include the following SNF source terms:

- activity,
- decay heat,

- gamma heat,
- photon emission,
- neutron emission,
- neutron flux on assembly surface,
- plutonium content,
- specific activities for a list of 69 nuclides (Section 3), and
- specific concentrations for a list of 115 nuclides (Section 3).

Most of the results are presented as a function of cooling time up to 200 years. Results are presented at cooling times relevant to fuel assembly discharge from a reactor, pool storage, interim dry cask storage, extended dry storage, and early stage of storage in a geological repository. The integral quantities presented in this report are of interest to the design, operation, and safety regulation of the SNF storage and transportation systems. For example, decay heat and gamma heat are important parameters for the system's heat transfer design. Photon emission, neutron flux, and activity are the main considerations for radiation shielding design and worker protection of the SNF system. Plutonium content is important for evaluation of criticality safety, safeguards, and fuel cycles.

This report is comprised of six sections and four appendixes. Section 2 presents the survey results of the database, Section 3 describes the computational methods and models used in this work, and Section 4 provides the sensitivity study results. Section 5 summarizes the reference solutions for UO_2-based BWR and PWR fuels and for the MOX-based PWR fuels. (There is no BWR MOX fuel in the database.) Section 6 provides the summary and conclusions. Detailed results of the concentrations and activities for the significant nuclides are included in the appendixes. In response to a specific request from the sponsor, analysis of maximum assembly decay heat was also performed in this work and the results are presented in Appendix D.

2 SURVEY OF US SPENT NUCLEAR FUEL AND CHARACTERISTICS

2.1 The GC-859 Database

The GC-859 database is an extension of the previous RW-859 [4] database, and it also contains SNF discharged after 2002 up to 2013. Some survey results based on the RW-859 database are published elsewhere [5]. Both databases were developed and maintained by EIA. All generators or owners of SNF and high-level radioactive waste of domestic origin are required by law to provide relevant information to the database as specified in Form GC-859 [6]. The database contains detailed information about permanently discharged SNF assemblies and the associated reactor and cycle data. It also contains limited information about projected assembly discharges, pool storage, dry storage, canisters, and nonfuel components. Data on permanently discharged fuel were evaluated in this study. For each assembly, the database contains:

- an assembly identifier (ID),
- the initial uranium and plutonium mass and the initial enrichment (of ^{235}U, ^{239}Pu, and ^{241}Pu),
- the discharge burnup,
- the last irradiation cycle number,
- the fuel vendor,
- the assembly lattice type,
- the assembly status code, and
- the storage location.

Unless identified otherwise, the enrichment and burnup used in this report refer to the average values of a given fuel assembly. The burnup is the final burnup after the assembly has been discharged from the reactor.

2.2 Distribution of Fuel Enrichment, Burnup, and Lattice Type

This section presents the statistics and distributions of fuel assemblies based on the survey results. Figure 1 shows the number of SNF assemblies discharged annually from BWRs and PWRs as a function of the discharge year. As shown, the number of discharged assemblies steadily increased up to the early 1990s as more reactors came into service. The current average discharge rates are ~4,100 assemblies per year for BWRs and ~3,300 assemblies per year for PWRs. (The number of reactors has not changed significantly since 1990.) The number of assemblies decreased sharply in 2013 because the data were incomplete for that year. In total there have been nearly 139,000 BWR assemblies discharged from the late 1960s to 2013, and over 105,000 PWR assemblies were discharged during the same period.

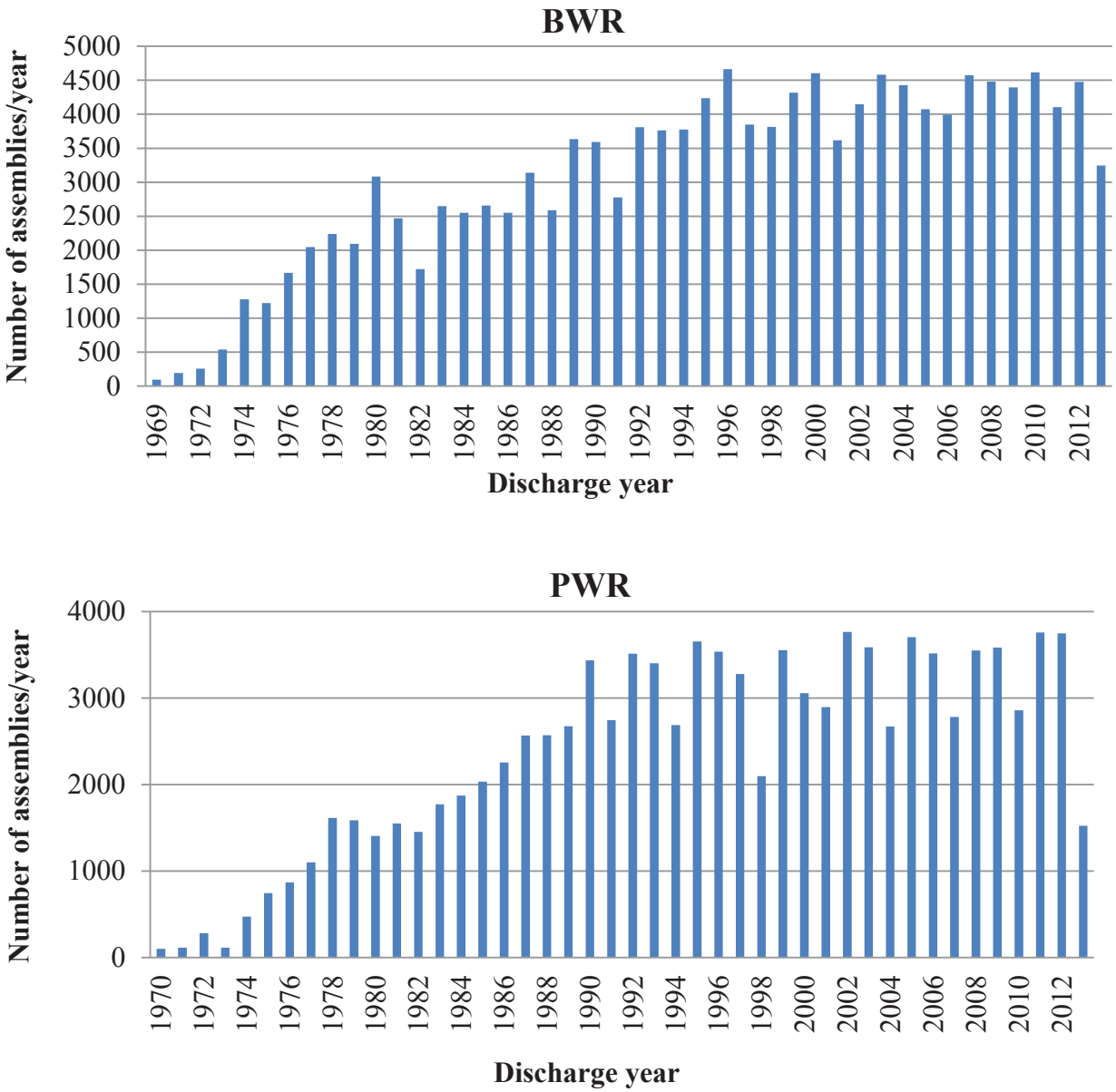

Figure 1. Annual number of BWR (top) and PWR (bottom) fuel assemblies discharged.

Figure 2 shows the number of fuel assemblies as a function of initial enrichment for BWR (left) and PWR (right) assemblies. The data are divided into three time periods: 1968–1983, 1984–2002, and 2003–2013. As shown, the average enrichment increases in later time groups. The figure also shows that enrichment varies within 2–4% for the majority of the BWR assemblies and 3–5% for PWR assemblies.

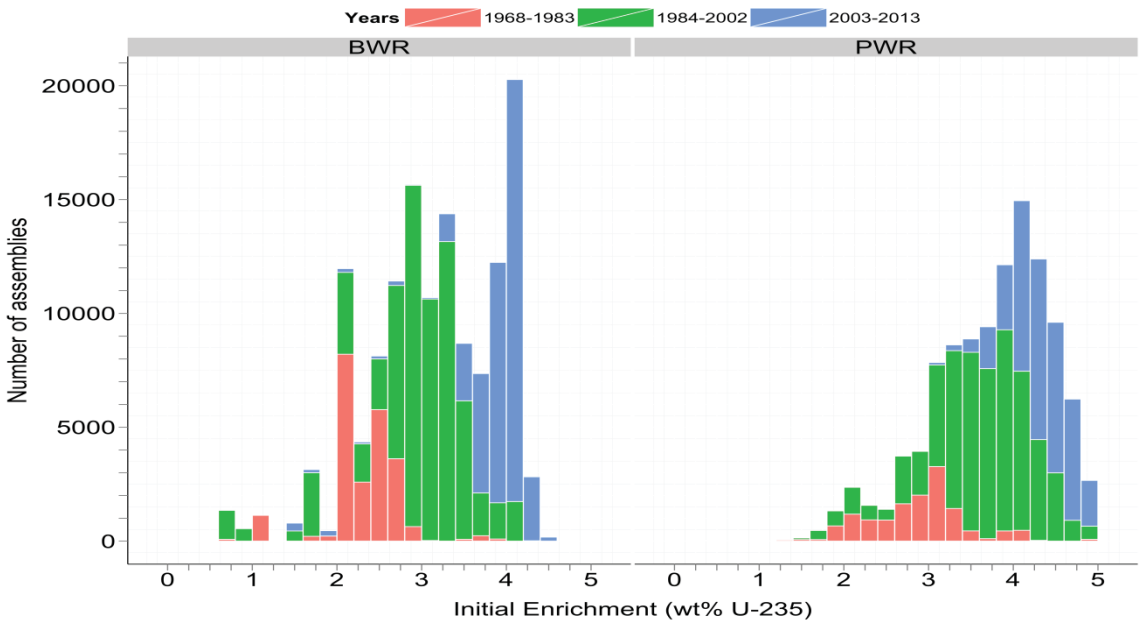

Figure 2. Number of BWR (left) and PWR (right) assemblies in three time periods as a function of initial enrichment (wt% ^{235}U).

Figure 3 shows the number of assemblies as a function of fuel burnup in the same three time periods. It can be seen that the burnup increases in later time groups.

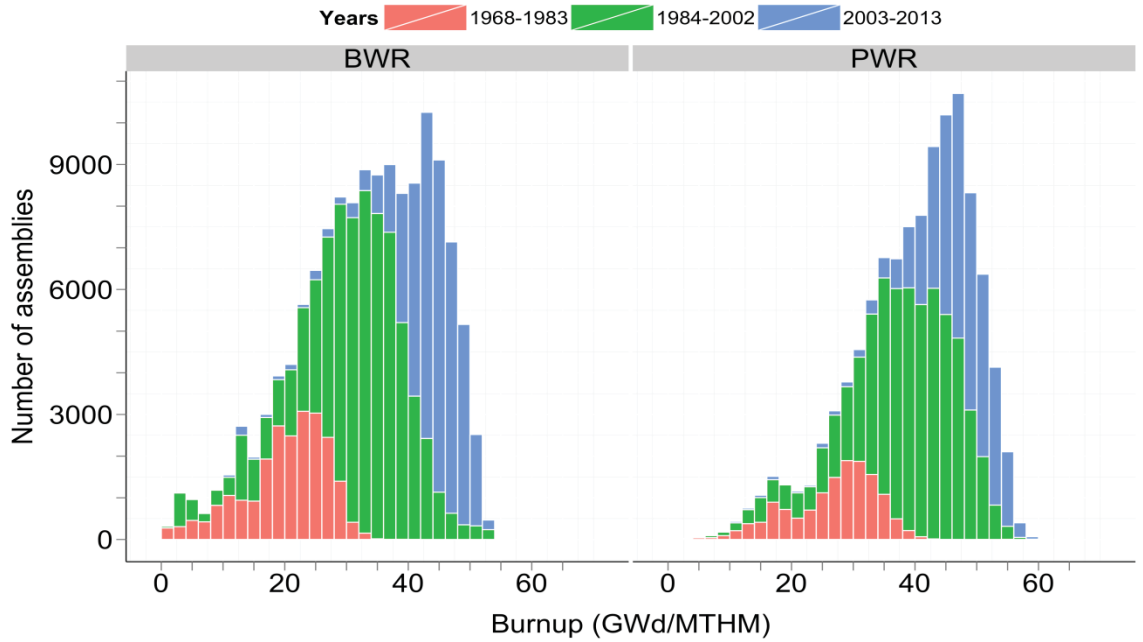

Figure 3. Number of BWR (left) and PWR (right) assemblies in three time periods as a function of assembly-average burnup.

Figure 4 shows information similar to that shown in Figure 3 except that the data are not divided into time periods. As shown, the burnup varies within 20–50 GWd/MTU for the majority of BWR assemblies and 30–52 GWd/MTU for PWRs, although a few assemblies have extremely low or high burnups. Median burnups are 35 GWd/MTU for BWR assemblies and 42 GWd/MTU for PWR assemblies.

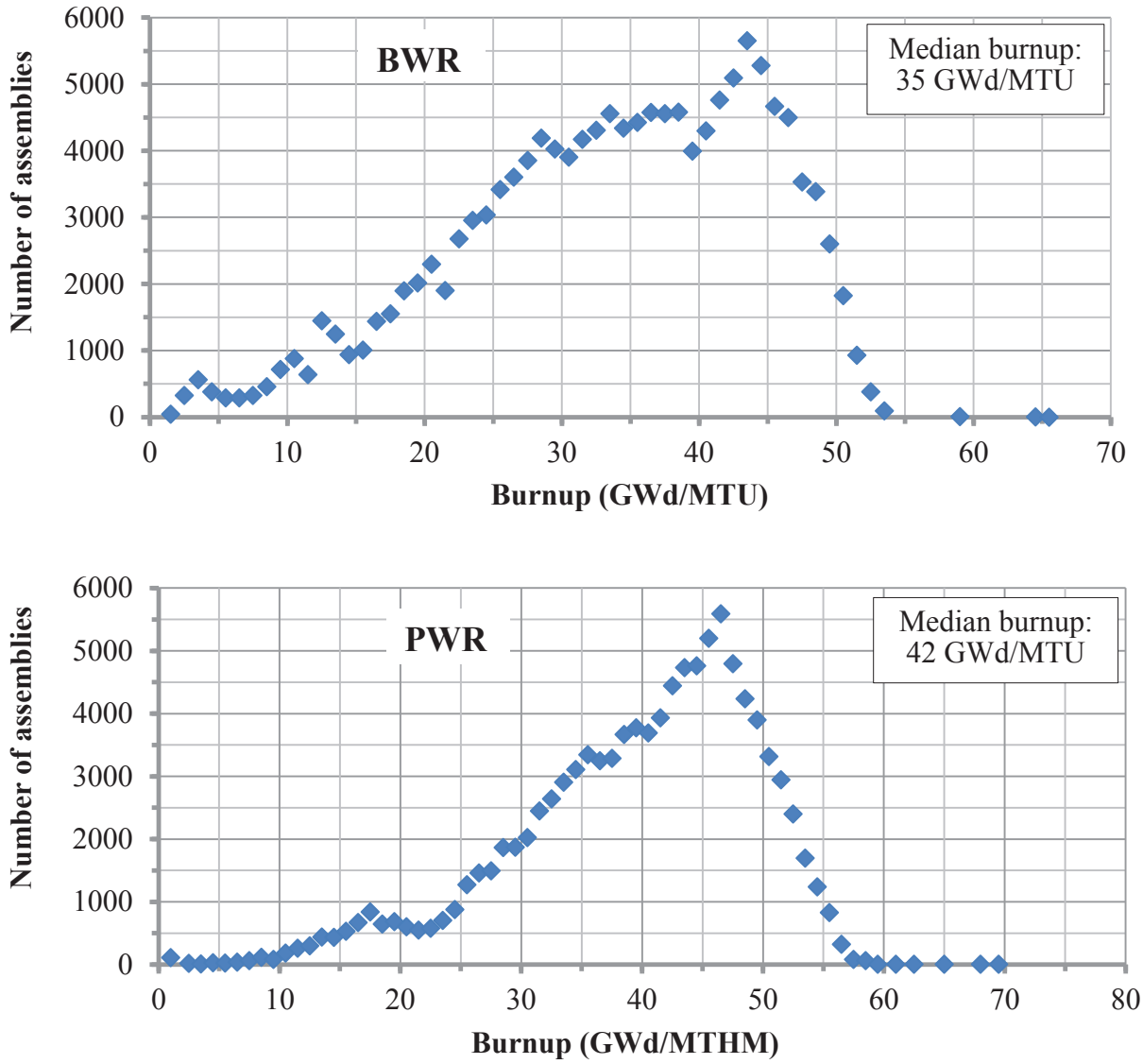

Figure 4. Number of assemblies (in one group) as a function of fuel burnup for BWR (top); and PWR (bottom).

Table 1 shows the number and percentage of BWR and PWR assemblies in several burnup intervals. As shown, for BWR, *25–35* and *35–45* are the top two burnup intervals for the number of assemblies; for PWR the intervals are *35–45* and *45–55.* This indicates that BWR assemblies generally have lower burnups than PWR assemblies. Only 8 BWR assemblies reached burnups above 55 GWd/MTU, but the number is 1,307 for PWR assemblies. The total number of BWR and PWR assemblies with burnups higher than 55 GWd/MTU is only 0.54% among all assemblies in the GC-859 database.

Table 1. Number of BWR and PWR SNF assemblies in each burnup group

Burnup interval (GWd/MTU)	BWR		PWR	
	No. of assemblies	Percent (%)	No. of assemblies	Percent (%)
0–15	8,506	6.227	1,970	1.873
15–25	20,033	14.665	6,662	6.334
25–35	38,954	28.516	21,066	20.029
35–45	47,171	34.531	38,876	36.962
45–55	21,932	16.055	35,296	33.559
55–65	6	0.004	1,303	1.239
65–70	2	0.001	4	0.004
Subtotals	136,604	100	105,177	100

Figure 5 shows the distribution of total initial heavy metal mass between BWR and PWR assemblies (left) and the distribution for the total number of assemblies (right). There is significantly more heavy metal in the PWR assemblies in total than in the BWR assemblies, even though there are more BWR assemblies. This is because a PWR assembly usually contains more uranium than a BWR assembly. For example, a typical fresh 17 × 17 PWR assembly contains ~460 kg uranium, whereas an 8 × 8 BWR assembly only contains ~170 kg uranium.

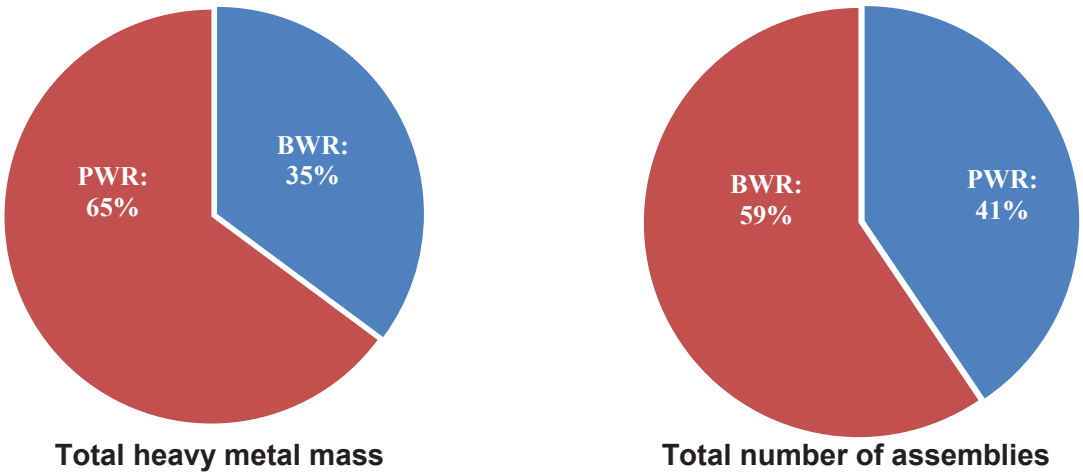

Figure 5. Distribution of total heavy metal mass (left) and total number of assemblies (right) for all BWR and PWR fuel assemblies in the GC-859 database.

Figure 6 shows the distribution of lattice sizes among BWR assemblies (left) and PWR assemblies (right). As shown, for BWR lattice size, 8 × 8 has the largest percentage among all assemblies, followed by 10 × 10, 9 × 9, and 7 × 7. The other assembly designs include a 6 × 6 lattice used in BWR Type 1 plant designs and an 11 × 11 lattice design used at the Big Rock Point reactor until 1997. For PWR lattice size, 17 × 17 has the largest percentage among all assemblies, followed by 15 × 15, 14 × 14, and 16 × 16. Note that within each lattice type, there are usually many different design variants, but this level of detail is not available in the GC-859 database.

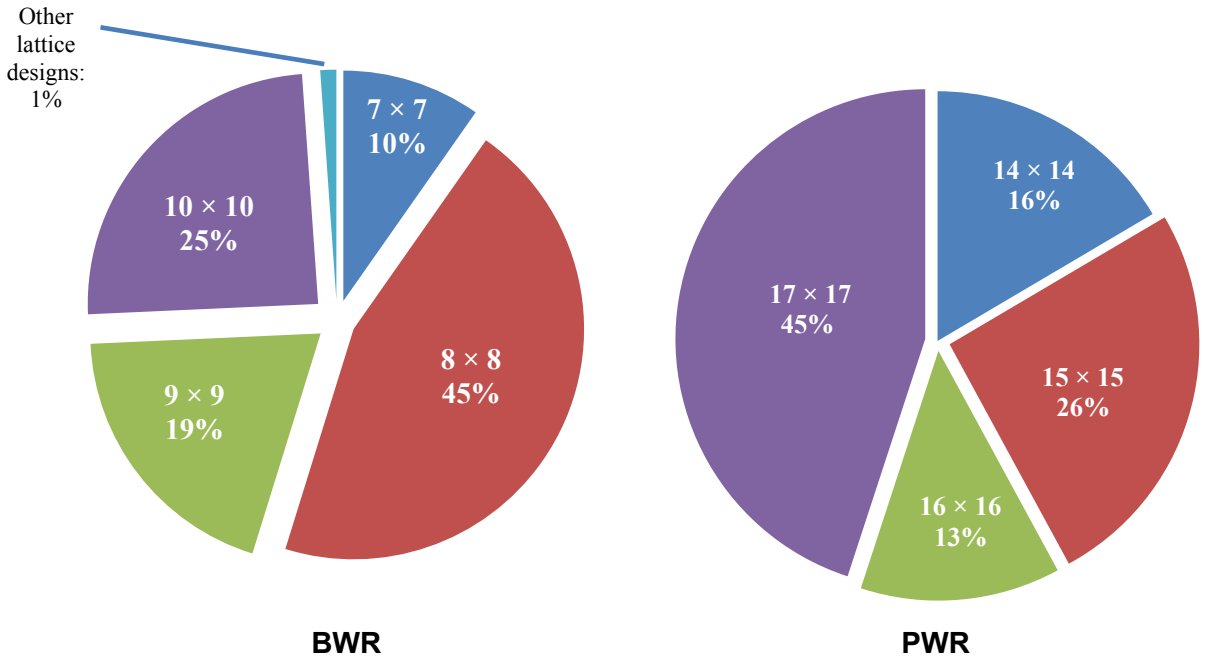

Figure 6. Distribution by lattice size for BWR (left) and PWR (right) assemblies.

2.3 Evolution of Fuel Enrichment, Burnup, and Lattice Size

Figure 7 depicts the variation of median fuel enrichment (the dots connected by lines) as a function of discharge year for all BWR and PWR assemblies. Also shown are the 5% and 95% enrichment values to illustrate the range for 90% of the assemblies. It can be seen that the median enrichment in general increases over time, except for a significant decrease between 1972 and 1975 for PWRs. This corresponds to a time period when many new reactors first start operations. The *5%–95%* range is relatively small (1–1.5 percentage points) for most years except for a few years between 1975 and 1990, during which the 5% values significantly deviate from the median values. This is likely due to the low enriched fuel assemblies used in the initial cores when reactors started operation during that period. It should also be noted that the initial enrichment of commercial nuclear fuel in the US is currently limited to less than 5 wt% ^{235}U.

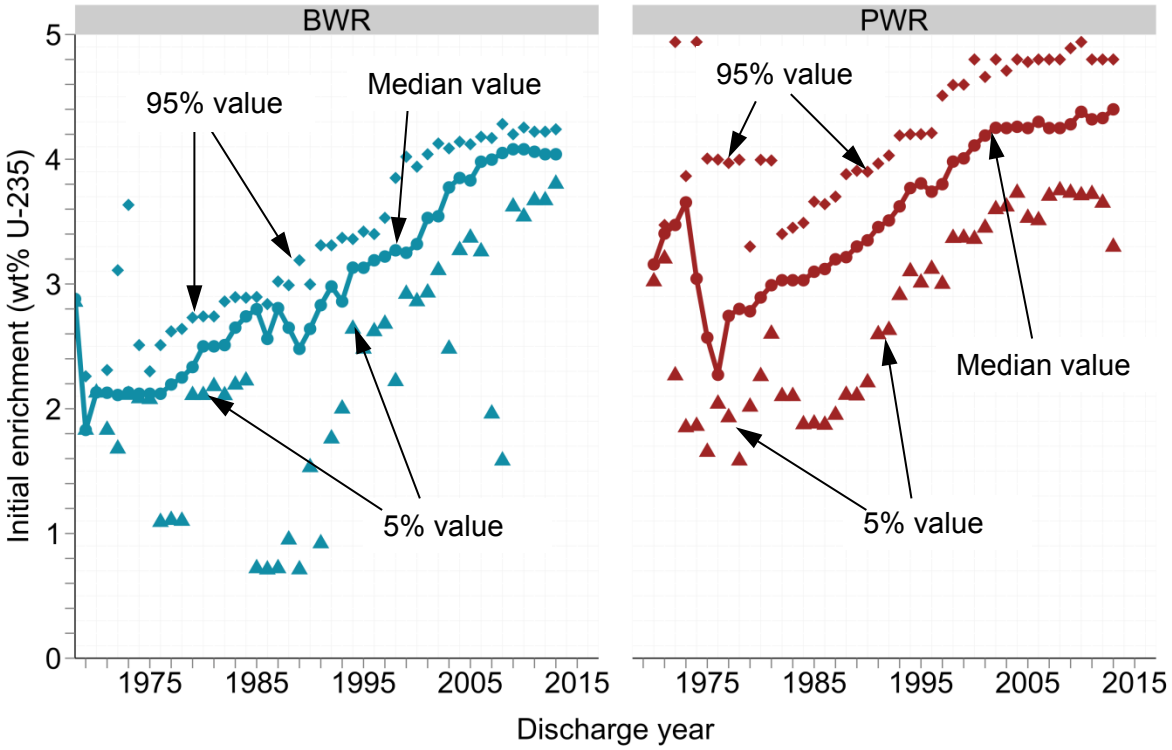

Figure 7. Evolution of median initial enrichment as a function of fuel discharge year for all BWR (left) and PWR (right) assemblies.

Figure 8 shows the variation of median burnup as a function of discharge year for all BWR and PWR assemblies. The discharge burnup of fully burned fuel is correlated to the fuel's initial enrichment because the amount of fissile materials in an assembly limits the burnup that can be achieved. Therefore, similar observations can be made for the evolution of burnup as for initial enrichment. The median burnup generally increases over time, and it is consistent with the trend of the median initial enrichment.

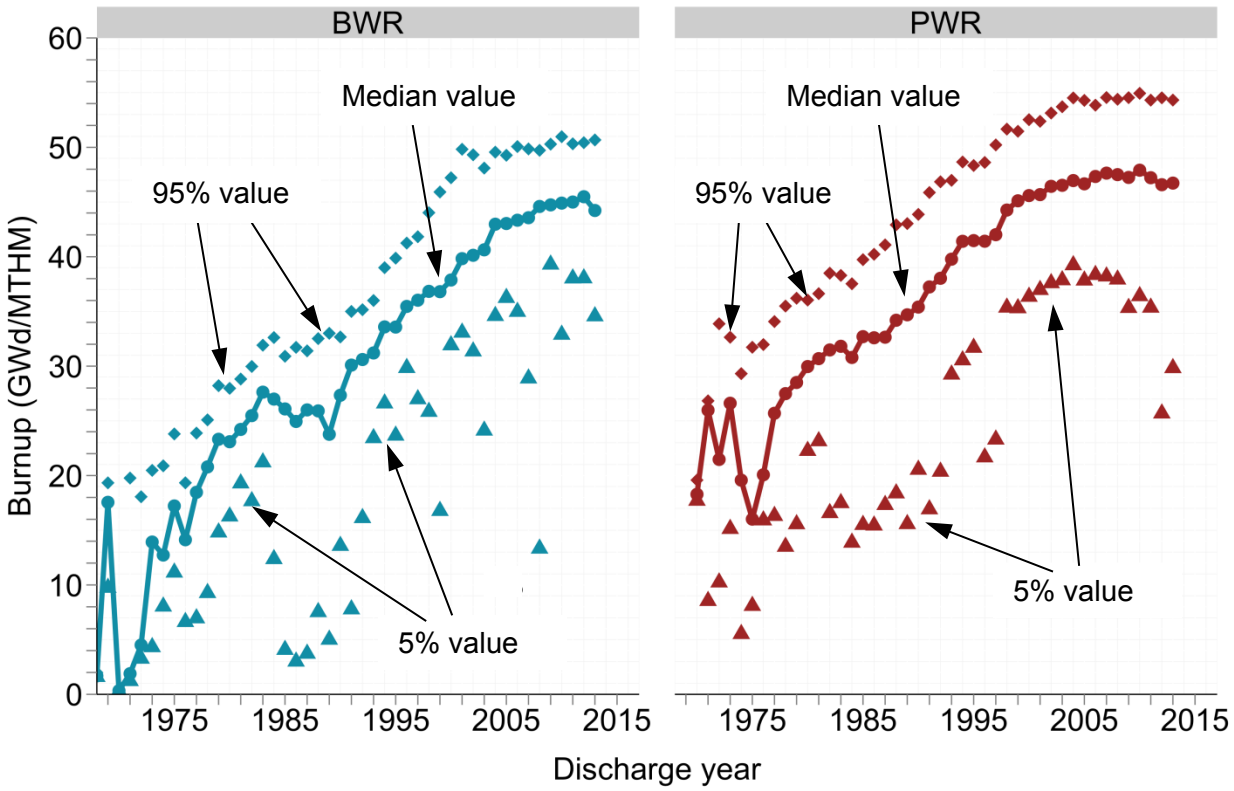

Figure 8. Evolution of the median burnup as a function of fuel discharge year for all BWR (left) and PWR (right) assemblies.

Figure 9 shows the number of assemblies for each BWR (top) and PWR (bottom) assembly lattice size as a function of discharge year. For the BWR assemblies, the dominant lattice size changes over time. For example, 7 × 7 was the dominant lattice size from 1970 to 1979, then 8 × 8 from 1980 to 1998, then 9 × 9 from 1999 to 2006, and 10 × 10 beyond 2006. For PWR assemblies (bottom), the predominant lattice size is 17 × 17. The number of assemblies with lattice sizes 15 × 15, 14 × 14, and 16 × 16 are similar over the last several decades. BWRs can use different lattice designs for the same reactor, which is not the case for PWR plants.

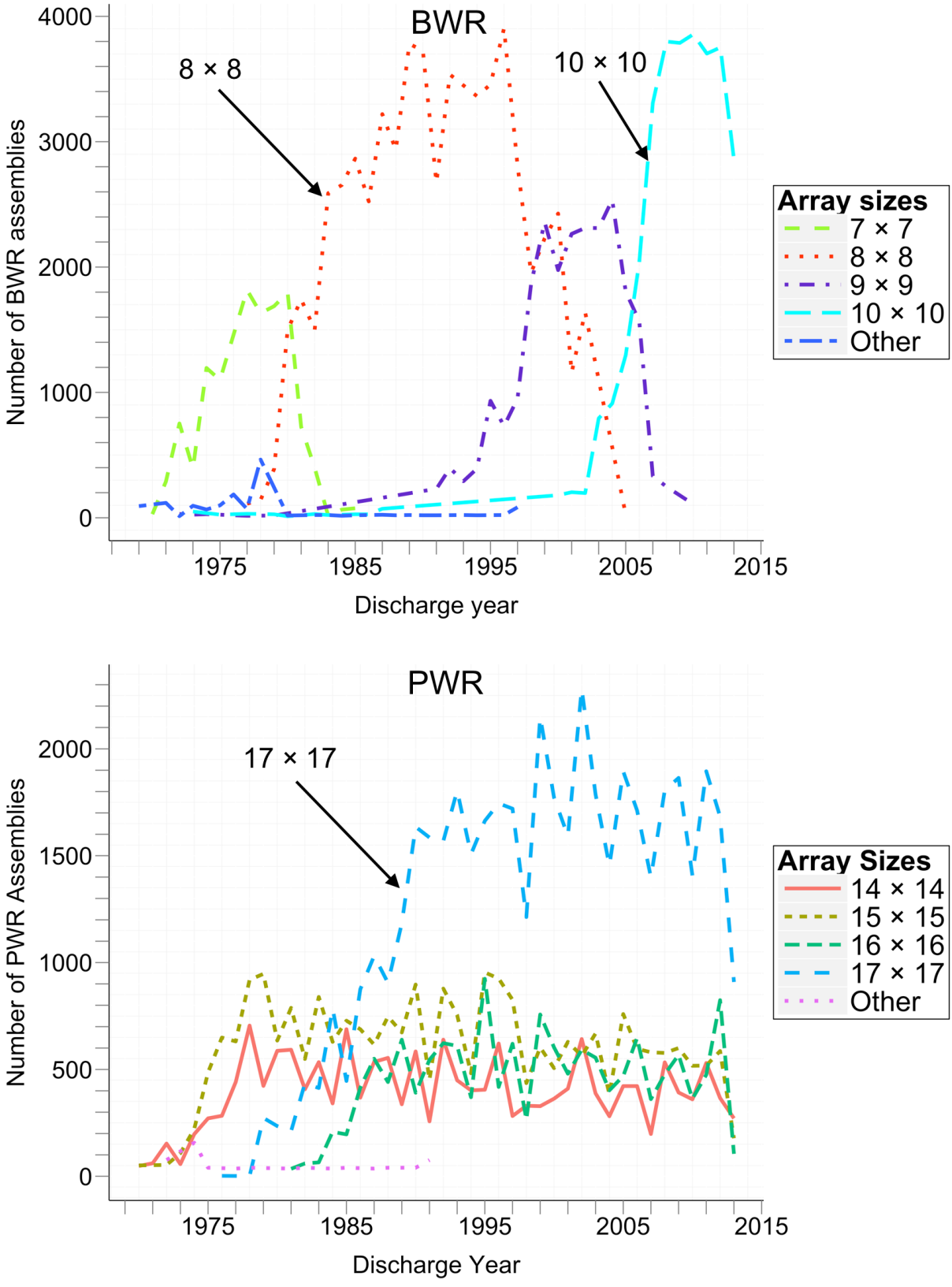

Figure 9. Evolution of assembly lattice size as a function of fuel discharge year for BWR (top) and PWR (bottom) assemblies.

2.4 Categorization of the Fuel Assemblies Based on Discharge Year

To further characterize the enrichment and burnup of the fuel assemblies in the GC-859 database, all assemblies are divided into three groups based on the time period in which they were discharged:

- 1968–1983,
- 1984–2002, and
- 2003–2013.

Groups for the same time periods were established for BWR and PWR assemblies. (The selection of cutoff years for each group is somewhat arbitrary, but the three groups generally correspond to low, medium, and high enrichment and burnup, respectively, as shown in Figure 7 and Figure 8.) Figure 10 shows burnup and enrichment of all fuel assemblies. Each point in this figure represents a single fuel assembly in the database. More points appear in the upper right region of the figure for later time groups, indicating that higher enrichment and burnup are used in more recently discharged fuels, which is consistent with what is shown in Figure 7 and Figure 8. It can also be seen that burnup generally increases with enrichment. A few assemblies significantly deviate from the general trend as a result of some nonroutine reactor operations. For example, some SNF assemblies with high enrichments and low burnups were observed from several plants that were shut down before reaching their expected lifetime. These assemblies were not fully burned before they were discharged due to the plant shutdown. When leaking fuel rods are identified, the affected assemblies are removed from the core. If the affected assemblies are not repaired, they are permanently discharged before reaching their typical burnup. As shown in Figure 10, several assemblies reached burnups close to or above 65 GWd/MTU. These assemblies may have been irradiated for a test program; however, details about these assemblies are not available in the database.

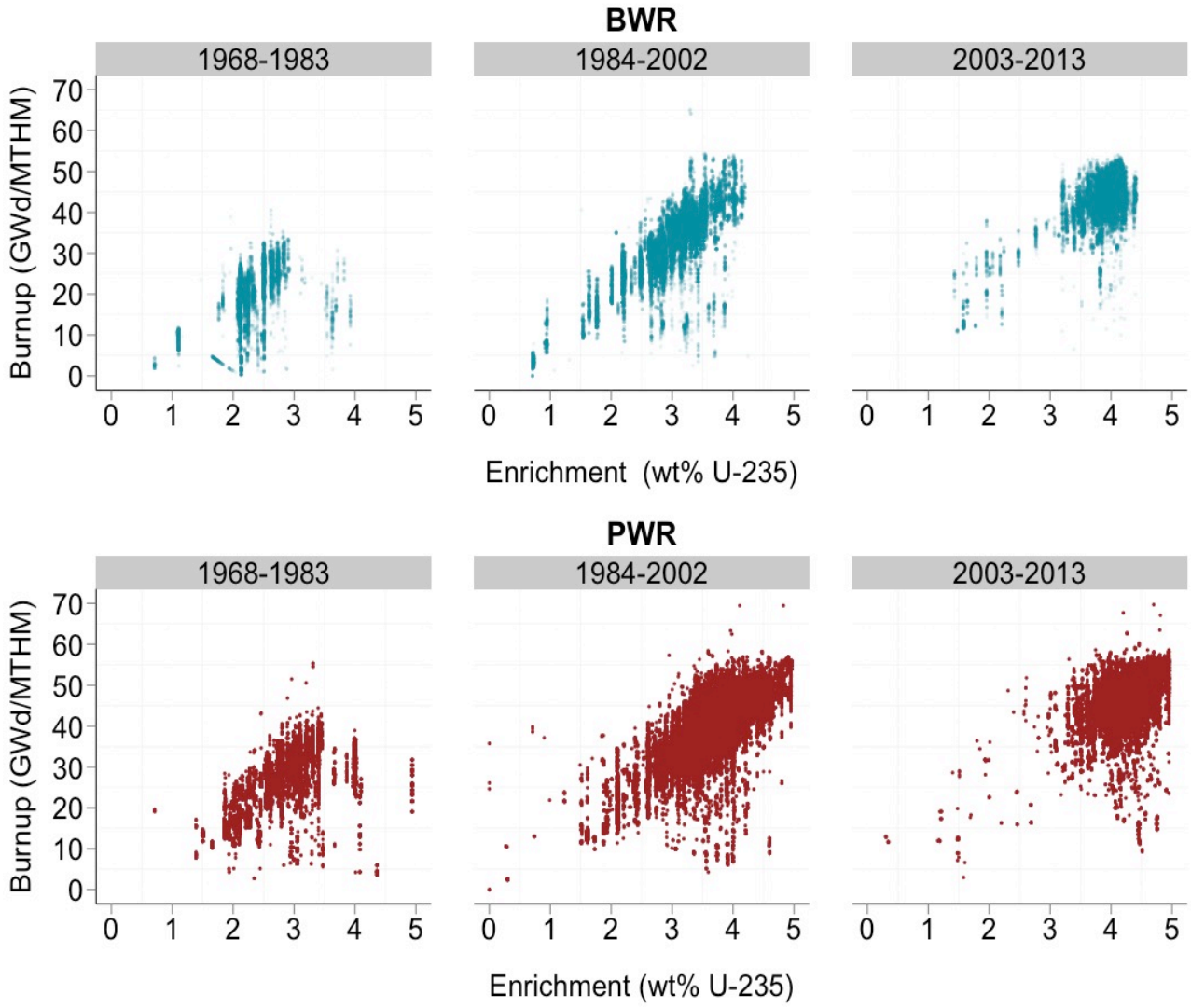

Figure 10. Burnup and initial enrichment for each of the BWR (top) and PWR (bottom) assemblies in the GC-859 database.

Table 2 summarizes the fuel parameters for each group of assemblies. It shows the full range of the enrichment and burnup for each group, in addition to the median values and number of assemblies. The median values are significantly higher in later groups. The *[5%, 95%]* range is much smaller than the full range shown in the *[min, median, max]* columns, suggesting that the majority of the assemblies vary in a small range. This is consistent with what is shown in Figure 10.

Table 2. Summary of enrichment and burnup for each UO_2 BWR and PWR group

Group ID	Discharge year range	Enrichment (%) [min, median, max]	Enrichment (%) [5%, 95%]	Burnup (GWd/tU) [min, median, max]	Burnup (GWd/tU) [5%, 95%]	Number of assemblies
BWR-1	1968–1983	[0.71, **2.33**, 3.94]	[1.11, 2.75]	[0.1, **21.7**, 40.5]	[9.2, 29.1]	21,539
BWR-2	1984–2002	[0.71, **3.00**, 4.24]	[1.76, 3.76]	[1.6, **32.6**, 65.2]	[13.5, 43.2]	68,087
BWR-3	2003–2013	[1.43, **3.99**, 4.43]	[3.31, 4.21]	[6.5, **44.1**, 54.0]	[34.4, 50.2]	46,978
Total # of BWR assemblies:						**136,604**
PWR-1	1968–1983	[0.71, **2.94**, 4.94]	[1.95, 4.00]	[2.8, **28.3**, 55.4]	[13.5, 36.5]	13,628
PWR-2	1984–2002	[0.71, **3.61**, 4.97]	[2.40, 4.46]	[2.4, **39.4**, 69.5]	[21.7, 50.1]	56,293
PWR-3	2003–2013	[0.30, **4.28**, 4.96]	[3.96, 4.80]	[3.0, **47.1**, 69.7]	[35.7, 54.3]	35,256
Total # of PWR assemblies:						**105,177**

While MOX fuel has been widely used in Europe and Japan to make use of the plutonium resource recycled from spent UO_2 fuels, it is not widely used in the US. MOX fuel was used in several demonstration projects in the 1960s and 1970s at several US nuclear power plants including San Onofre, Ginna, Dresden, Quad Cities, and Big Rock Point [7]. Some of those MOX fuels were not full MOX fuel assemblies but included a mix of MOX and UO_2 fuel rods. A more recent test at the Catawba power station in 2005 included 4 MOX assemblies using weapons-grade plutonium. The GC-859 database only contains information for the 8 MOX assemblies from San Onofre and Catawba, as shown in Table 3. As shown, the four assemblies from each of the two PWR reactors have almost identical fuel parameters; therefore, one group is selected for each reactor, as discussed in the following subsection. Because fresh MOX fuel contains plutonium in addition to uranium, it has distinctly different characteristics in some SNF source terms when compared to UO_2 fuel, so MOX fuel is therefore included in this study.

Table 3. Parameters of each of 8 MOX fuel assemblies in GC-859

Reactor name	Initial U (kg)	Initial Pu (kg)	^{235}U (wt%)	^{239}Pu/Pu (wt%)	Fissile* (wt%)	Pu/heavy metal (wt%)	Burnup (GWd/MTHM)	Discharge year	Lattice type
San Onofre Unit 1	311.2	11.2	0.71	80.3	3.67	3.49	19.3	1973	14 × 14
	311.2	11.2	0.71	80.3	3.67	3.49	19.6	1973	14 × 14
	311.2	11.2	0.71	80.3	3.67	3.49	19.2	1973	14 × 14
	311.2	11.2	0.71	80.3	3.67	3.49	19.1	1973	14 × 14
Catawba Unit 1	446.1	20.4	0.25	94.1	4.36	4.37	40.1	2008	17 × 17
	445.7	20.4	0.25	94.1	4.36	4.38	40.5	2008	17 × 17
	445.7	20.4	0.25	94.0	4.35	4.37	40.2	2008	17 × 17
	445.4	20.3	0.25	94.0	4.35	4.37	40.5	2008	17 × 17

*Fissile includes ^{235}U, ^{239}Pu, and ^{241}Pu.

2.5 Representative Parameters for BWR, PWR, and MOX Groups

Reference solutions are generated in this work based on representative fuel parameters. Table 4 shows the median enrichment and burnup for each BWR and PWR group. In addition to the three groups described in the previous subsection, two extended burnup groups, BWR-Ext and PWR-Ext, are added; the extended groups have a burnup of 72 GWd/MTU and an enrichment of 5%. Table 5 shows the parameters for the two MOX groups. While MOX fuel can be used in either BWRs or PWRs, all of the MOX fuel assemblies listed in the GC-859 database are from PWRs. Therefore, unless specified otherwise, MOX fuel groups discussed in this report refer only to MOX fuel from PWRs, and the BWR and PWR fuel groups refer to UO_2-based fuel. Burnup simulations are performed in this work using the representative parameters for each group to provide reference solutions for SNF source terms.

Table 4. Representative parameters for each UO_2 BWR and PWR group

Group ID	Median enrichment (wt% ^{235}U)	Median burnup (GWd/MTU)
BWR-1	2.33	21.73
BWR-2	3.00	32.58
BWR-3	3.99	44.14
BWR-Ext	5.00	72.00
PWR-1	2.94	28.32
PWR-2	3.61	39.44
PWR-3	4.28	47.08
PWR-Ext	5.00	72.00

Table 5. Representative parameters for each MOX group

Group ID	Pu/heavy metal (wt%)	$^{239}Pu/Pu$ (wt%)	^{235}U (wt%)	Fissile (wt%)	Burnup (GWd/MTHM)
MOX-1	3.49	80	0.71	3.67	20
MOX-2	4.37	94	0.25	4.36	40

3 MODELING AND COMPUTATIONAL METHODS

SCALE (version 6.1.3) was used in this work to generate the reference solutions. Specifically, the TRITON module in SCALE was used to generate the ORIGEN neutron cross section libraries, which were then used in ORIGEN standalone calculations. The following subsection provides a brief description of TRITON and ORIGEN in SCALE.

3.1 TRITON and ORIGEN

In the burnup process, the neutron flux and neutron spectrum of the nuclear system affect the evolution of the nuclide compositions during irradiation; in turn, the changes in composition affect the neutron flux and spectrum. The TRITON sequence in SCALE accounts for these interdependencies. To calculate the space-dependent neutron flux and spectrum, TRITON can call NEWT (a two-dimensional deterministic transport code) or KENO (a three-dimensional Monte Carlo code) to perform neutron transport calculation. NEWT was used in this work because it runs much faster than KENO while retaining sufficient accuracies and avoiding stochastic uncertainties. For fuel irradiation, TRITON calls ORIGEN to perform the depletion and decay calculations. TRITON allows users to save the burnup-dependent assembly-average neutron cross sections. These cross sections can be used in the standalone ORIGEN calculations. Multiple TRITON cases are usually run beforehand to cover the parameter space (including enrichment and moderator density) and generate a set of ORIGEN cross section libraries. Customized cross section libraries are then generated by interpolating these pregenerated libraries using the specific parameter values for a particular ORIGEN case. The customized libraries were used in the ORIGEN calculations to generate the reference solution. An ORIGEN case takes only seconds to complete. This approach saves time by performing the normally time-consuming TRITON calculations beforehand. In addition, the accuracies are retained because the details of the TRITON models are preserved in the saved cross section libraries. The procedure is shown in Figure 11.

The ORIGEN isotope depletion and decay code is widely used by researchers, regulators, industry, and universities for design, safety, and licensing analyses. ORIGEN has been extensively validated against measured SNF destructive assay data [8] [9]. Excellent agreement between ORIGEN calculations and measured decay heat values from SNF assemblies has also been observed [10].

In this work, a Python script was developed to generate the ORIGEN input files. The particular cycle history, moderator density, ORIGEN library, initial compositions, cooling time, etc., for each ORIGEN case can be specified. The desired output and formats can also be specified in this script to generate input files for the OPUS post-processing code in order to extract output data. Once ORIGEN inputs are generated, SCALE is used to perform these calculations.

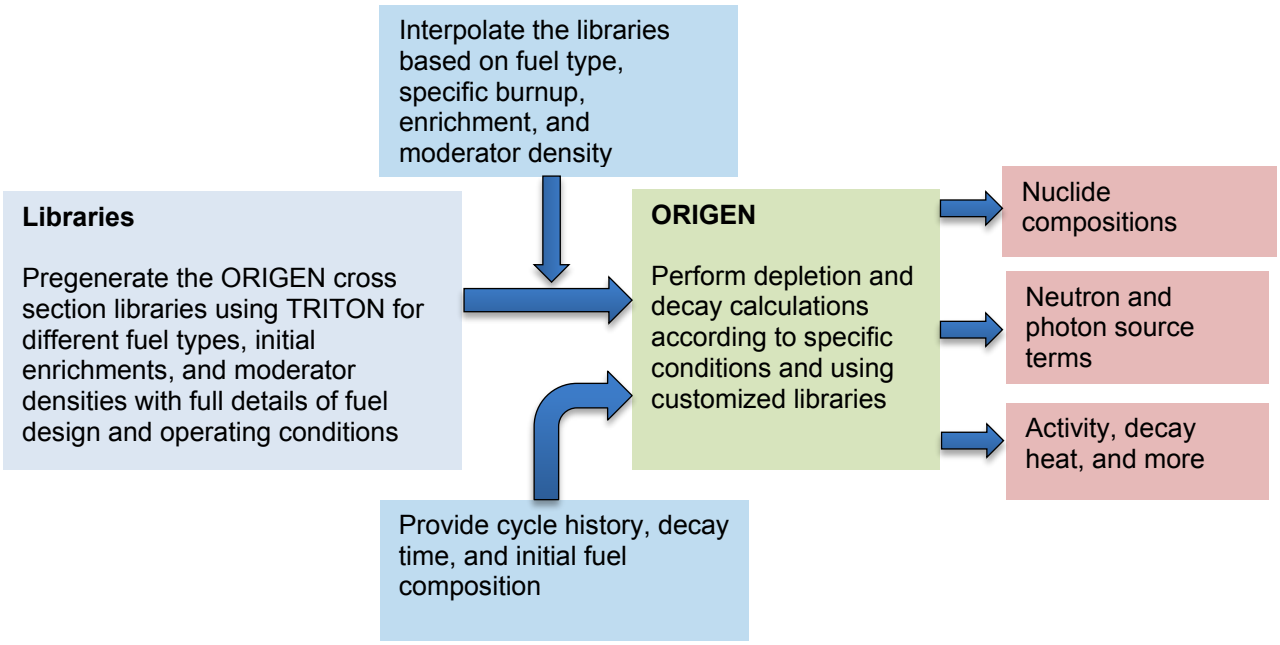

Figure 11. The TRITON/ORIGEN procedure used in this work to generate the reference solutions.

3.2 Assembly Models

Many different BWR and PWR fuel assembly designs have been used in the US over the past 40 years, as shown in Figure 9. For BWRs, 8 × 8 was the most widely used lattice size historically, and 10 × 10 is the most widely used in recent years. For PWRs, 17 × 17 is the dominant lattice size. ORIGEN libraries for these lattices are available in SCALE version 6.1.3. However, these libraries were generated using ENDF/B-V cross sections. To apply more up-to-date cross-section data for this study, TRITON models were developed to generate new ENDF/B-VII.0-based ORIGEN libraries for these lattice designs. The updated libraries were generated using SCALE version 6.1.3.

Figure 12 illustrates the TRITON models for the GE 8 × 8 and 10 × 10 lattice configurations. As shown, the fuel rods, gadolinium (Gd) rods, water rods, cladding, and channel box are modeled in detail. Gd rods were modeled using multiple concentric rings to account for the gradients in nuclide compositions caused by the large neutron absorption and self-shielding of Gd. Figure 13 shows the TRITON model based on the W 17 × 17 lattice configuration. Fuel rods, guide tubes, and cladding are modeled in detail. Internal studies show that the results generated using the GE 8×8 ORIGEN library are similar to those generated using the GE 10 × 10 library. Therefore, the ORIGEN library based on the GE 8 × 8 configuration was used to generate the reference solutions for BWRs. ORIGEN library based on the W 17 × 17 configuration was used to generate the reference solutions for PWRs. Updated MOX libraries were also generated with ENDF/B-VII.0 cross sections using SCALE 6.1.3, and they are used in this work.

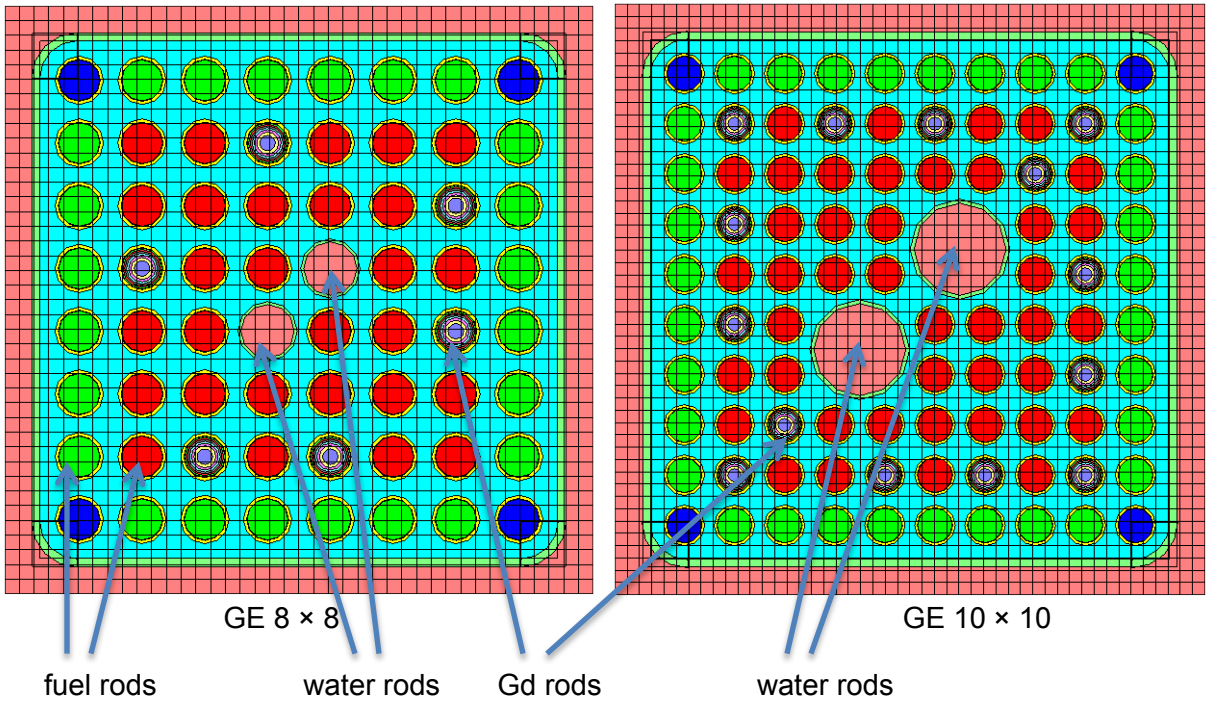

Figure 12. The TRITON models based on GE 8 × 8 and GE 10 × 10 fuel assembly lattice configurations.

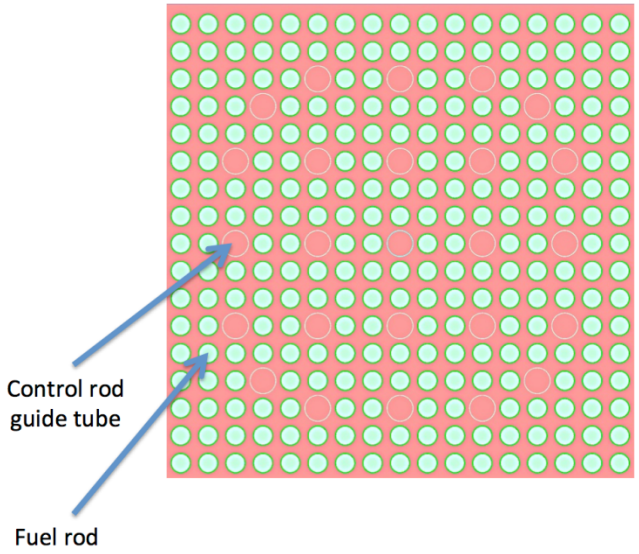

Figure 13. TRITON model based on W 17 × 17 fuel assembly lattice configuration.

3.3 Fuel Composition and Operating History Data

As discussed in Section 3.1, specific information on fuel design and operating conditions is needed to perform burnup simulations. Initial fuel composition is an important fuel design parameter. Uranium in fresh fuel rods contains not only ^{238}U and ^{235}U, but also two low-abundance isotopes: ^{234}U and ^{236}U. If the ^{235}U enrichment is known, the weight percentage of ^{234}U, ^{236}U, and ^{238}U are calculated using the following equations [11]:

$$\% \ ^{234}U = 0.0089E$$
$$\% \ ^{236}U = 0.0046E$$
$$\% \ ^{238}U = 100.0000 - 1.0135E$$

where E = wt% of ^{235}U (^{235}U enrichment)

The GC-859 database contains cycle-by-cycle burnup values and cycle lengths for a large fraction of assemblies. The average specific power for BWR assemblies is 24 MW/MTU, and for PWRs it is 38 MW/MTU. For the reference solutions, representative burnup values are used for each group; the total irradiation time was obtained by dividing the final burnup by the specific power. Three reactor cycles with the same duration for each cycle were assumed for all reference cases, so each cycle represents ⅓ of the total irradiation time. The downtime between cycles was assumed to be 45 days based on an analysis of average plant refueling outage times between 1995 and 2013 [1].

Moderator density is another important parameter for burnup simulations because it has a large impact on the neutron spectrum and neutron cross sections. In the TRITON models used to generate ORIGEN libraries, an average water density of 0.723 g/cm^3 with an average soluble boron concentration of 630 ppm was used for PWRs. For BWRs, an average water density of 0.450 g/cm^3, corresponding to approximately 40% void, was used in regions between the fuel pins, and a density of 0.7373 g/cm^3 was used outside the fuel channel and in water rods. For simplification, it was assumed that control rods or control blades were not inserted in the assemblies during irradiation.

3.4 List of Significant Nuclides

A study was conducted as part of this effort to determine the nuclides of high importance to applications in SNF storage, transportation, and disposal. The median burnup and enrichment of PWR-2 (shown in Table 4) was chosen for this study. ORIGEN calculations have been performed for this fuel group using cooling times of 2 hours, 5 years, and 200 years. In each calculation, the top 20 contributing nuclides for decay heat, isotopic mass, and activity were identified and then combined into one list. Table 6 lists the top 20 nuclides for each category at 5 years. As shown, the top 20 nuclides represent over 97% of total decay heat, mass, and activity. Lists of nuclides have been developed similarly for other cooling times. At short cooling times, the top 20 nuclides account for a smaller fraction (60–70% for the 2-hour case) of total decay heat and activity because many short-lived fission products are key contributors to decay heat and activity.

Table 6. The top 20 contributing nuclides for decay heat, mass, and activity for PWR-2 with a cooling time of 5 years

Decay heat		Mass		Activity	
Nuclide	**Watts/MTU**	**Nuclide**	**Grams/MTU**	**Nuclide**	**Curies/MTU**
^{90}Y	4.29E+02	^{238}U	9.36E+05	^{241}Pu	1.16E+05
^{137m}Ba	4.11E+02	^{235}U	7.98E+03	^{137}Cs	1.11E+05
^{134}Cs	3.77E+02	^{239}Pu	5.53E+03	^{137m}Ba	1.05E+05
^{106}Rh	2.07E+02	^{236}U	4.77E+03	^{90}Y	7.75E+04
^{137}Cs	1.18E+02	^{136}Xe	2.77E+03	^{90}Sr	7.75E+04
^{144}Pr	1.15E+02	^{240}Pu	2.51E+03	^{147}Pm	5.46E+04
^{238}Pu	1.01E+02	^{134}Xe	1.79E+03	^{134}Cs	3.70E+04
^{244}Cm	9.62E+01	^{144}Nd	1.58E+03	^{106}Rh	2.16E+04
^{90}Sr	9.00E+01	^{138}Ba	1.53E+03	^{106}Ru	2.16E+04
^{154}Eu	4.50E+01	^{139}La	1.44E+03	^{144}Pr	1.57E+04
^{241}Am	3.96E+01	^{140}Ce	1.43E+03	^{144}Ce	1.57E+04
^{147}Pm	2.00E+01	^{133}Cs	1.33E+03	^{85}Kr	8.52E+03
^{240}Pu	1.77E+01	^{142}Ce	1.33E+03	^{154}Eu	5.01E+03
^{85}Kr	1.28E+01	^{141}Pr	1.31E+03	^{125}Sb	3.12E+03
^{239}Pu	1.07E+01	^{132}Xe	1.30E+03	^{238}Pu	3.04E+03
^{144}Ce	1.03E+01	^{137}Cs	1.28E+03	^{244}Cm	2.75E+03
^{125}Sb	9.87E+00	^{241}Pu	1.12E+03	^{155}Eu	2.23E+03
^{241}Pu	3.69E+00	^{100}Mo	1.10E+03	^{241}Am	1.19E+03
^{155}Eu	1.64E+00	^{98}Mo	9.74E+02	^{125m}Te	7.65E+02
^{106}Ru	1.28E+00	^{97}Mo	9.54E+02	^{240}Pu	5.69E+02
Total[a]	2.12E+03	Total	1.00E+06	Total	6.81E+05
Subtotal[b]	99.8%	Subtotal	97.8%	Subtotal	99.8%

[a] Total includes contributions from all actinides and fission products in the fuel.
[b] Subtotal is the percent contribution of nuclides listed in the table to the total.

This study also included significant nuclides identified in other studies. The 28 nuclides considered important to burnup credit studies [12] are provided in List 1 below. A list of 69 nuclides (List 2) was considered important to accident consequence studies [13]. The activity from each of these nuclides will be explicitly listed in the appendix for each reference case. By combining these two lists with the top 20 contributors for PWR-2 at three different cooling times, an extended list of nuclides was determined, as shown in List 3 below. The mass of each nuclide on List 3 is included in the appendix for each reference case.

- List 1: the 28 nuclides important to burnup credit studies [12]:

^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{242}Pu, ^{241}Am, ^{243}Am, ^{237}Np, ^{95}Mo ^{99}Tc, ^{101}Ru, ^{103}Rh, ^{109}Ag, ^{133}Cs, ^{143}Nd, ^{145}Nd, ^{147}Sm, ^{149}Sm, ^{150}Sm, ^{151}Sm, ^{152}Sm, ^{151}Eu, ^{153}Eu, ^{155}Gd

- List 2: the 69 nuclides important to accident consequence studies [13]:

^{241}Am, ^{137m}Ba, ^{139}Ba, ^{140}Ba, ^{141}Ce, ^{143}Ce, ^{144}Ce, ^{242}Cm, ^{244}Cm, **^{58}Co‡**, **^{60}Co‡**, ^{134}Cs, ^{136}Cs, ^{137}Cs, ^{131}I, ^{132}I, ^{133}I, ^{134}I, ^{135}I, ^{85}Kr, ^{85m}Kr, ^{87}Kr, ^{88}Kr, ^{140}La, ^{141}La, ^{142}La, ^{99}Mo, ^{95}Nb, ^{97}Nb, ^{97m}Nb, ^{147}Nd, ^{239}Np, ^{143}Pr, ^{144}Pr, ^{144m}Pr, ^{238}Pu, ^{239}Pu, ^{240}Pu, ^{241}Pu, ^{86}Rb, ^{88}Rb, ^{103m}Rh, ^{105}Rh, ^{106}Rh, ^{103}Ru, ^{105}Ru, ^{106}Ru, ^{89}Sr, ^{90}Sr, ^{91}Sr, ^{92}Sr, ^{99m}Tc, ^{127}Te, ^{127m}Te, ^{129}Te, ^{129m}Te, ^{131}Te, ^{131m}Te, ^{132}Te, ^{133}Xe, ^{135}Xe, ^{135m}Xe, ^{90}Y, ^{91}Y, ^{91m}Y, ^{92}Y, ^{93}Y, ^{95}Zr, ^{97}Zr

- List 3: the combined list of 115 significant nuclides (nuclides also included in List 2 are in *red italic font*):

^{109}Ag, *^{241}Am,* ^{242}Am, ^{242m}Am, ^{243}Am, ^{137}Ba, *^{137m}Ba*, ^{138}Ba, *^{139}Ba*, *^{140}Ba,* ^{140}Ce, *^{141}Ce,* ^{142}Ce, *^{143}Ce*, *^{144}Ce*, *^{242}Cm,* ^{243}Cm, *^{244}Cm*, ^{245}Cm, ^{133}Cs, *^{134}Cs*, *^{136}Cs*, *^{137}Cs*, ^{151}Eu, ^{153}Eu, ^{154}Eu, ^{155}Eu, ^{155}Gd, *^{131}I, ^{132}I*, ^{133}I, *^{134}I, ^{135}I, ^{85}Kr, ^{85m}Kr, ^{87}Kr, ^{88}Kr,* ^{139}La, *^{140}La*, *^{141}La, ^{142}La,* ^{100}Mo, ^{95}Mo, ^{97}Mo, ^{98}Mo, *^{99}Mo*, ^{93m}Nb, *^{95}Nb*, *^{97}Nb*, *^{97m}Nb*, ^{143}Nd, ^{144}Nd, ^{145}Nd, *^{147}Nd,* ^{148}Nd, ^{237}Np, *^{239}Np*, ^{147}Pm, ^{141}Pr, *^{143}Pr, ^{144}Pr*, *^{144m}Pr*, *^{238}Pu*, *^{239}Pu, ^{240}Pu, ^{241}Pu*, ^{242}Pu, *^{86}Rb*, *^{88}Rb*, ^{103}Rh,*^{103m}Rh, ^{105}Rh, ^{106}Rh*, ^{101}Ru, *^{103}Ru, ^{105}Ru, ^{106}Ru*, ^{125}Sb, ^{147}Sm, ^{149}Sm, ^{150}Sm, ^{151}Sm, ^{152}Sm, *^{89}Sr*, *^{90}Sr*, *^{91}Sr*, *^{92}Sr*, ^{99}Tc, *^{99m}Tc*, ^{125m}Te, *^{127}Te*, *^{127m}Te*, *^{129}Te, ^{129m}Te*, *^{131}Te*, *^{131m}Te*, *^{132}Te*, ^{234}U, ^{235}U, ^{236}U, ^{238}U, ^{132}Xe, *^{133}Xe*, ^{134}Xe, *^{135}Xe*, *^{135m}Xe*, ^{136}Xe, *^{90}Y*, *^{91}Y, ^{91m}Y, ^{92}Y*, *^{93}Y,* ^{93}Zr, *^{95}Zr, ^{97}Zr*

‡ Note that ^{58}Co and ^{60}Co in SNF almost entirely originate from impurities in fuel assembly structural materials, and the Co impurity level varies by orders of magnitude over the past several decades. Only actinides and fission products in fuel materials were considered in this work. Therefore, both ^{58}Co and ^{60}Co are removed from List 3 and are not included in the results of this report.

4 SENSITIVITY OF INTEGRAL QUANTITIES TO FUEL PARAMETERS

As discussed in Section 2 (e.g., Table 2 and Figure 10), the fuel parameters of the BWR and PWR assemblies vary across a wide range. Sensitivity studies have been performed in this work to quantify how the integral quantities change with the varying parameters.

4.1 Sensitivity to Burnup

In order to quantify the sensitivity to burnup, a W17 × 17 PWR assembly with 3.61% enrichment (same enrichment as PWR-2 shown in Table 4) and a five-year cooling time was chosen for this study. Seven cases with burnup values of 5, 15, 25, 35, 45, 55, or 60 GWd/MTU were simulated. The integral quantities—including activity, gamma heat, decay heat, photon emission, neutron emission, and Pu total—were obtained from the outputs. Figure 14 shows the results normalized to the corresponding values of the 60 GWd/MTU case. *Neutron emission* has the steepest slope with burnup, followed by *decay heat*, *gamma heat*, *photon emission*, *activity*, and *Pu total*. At the 5-year cooling time, neutron emission is primarily from ^{244}Cm and increases with the ~4th power of the burnup; photon emission is mainly from ^{137}Cs and is nearly linear with burnup. Plutonium builds up faster at low burnups and then plateaus at higher burnups due to the depletion of ^{239}Pu. The absolute values of the calculated integral quantities are shown in Table 7.

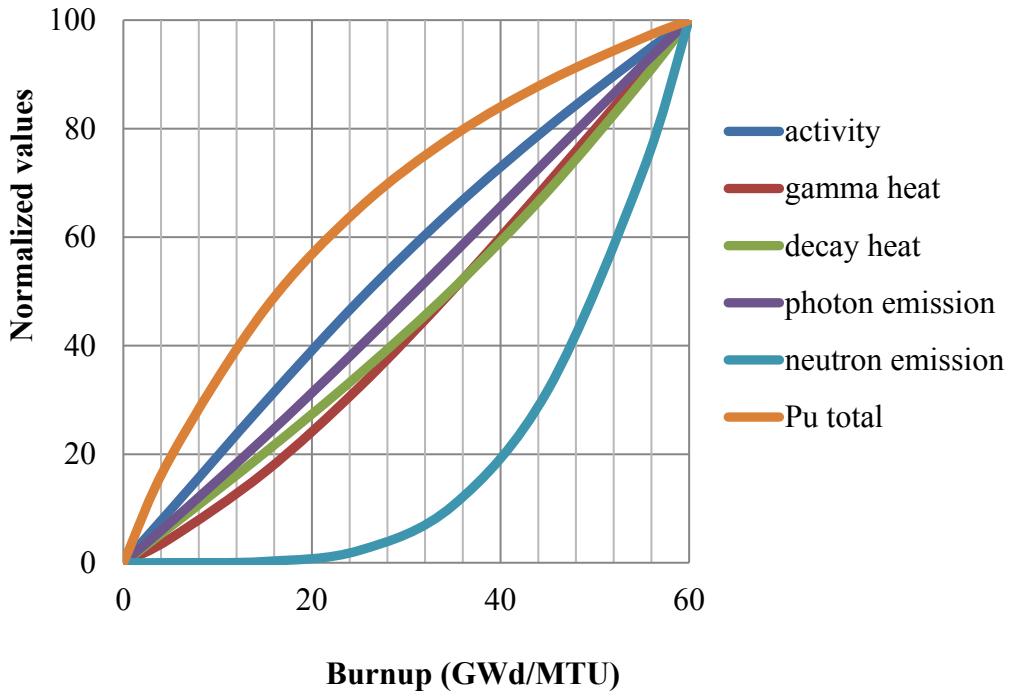

Figure 14. Sensitivity of integral quantities to fuel burnup (results normalized to the case with the highest burnup).

Table 7. Integral quantities as a function of fuel burnup (values based on 1 MTU)

Burnup GWd/MTU	Total activity	Total gamma heat	Total decay heat	Total photon emission	Total neutron emission	Total Pu
	(Curies)	(Watts)	(Watts)	(Photon/s)	(Neutron/s)	(Grams)
5	9.26E+04	6.10E+01	2.45E+02	1.48E+15	3.55E+05	2.32E+03
15	2.82E+05	2.27E+02	7.49E+02	4.60E+15	5.31E+06	5.59E+03
25	4.61E+05	4.40E+02	1.28E+03	7.90E+15	5.11E+07	7.82E+03
35	6.22E+05	6.85E+02	1.87E+03	1.13E+16	2.40E+08	9.42E+03
45	7.65E+05	9.50E+02	2.53E+03	1.48E+16	7.19E+08	1.06E+04
55	8.93E+05	1.22E+03	3.28E+03	1.82E+16	1.62E+09	1.16E+04
60	9.54E+05	1.36E+03	3.69E+03	1.99E+16	2.26E+09	1.20E+04

Figure 15 shows the change of Pu isotopic contents as a function of burnup. The ^{239}Pu and ^{240}Pu are the top two isotopes in abundance. Although ^{241}Pu accumulates at a faster rate than ^{242}Pu at lower burnups, its abundance is similar to that of ^{242}Pu at high burnups.

While ^{239}Pu builds up quickly at low burnups, it remains nearly constant after the burnup reaches 30 GWd/MTU because its depletion rate increases due to the burn-out of ^{235}U at higher burnups. However, ^{240}Pu grows almost linearly with burnup. The sum of Pu isotopes, or Pu total, also increases continuously with burnup although, at high burnups it increases at a lower rate than at lower burnups.

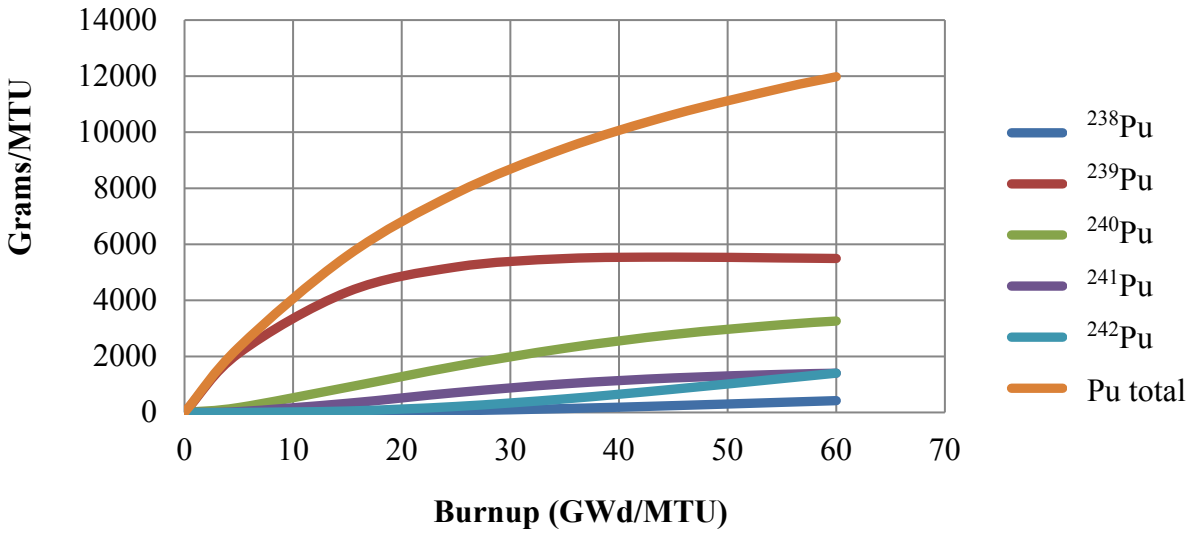

Figure 15. Sensitivity of Pu isotopes to fuel burnup.

4.2 Sensitivity to Cooling Time

A study was conducted to quantify the sensitivity of integral quantities to cooling time. In this study, the burnup (39 GWd/MTU) and enrichment (3.61%) for PWR-2 were used. Nine different cooling times ranging from 5 hours to 200 years were simulated, and the results were obtained for each cooling time step.

Figure 16 shows the normalized integral quantities for these cooling times. Each integral quantity at each cooling time step was normalized by its corresponding value at the end of the first cooling time step (5 hours). As shown, except for the Pu total, all other quantities decrease dramatically with cooling time. For example, the neutron emission decreases by 50% after 5 years, whereas the activity, gamma heat, decay heat, and photon emission decreases by 90% after about 3 months. The differences in decay rate are largely driven by the half-lives of the top contributing nuclides. The neutron emission mainly comes from decay of ^{242}Cm with a half-life of 160 days and ^{244}Cm with a half-life of 18 years. At short cooling times, short-lived fission products are major contributors to activity, gamma heat, decay heat, and photon emission, and their half-lives range from seconds to weeks. This results in a rapid initial decrease of these quantities. The absolute values of the calculated integral quantities are shown in Table 8.

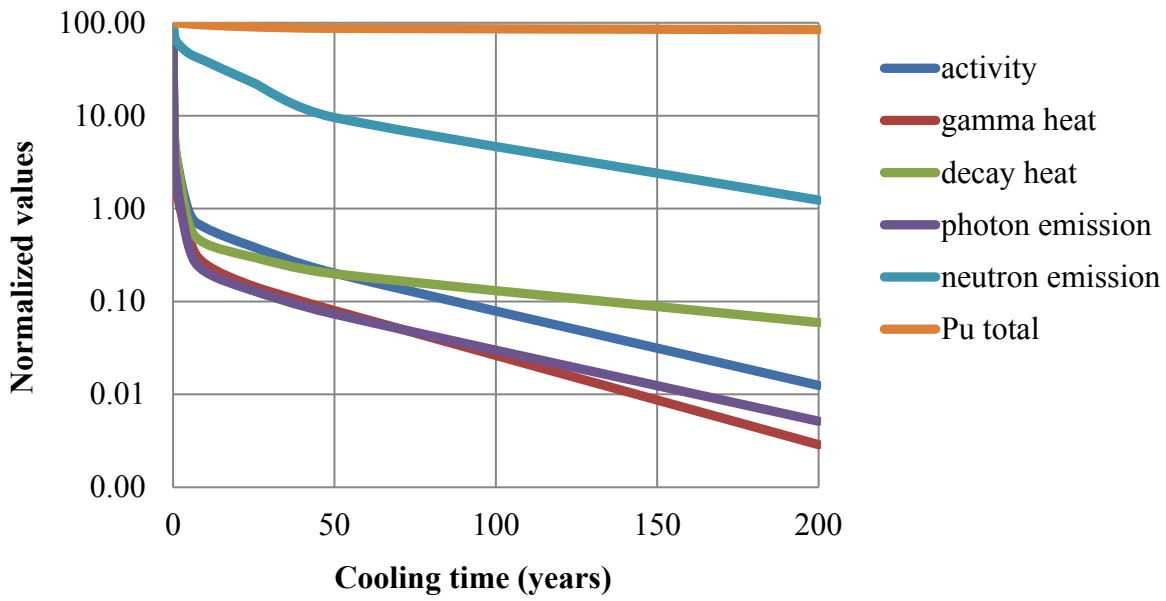

Figure 16. Sensitivity of integral quantities to cooling time (results normalized to the case with 5 years of cooling time).

Table 8. Integral quantities as a function of cooling time (values based on 1 MTU)

Cooling time	Total activity	Total gamma heat	Total decay heat	Total photon emission	Total neutron emission	Total Pu
	(Curies)	(Watts)	(Watts)	(Photon/s)	(Neutron/s)	(Grams)
5 hours	7.47E+07	1.67E+05	3.16E+05	3.39E+18	8.32E+08	1.01E+04
1 day	5.57E+07	1.14E+05	2.12E+05	2.47E+18	8.32E+08	1.02E+04
3 months	7.59E+06	1.21E+04	3.12E+04	2.09E+17	7.13E+08	1.02E+04
1 year	2.78E+06	2.83E+03	1.16E+04	7.14E+16	5.27E+08	1.02E+04
5 years	6.81E+05	7.89E+02	2.12E+03	1.27E+16	3.88E+08	9.94E+03
10 years	4.64E+05	4.23E+02	1.33E+03	7.09E+15	3.22E+08	9.70E+03
25 years	2.88E+05	2.43E+02	9.46E+02	4.41E+15	1.87E+08	9.23E+03
50 years	1.51E+05	1.33E+02	6.28E+02	2.48E+15	7.95E+07	8.90E+03
200 years	9.33E+03	4.80E+00	1.87E+02	1.74E+14	1.03E+07	8.64E+03

4.3 Sensitivity to Initial Enrichment

A study was conducted to quantify the sensitivity of integral quantities to initial enrichment. In this study, burnup was fixed at 39 GWd/MTU, and the cooling time was fixed at 5 years. Enrichment was varied in the range 1.84%–5.0%, which is the range for the PWR-2 group shown in Table 2, using eight values. Figure 17 shows the variation of each integral quantity as a function of enrichment. Values were normalized to the corresponding values from the 1.84% enrichment case. As shown, except for neutron emission, all other quantities had small changes with enrichment. At this cooling time (5 years), fission products are the main contributors to activity, decay heat, gamma heat, and photon emission. These factors depend mainly on burnups and cooling times. For fuels with lower enrichments, higher fluences are required to reach the same burnup because of the lower fissile content, which leads to more neutron absorption of ^{238}U and thus greater generation of transuranic nuclides, including Cm. Therefore, there are higher neutron emissions at lower enrichment, as ^{242}Cm and ^{244}Cm are the two main neutron emitters in SNF. This also explains why there is more Pu mass at lower enrichment, but the consumption rate on Pu fissile isotopes is also higher at lower enrichment due to the lower quantities of ^{235}U (the other main fissile isotopes). Thus, Pu total increases at a lower rate than neutron emission at lower enrichment. The absolute values of the calculated integral quantities are presented in Table 9.

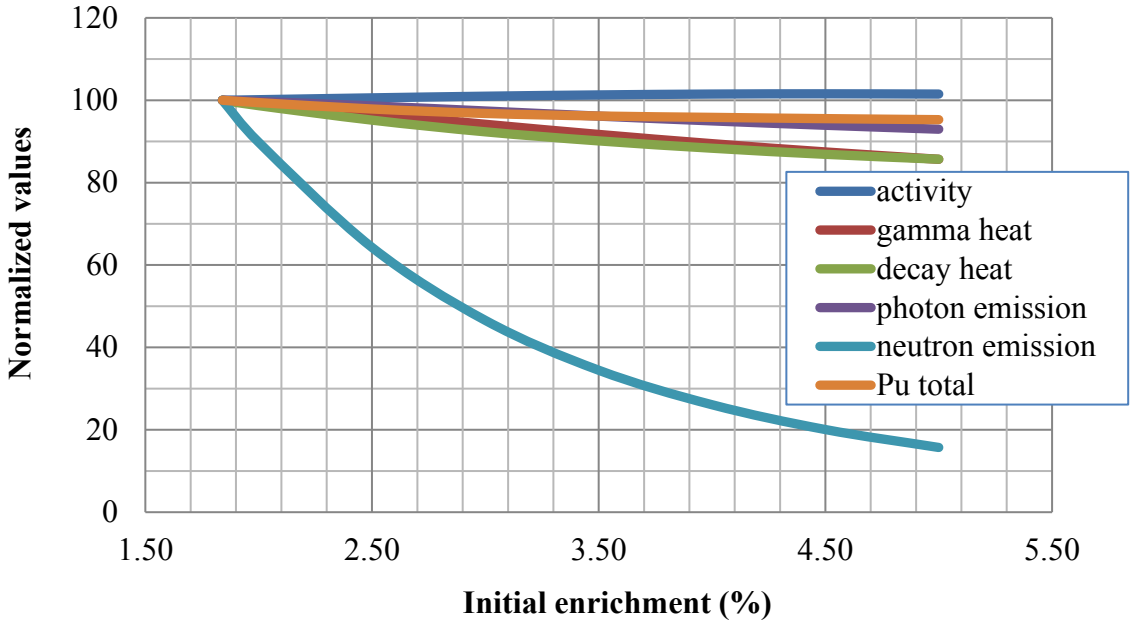

Figure 17. Sensitivity of integral quantities to initial enrichment (values normalized to the case with 1.84% enrichment).

Table 9. Integral quantities as a function of initial enrichment (values based on 1 MTU)

Enrichment (%)	Total activity	Total gamma heat	Total decay heat	Total photon emission	Total neutron emission	Total Pu
	(Curies)	(Watts)	(Watts)	(Photon/s)	(Neutron/s)	(Grams)
1.84	6.72E+05	8.66E+02	2.36E+03	1.33E+16	1.20E+09	1.03E+04
2.0	6.73E+05	8.59E+02	2.33E+03	1.32E+16	1.08E+09	1.03E+04
2.5	6.76E+05	8.37E+02	2.25E+03	1.31E+16	7.70E+08	1.01E+04
3.0	6.79E+05	8.15E+02	2.18E+03	1.29E+16	5.58E+08	1.00E+04
3.5	6.81E+05	7.94E+02	2.13E+03	1.28E+16	4.13E+08	9.95E+03
4.0	6.82E+05	7.74E+02	2.09E+03	1.26E+16	3.13E+08	9.91E+03
4.5	6.83E+05	7.57E+02	2.05E+03	1.25E+16	2.40E+08	9.88E+03
5.0	6.82E+05	7.42E+02	2.02E+03	1.23E+16	1.88E+08	9.86E+03

In summary, the sensitivity of the integral quantities to burnup, cooling time, and enrichment are quantified. The results show that all the integral quantities studied are sensitive to burnup, and they are also very sensitive to cooling time except for *Pu total,* which decreased by only ~15% over the first 200 years. For the sensitivity to initial enrichment, variations of all quantities except for neutron emission were within 20% over the range of initial enrichment studied here; the neutron emission decreased by ~80%. These results help illustrate how much these quantities change with the varying fuel parameters without the need to perform detailed simulations.

5 REFERENCE SOLUTIONS

Burnup calculations have been performed for each representative case, including all BWR, PWR, and MOX fuel groups shown in Table 4 and Table 5, with cooling times varying from 5 hours to 200 years. The results for the integral quantities are illustrated as a function of cooling time and are presented in this section in the following order:

- activity,
- decay heat,
- gamma heat,
- photon emission,
- neutron flux, and
- Pu content.

All results are based on 1 metric ton of initial heavy metal loading (MTHM). The mass unit MTU is interchangeable with MTHM in the context of UO_2 fuel. These results can be converted to an assembly basis by multiplying the quantities by the actual initial loading of uranium or heavy metal of a given assembly. An 8 × 8 BWR assembly usually has an initial loading of ~0.17 MTU, while a 17 × 17 PWR assembly would have an initial loading of ~0.46 MTU.

5.1 Results in Appendixes

Reference solutions for nuclides on Lists 2 and 3 are included in the appendixes. The values of the integral quantities are also tabulated and presented there. Also included in appendixes are the activities of the nuclides on List 2 and the mass of each nuclide on List 3 for each representative case at several cooling time steps. The results for BWR, PWR, and MOX are presented in Appendixes A, B, and C, respectively. (Descriptions of Lists 2 and 3 can be found in Section 3.4.) Appendix D includes results for maximum assembly decay heat analysis.

5.2 Activity

The total activities for the BWR, PWR, and MOX groups are shown in Figure 18, Figure 19 and Figure 20, respectively. The results for PWRs were also included in the figure for the MOXs (Figure 20) for comparison. As shown, the total activities of all cases decrease by over 3 orders of magnitude in the first 200 years after discharge. Within each set, the differences in activity due to different burnups are small at short cooling times, but they become pronounced after ~2 years of cooling time. The results for MOX fuel are similar to those for UO_2 fuel with similar burnups (Figure 20). At longer cooling times, the contribution to activity from actinides and cesium isotopes becomes more significant. Actinides and cesium isotopes are increasingly accumulated at higher burnups, so greater activities are observed in fuel with higher burnups at longer cooling times, as shown in the following three figures.

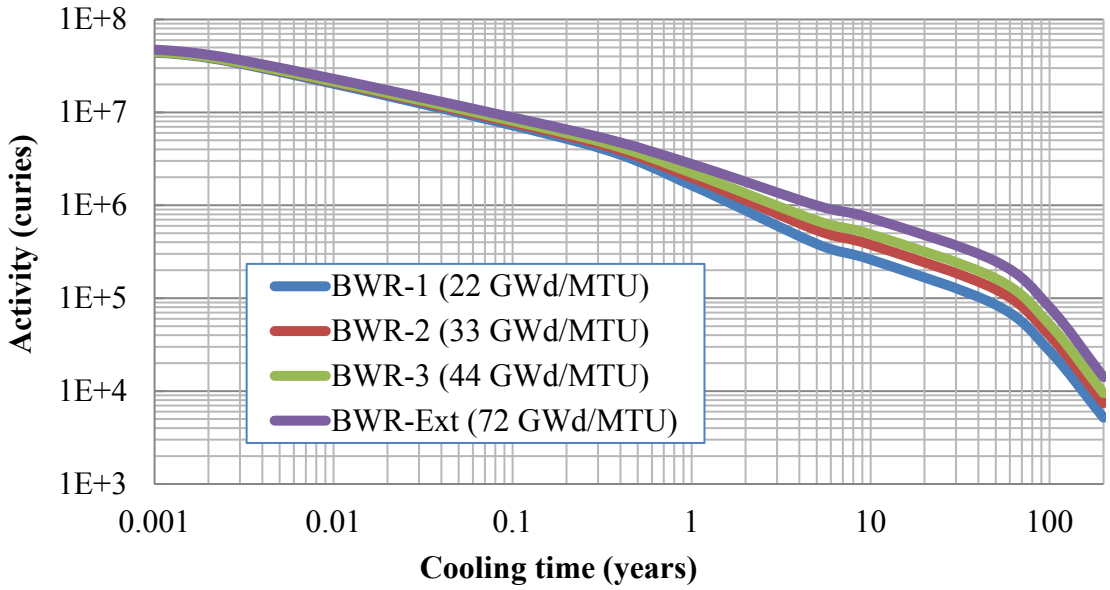

Figure 18. Activity as a function of cooling time for BWR assemblies.

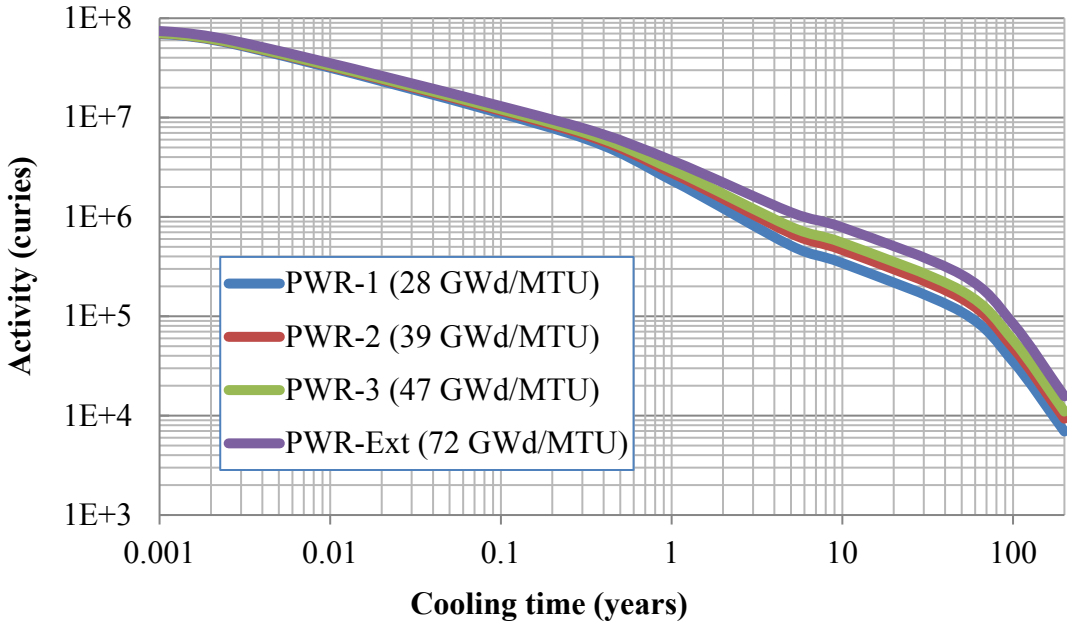

Figure 19. Activity as a function of cooling time for PWR assemblies.

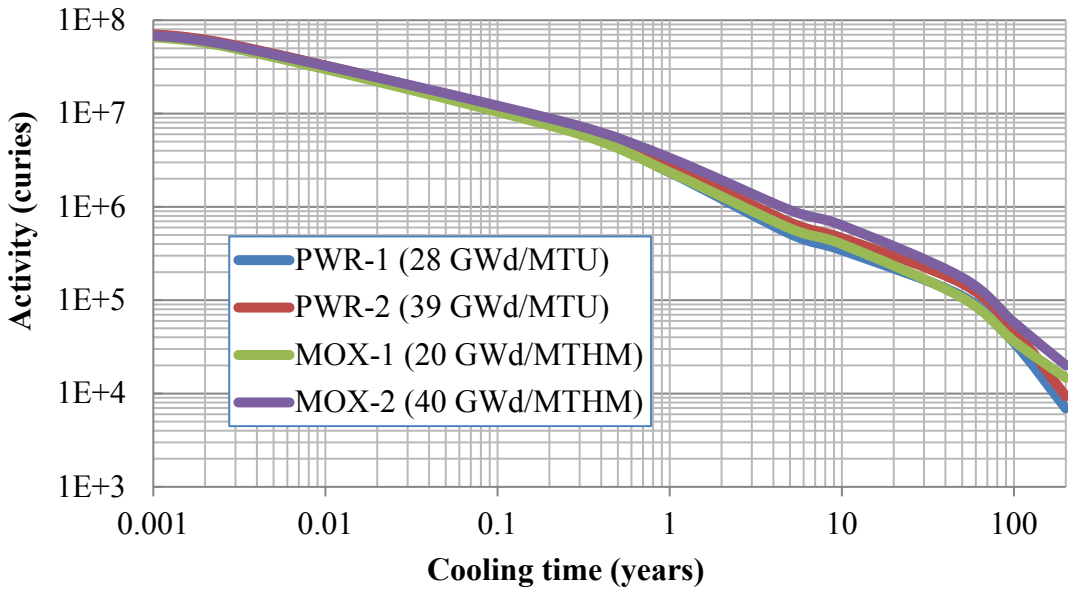

Figure 20. Activity as a function of cooling time for UO_2 and MOX assemblies.

5.3 Decay Heat

The results of total decay heat for each set of BWR, PWR, and MOX assemblies are shown in Figure 21, Figure 22, and Figure 23, respectively. The decay heat decreases by over 2 orders of magnitude in 200 years after discharge. The results are similar at short cooling times (<0.1 year) among different burnups, but they begin to diverge at longer cooling times (>1 year) because the decay heat is mainly driven by different sets of nuclides that have different half-lives. At longer cooling times, the relative contributions from actinides increase [14], and fuels with higher burnups have accumulated more actinides. Therefore, higher decay heat is observed at higher burnups, especially at longer cooling times. Because MOX fuel is initially loaded with Pu in addition to U, more actinides are usually generated in MOX during irradiation than in UO_2 fuels with similar burnups. This explains why both MOX cases have higher decay heat than the PWR cases after a cooling time of ~30 years, even though MOX-1 has lower burnup than the two PWR cases (Figure 23). At short cooling times, both PWR and MOX have higher decay heat than BWR because it was assumed that they had higher power densities (as described in Sect. 3), and power densities have major impacts on short-term decay heat, especially near the end of irradiation.

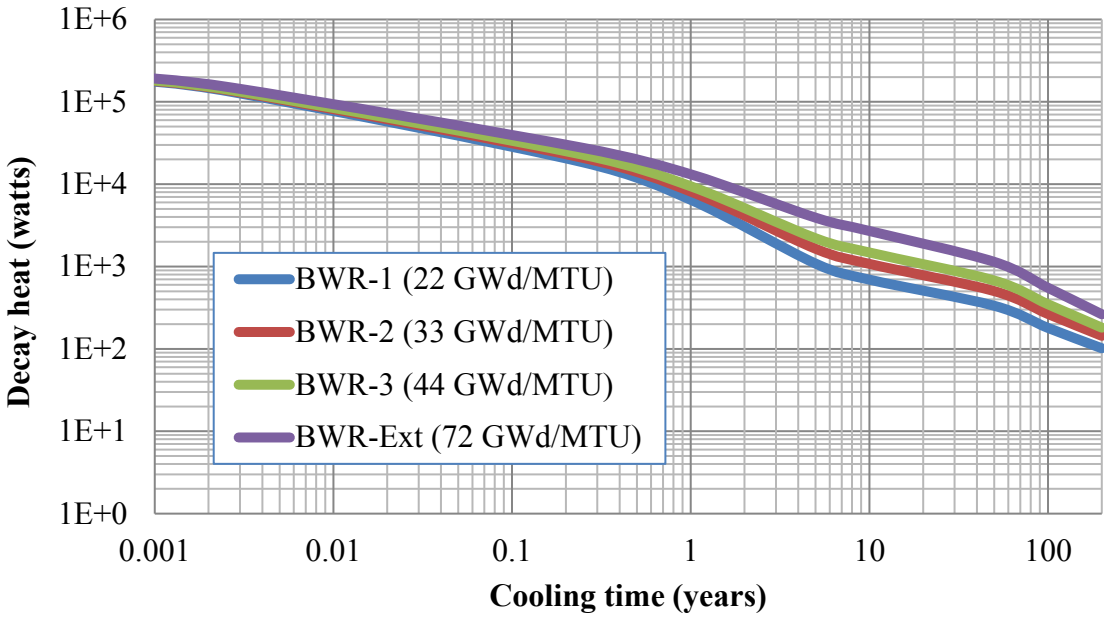

Figure 21. Decay heat as a function of cooling time for BWR assemblies.

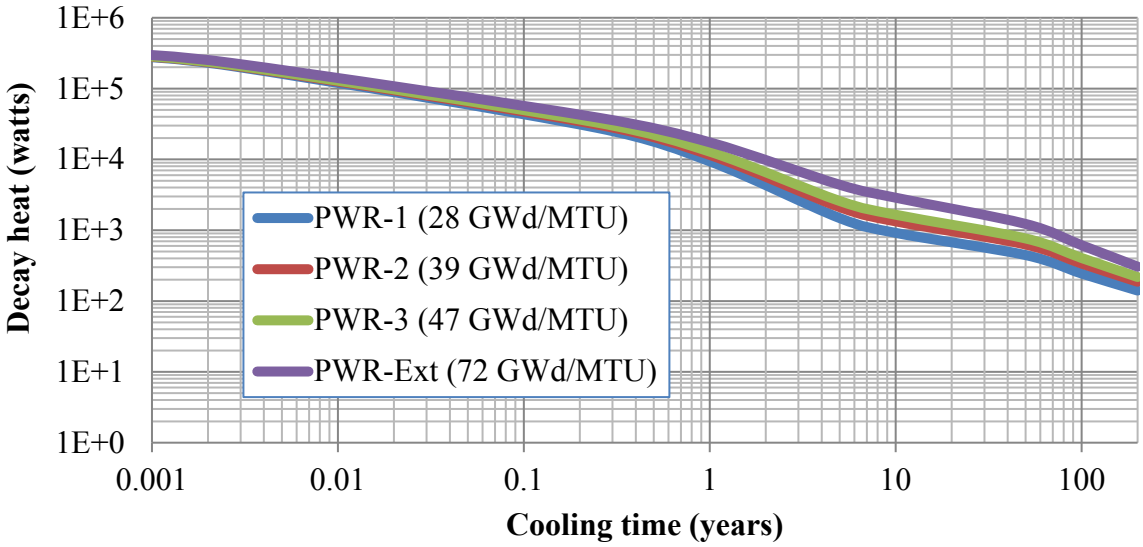

Figure 22. Decay heat as a function of cooling time for PWR assemblies.

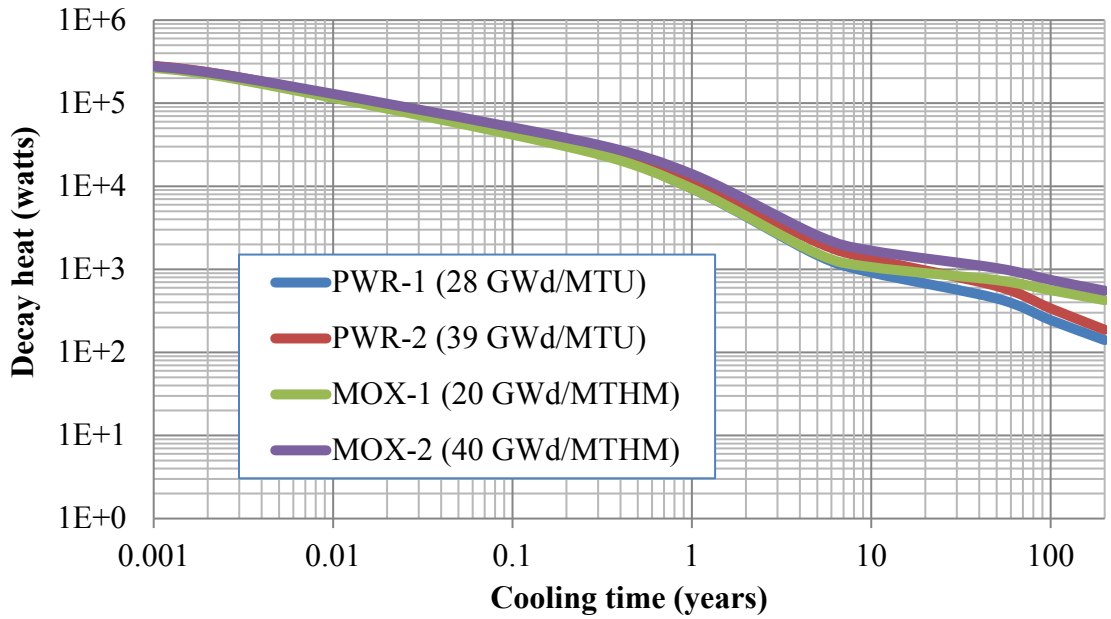

Figure 23. Decay heat as a function of cooling time for MOX assemblies.

5.4 Gamma Heat

The gamma heat is the total energy of all emitted gamma rays from decay of radionuclides in an SNF assembly. This value is the gamma component of the decay heat power. The absorbed dose rate in air is nearly proportional to the energy of the emitted photon over the energy range of 70 keV to about 4 MeV. The gamma heat is therefore closely related to the unshielded dose rate near an assembly. The results of gamma heat for each set of BWR, PWR, and MOX assemblies are shown in Figure 24, Figure 25, and Figure 26, respectively. The gamma heat decreases by four orders of magnitude in 200 years after discharge. After ~5 years of cooling time, the gamma radiation is mainly driven by the decay of ^{134}Cs (2-year half-life), ^{137}Cs (30-year half-life), and ^{154}Eu (8.6-year half-life), and the gamma radiation for each increases with increasing burnup. Therefore, the gamma heat from fuel with higher burnups is higher than that from low burnup fuels at cooling times longer than ~5 years. The results for MOX fuel are similar to those for UO_2 fuel with similar burnups.

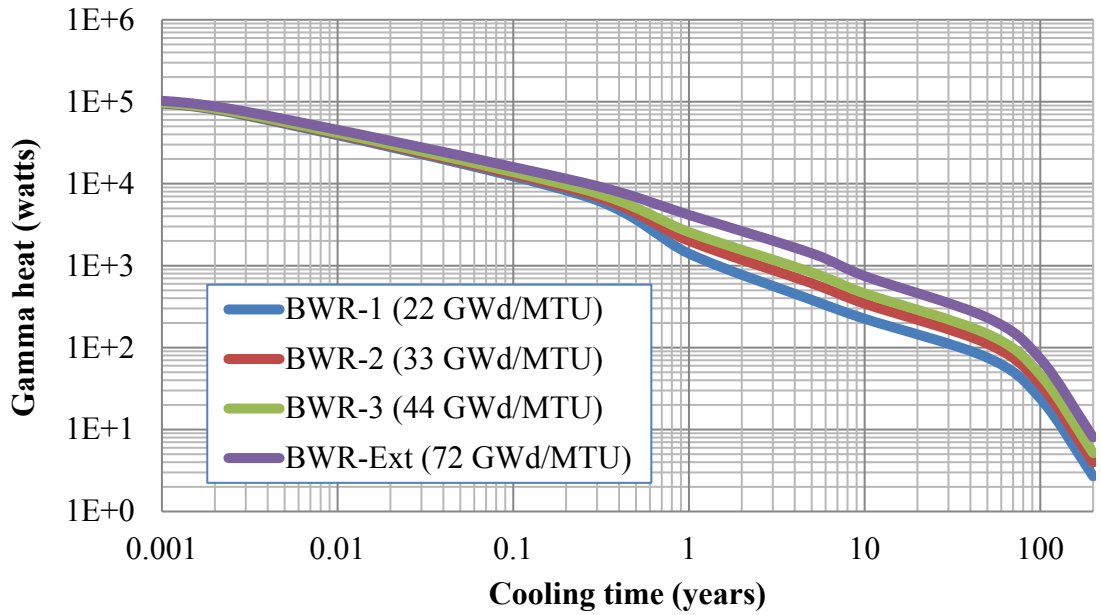

Figure 24. Gamma energy release as a function of cooling time for BWR assemblies.

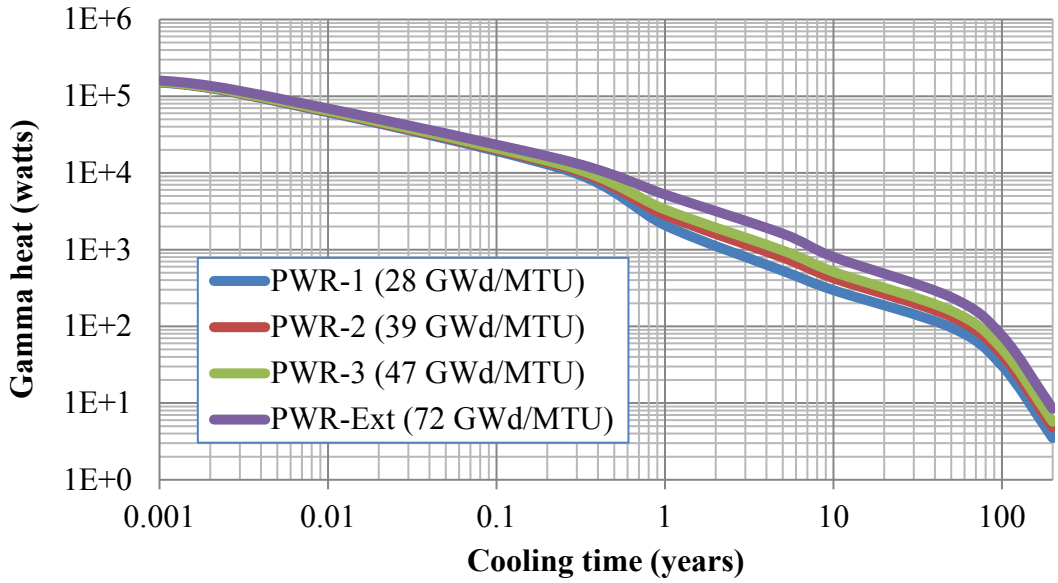

Figure 25. Gamma energy release as a function of cooling time for PWR assemblies.

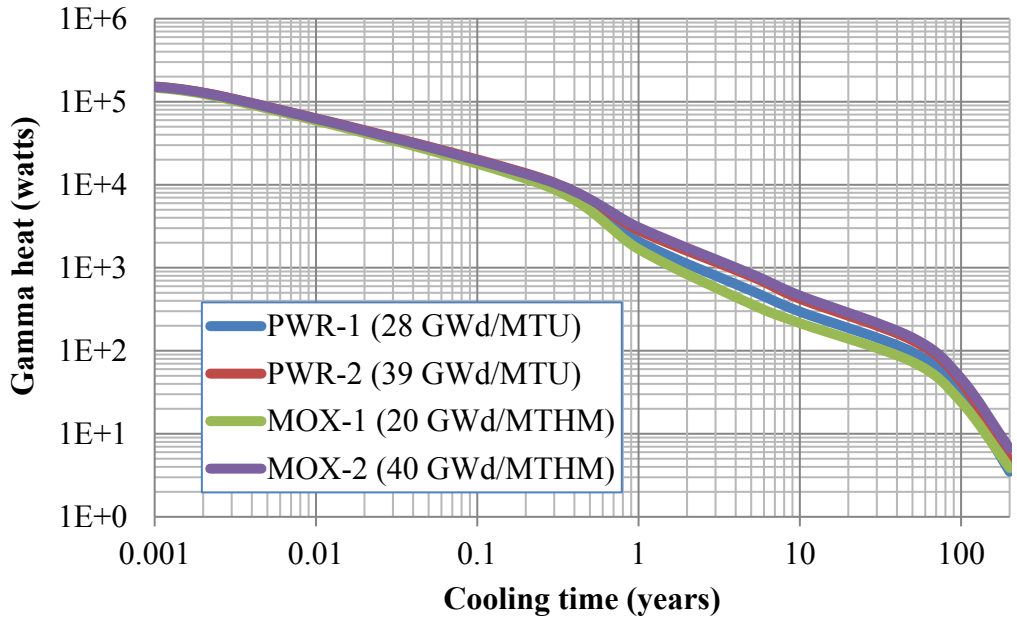

Figure 26. Gamma energy release as a function of cooling time for MOX assemblies.

5.5 Photon Emission

The results of total photon emission for each set of BWR, PWR, and MOX assemblies are shown in Figure 27, Figure 28, and Figure 29, respectively. This is the total number of photons emitted in all energy groups considered. The photon emission decreases by nearly 4 orders of magnitude in 200 years after discharge. The results are similar at short cooling times (<0.1 year) among different burnups, but they begin to diverge at longer cooling times (>1 year). The photon emission is dominated by short-lived fission products at short cooling times, then by ^{137}Cs, ^{154}Eu, and ^{134}Cs at intermediate cooling times and by mainly ^{137}Cs after ~5 years of cooling time. Generally, ^{137}Cs, ^{154}Eu, and ^{134}Cs trend with burnup and thus lead to higher photon emission in fuels with higher burnups. MOX fuel produces a similar amount of photon emission as UO_2 fuel with similar burnups.

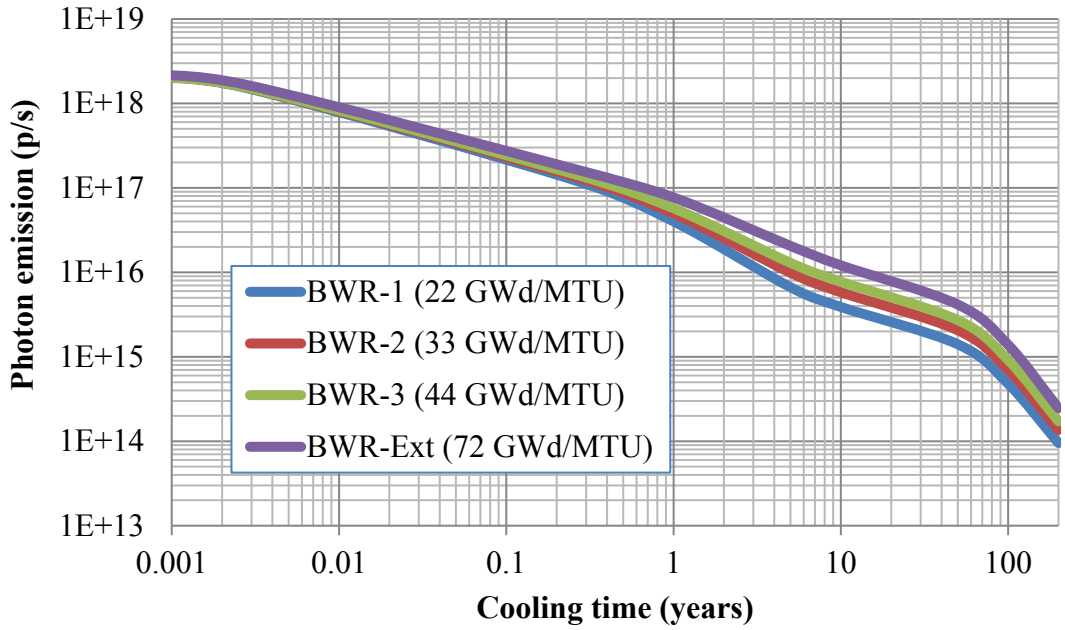

Figure 27. Photon emission as a function of cooling time for BWR assemblies.

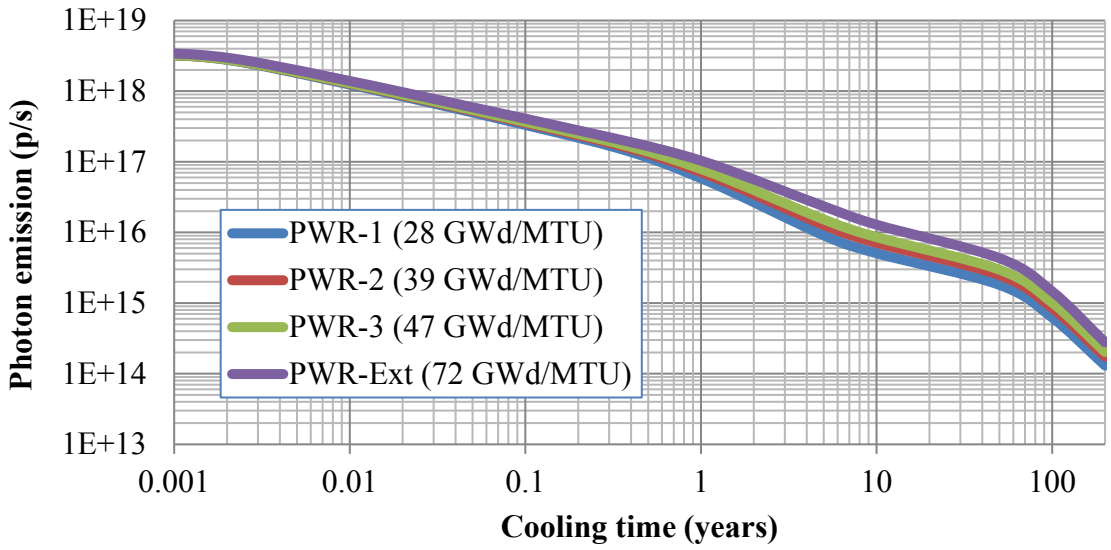

Figure 28. Photon emission as a function of cooling time for PWR assemblies.

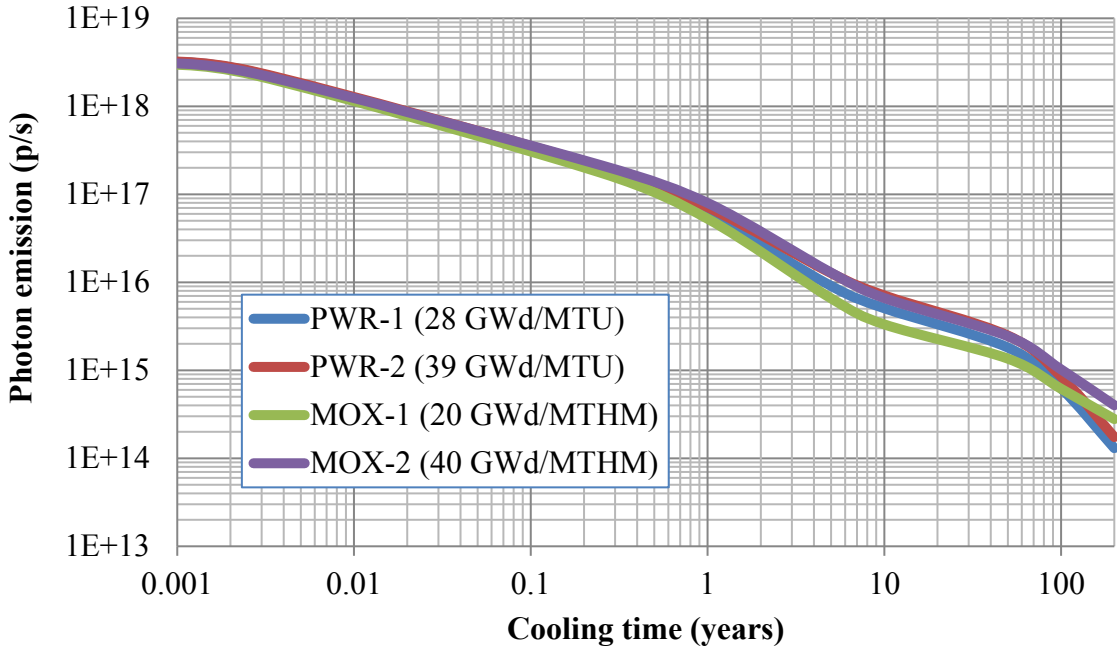

Figure 29. Photon emission as a function of cooling time for MOX assemblies.

5.6 Neutron Flux

Neutron emissions can be calculated by ORIGEN, but certain applications require knowing the neutron flux on the outer surface of the assembly or at a certain distance from the fuel. Ideally, the energy-dependent neutron emission in each fuel pin of a given assembly at different axial nodes needs to be calculated, and then neutron transport calculations should be performed to estimate the probability that an emitted neutron travels through media and reaches a particular location of interest. Such detailed calculations are beyond the scope of this project. Therefore, assumptions are made in this work to estimate the neutron flux on the outer surface of the assembly in which the neutron emission and material content were assumed to be uniform across the whole assembly. Two neutron transport models have been developed using MAVRIC (a module in SCALE) for BWR and PWR assembly designs. The PWR and MOX cases considered share the same model because they have the same geometry. In this calculation, an average neutron energy spectrum is used to represent the neutron spectra among emitted neutrons from SNF in both cases. With these calculations, factors for converting neutron emission to neutron flux (on assembly surface) are quantified and presented in Table 10.

Table 10. Conversion factor used to convert neutron emission to neutron flux on assembly surface

Fuel type	Conversion factor ($1/cm^2$)
BWR	6.05E-05
PWR	5.72E-05
MOX	5.72E-05

After multiplying the total neutron emissions by these conversion factors, the neutron flux for each case is calculated and illustrated in Figure 30, Figure 31, and Figure 32 for BWR, PWR, and MOX, respectively. Unlike the integral quantities shown previously, the neutron flux is very sensitive to burnup at all cooling times (instead of just at longer cooling times). The primary neutron emitter in SNF is ^{244}Cm (18 year half-life), and the contribution from ^{242}Cm (160-day half-life) is significant at short cooling times (<2 years). In addition, contributions from ^{240}Pu spontaneous fission and (α, n) reaction can be significant (~10%) in fuels with low burnup (<~20 GWd/MTU) [15]. Note that the content of both ^{242}Cm and ^{240}Pu (6,563-year half-life) increases nearly linearly with burnup, whereas that of ^{244}Cm increases with nearly to the 4th power of burnup. The combined dependence on burnup of these three neutron emitters explains the large difference in neutron flux among the 4 cases with different burnups in each plot. The total neutron flux decreases by less than 2 orders of magnitude (much less than other integral quantities shown previously), which is due to the relative long half-lives of ^{244}Cm and ^{240}Pu. As shown in Figure 32, MOX produces much higher neutron flux than UO_2 fuel (by a factor of ~ 5) with similar burnups, mainly because MOX fuel is initially loaded with Pu and thus has greater accumulations of higher actinides, including curium, after irradiation.

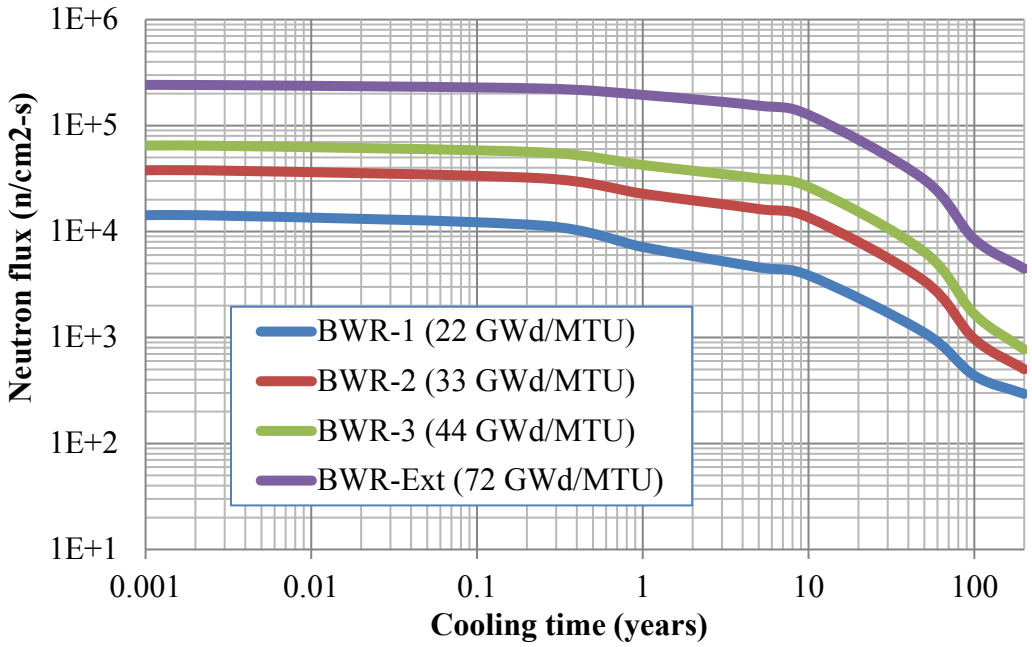

Figure 30. Total neutron flux as a function of cooling time for BWR assemblies.

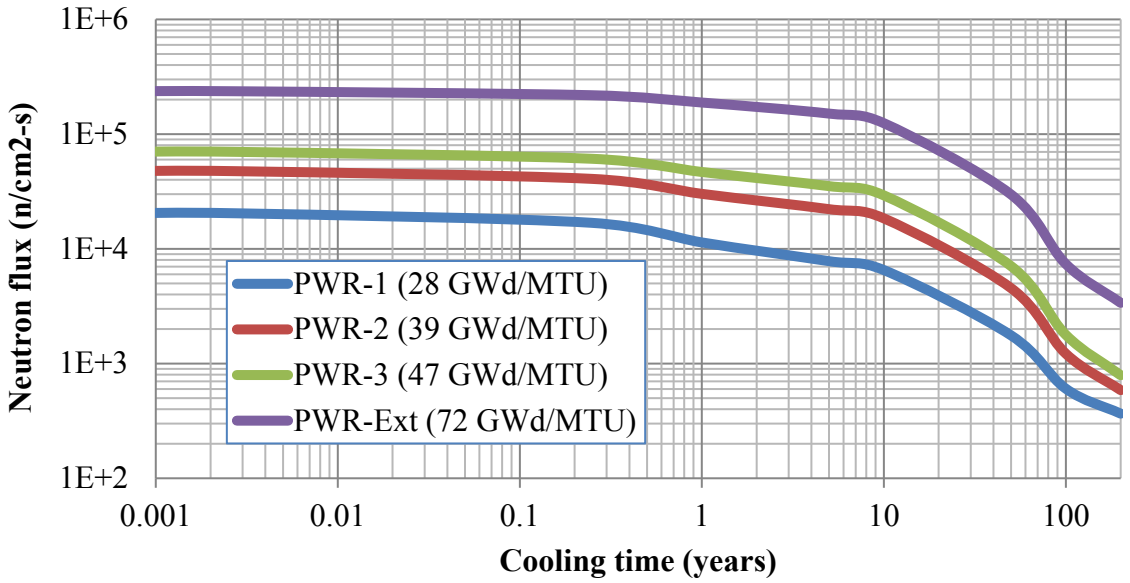

Figure 31. Total neutron flux as a function of cooling time for PWR assemblies.

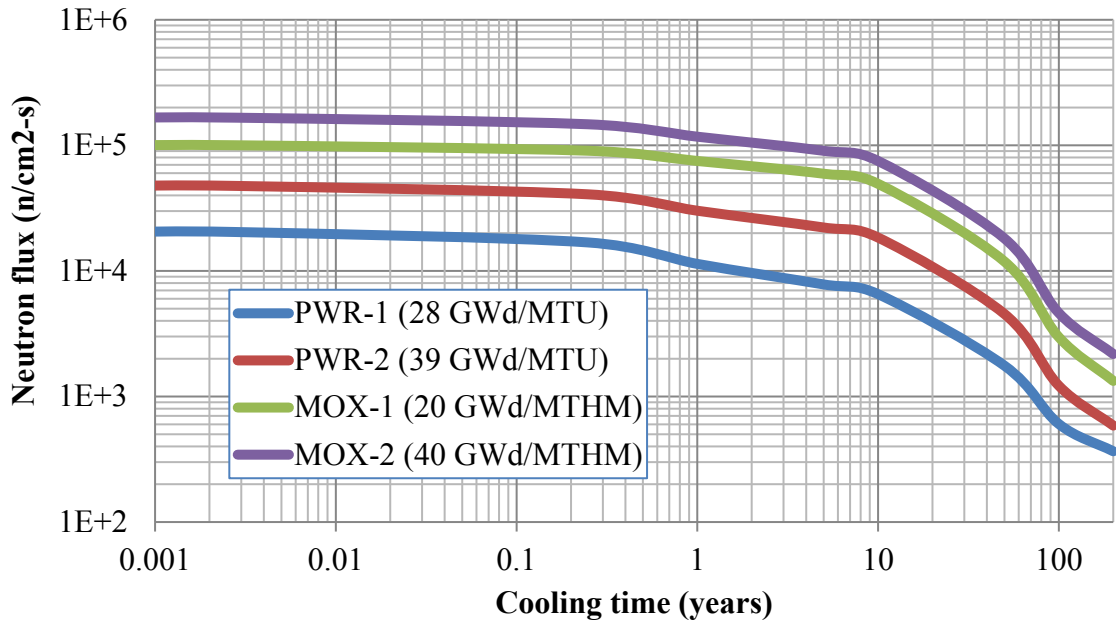

Figure 32. Total neutron flux as a function of cooling time for MOX assemblies.

5.7 Plutonium Content

The Pu totals (the sum of isotopic contents for all Pu isotopes) as calculated by ORIGEN for BWR, PWR, and MOX assemblies are illustrated in Figure 33, Figure 35, and Figure 36, respectively. Because ^{239}Pu and ^{240}Pu, the two most abundant Pu isotopes, have long half-lives, the Pu total decreases by only 10–20% in 200 years after discharge. The decrease is mainly caused by the decay of ^{241}Pu (14-year half-life). While ^{238}Pu has a relatively short half-life (87.7 years), its abundance is relatively small. As the sensitivity study shows in Section 4, the

amounts of all Pu isotopes increase with burnup, except that ^{239}Pu plateaus at high burnup. These three plots show that the cases with higher burnups have much higher Pu totals. The Pu total of MOX fuel is ~3 times higher than that of UO_2 fuel with similar burnups (Figure 36), because MOX fuel is initially loaded with a significant amount of Pu. Figure 34 shows the Pu isotopic masses from BWR-2 as a function of cooling time. As expected, ^{241}Pu and ^{238}Pu decrease significantly, and ^{239}Pu, ^{240}Pu, and ^{242}Pu remain nearly constant over the 200 years of cooling time. The combined masses of ^{239}Pu and ^{240}Pu account for more than 80% of the total Pu mass.

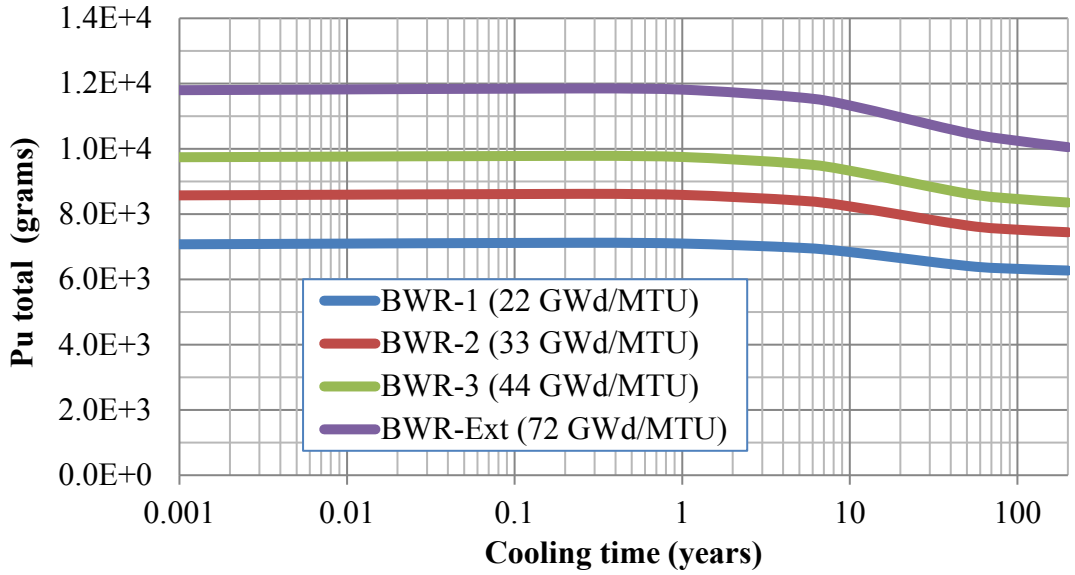

Figure 33. Pu total as a function of cooling time for BWR assemblies.

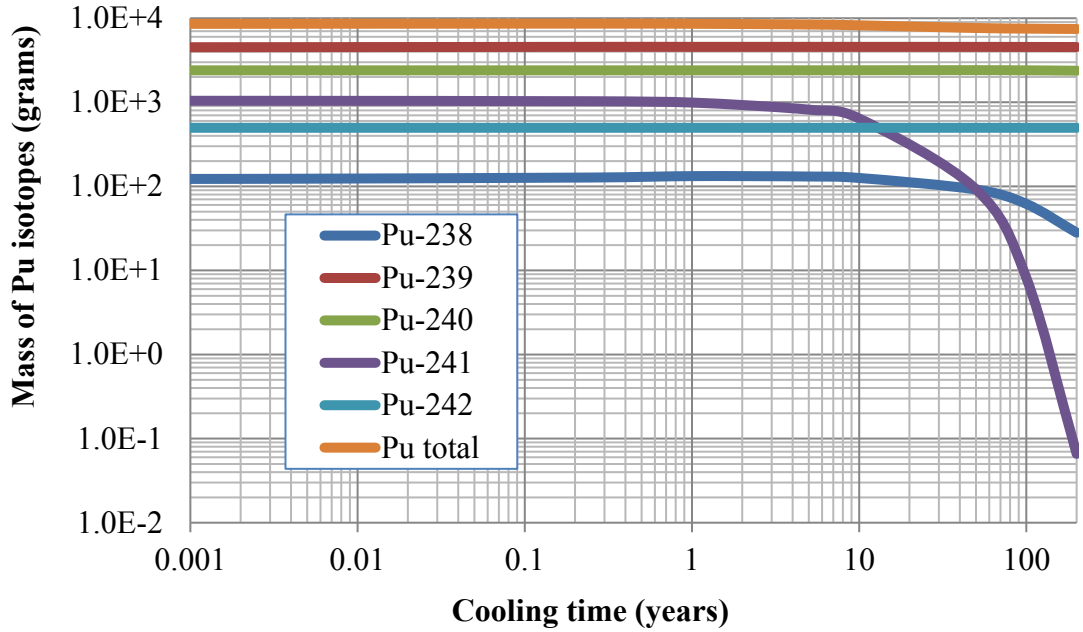

Figure 34. Pu isotopes as a function of cooling time for BWR-2.

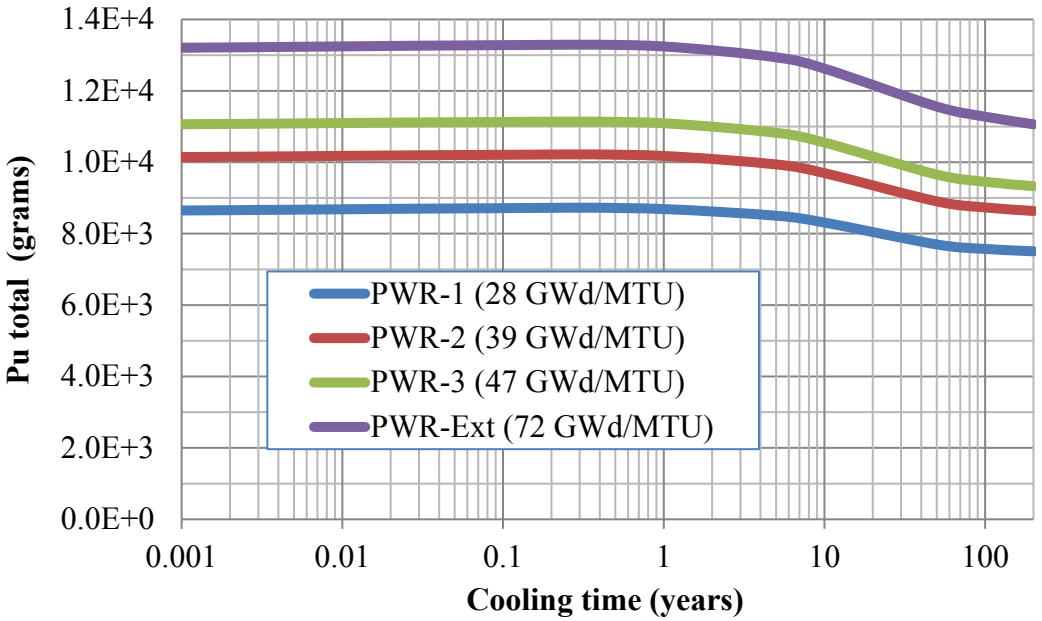

Figure 35. Pu total as a function of cooling time for PWR assemblies.

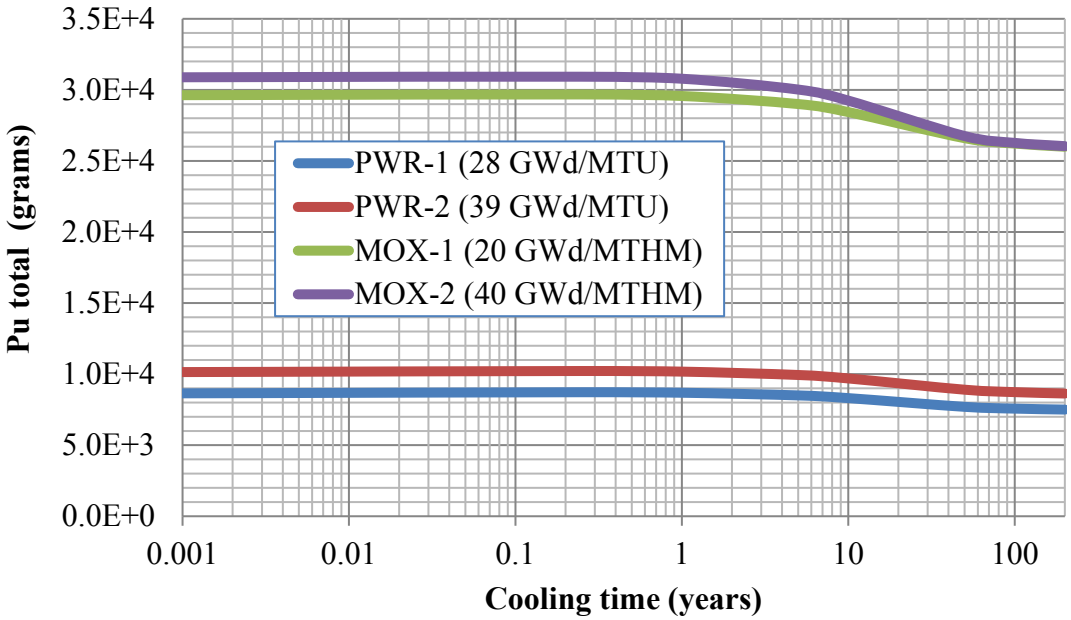

Figure 36. Pu total as a function of cooling time for PWR and MOX assemblies.

5.8 Summary

Figure 37 summarizes the integral quantities of all BWR cases analyzed in this effort. These results correspond to 5 years of cooling time, and they are normalized to the highest burnup

case. As shown, all integral quantities trend with burnup but at different rates. Gamma heat, decay heat, and photon emission have similar distributions among the four different cases. Neutron flux has the steepest dependence on burnup. Pu total has the flattest dependence on burnup, followed by activity. Table 11 includes the absolute values of the integral quantities shown in this figure.

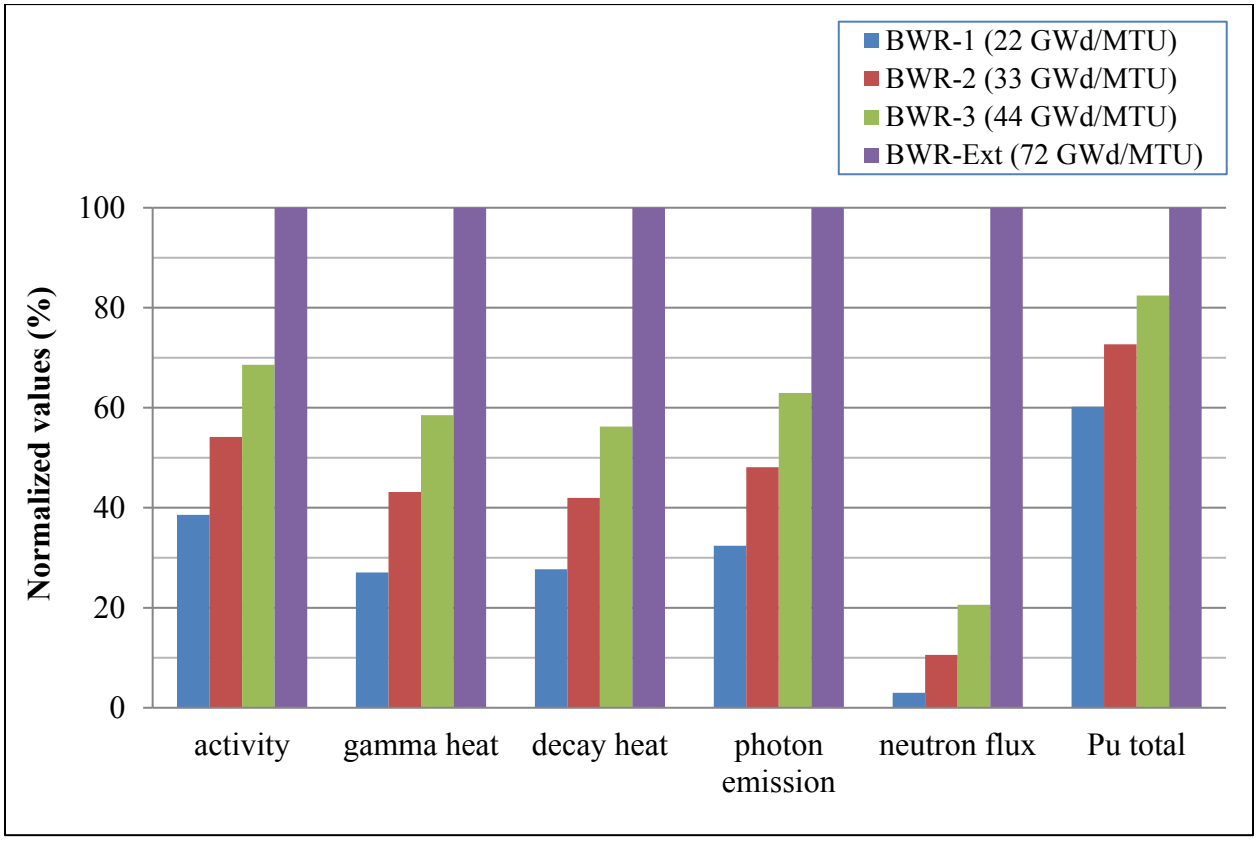

Figure 37. Summary for BWR assemblies (values normalized to the case with the highest burnup).

Table 11. Summary for BWR assemblies (values based on 1 MTU)

	Unit	BWR-1	BWR-2	BWR-3	BWR-Ext
Activity	Curies	3.82E+05	5.37E+05	6.80E+05	9.94E+05
Gamma heat	Watts	3.75E+02	5.99E+02	8.13E+02	1.39E+03
Decay heat	Watts	1.07E+03	1.63E+03	2.18E+03	3.91E+03
Photon emission	Photon/s	6.54E+15	9.74E+15	1.28E+16	2.04E+16
Neutron flux	N/cm^2-s	4.53E+03	1.62E+04	3.16E+04	1.56E+05
Pu total	Gram	6.96E+03	8.39E+03	9.50E+03	1.16E+04

Figure 38 summarizes the integral quantities of two PWR cases and two MOX cases. These results correspond to 5 years of cooling time, and they are normalized to the highest burnup MOX case. As shown, the first four integral quantities—activity, gamma heat, decay heat, and photon emission—trend with burnup, and their dependence on burnup is similar to the BWR cases. However, for neutron flux and Pu total, MOX fuel has much higher quantities than UO_2 fuel with similar burnups. Table 12 includes the absolute values of the integral quantities shown in Figure 38.

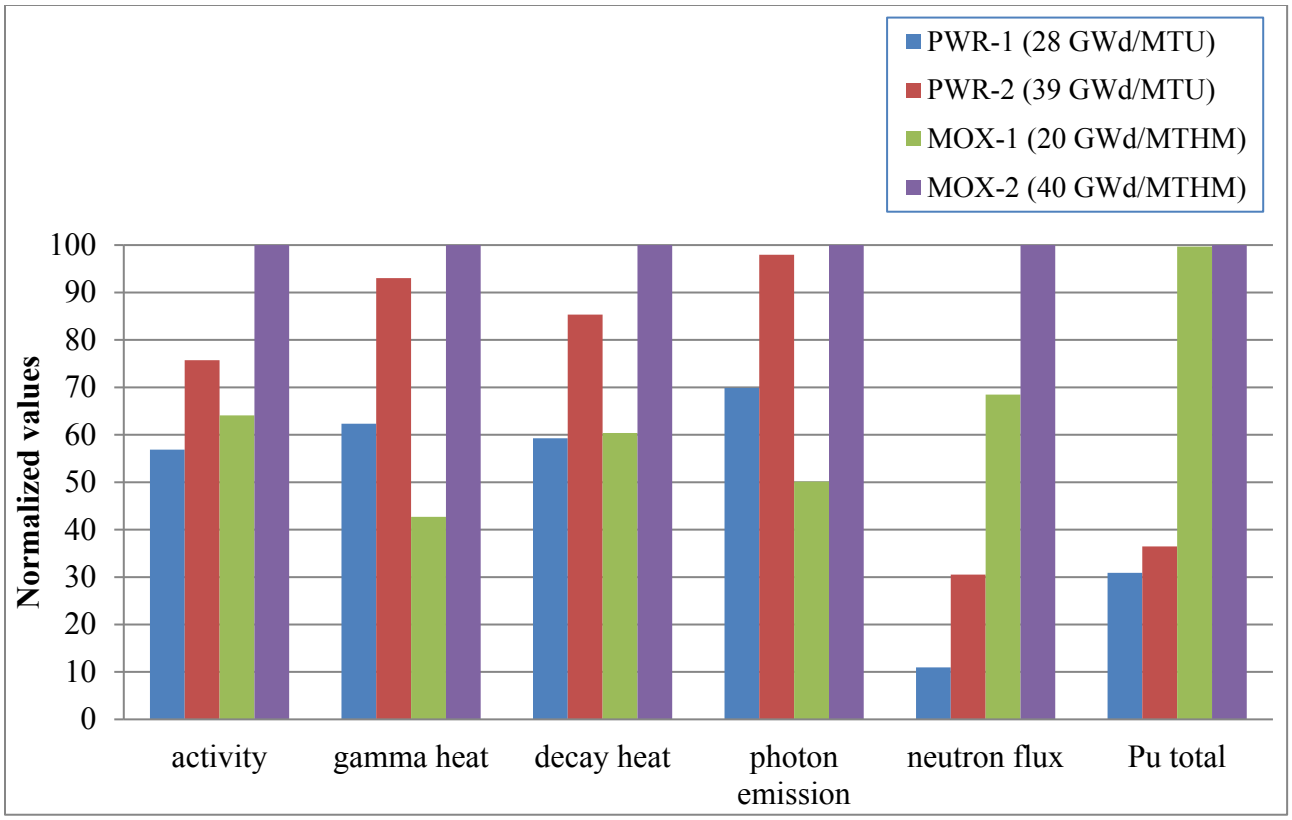

Figure 38. Summary for PWR and MOX assemblies.

Table 12. Summary for PWR and MOX assemblies (values based on 1 MTU)

	Unit	PWR-1	PWR-2	MOX-1	MOX-2
Activity	Curies	5.14E+05	6.84E+05	5.79E+05	9.03E+05
Gamma heat	Watts	5.37E+02	8.01E+02	3.68E+02	8.61E+02
Decay heat	Watts	1.49E+03	2.14E+03	1.52E+03	2.51E+03
Photon emission	Photon/s	9.06E+15	1.27E+16	6.50E+15	1.30E+16
Neutron flux	N/cm^2-s	9.04E+03	2.52E+04	5.64E+04	8.24E+04
Pu total	Gram	8.98E+03	1.06E+04	2.90E+04	2.91E+04

6 SUMMARY AND CONCLUSIONS

This report documents a survey of all US commercial SNF assemblies in the GC-859 database and provides SNF reference source terms (e.g., nuclide inventories, decay heat, and neutron/photon emission). These reference source terms were calculated using ORIGEN for cooling times up to 200 years and using representative fuel parameters based on the survey results.

Based on the survey, the following observations are made regarding to the distribution and evolution of fuel parameters among all fuel assemblies in the database:

- The GC-859 database contains over 240,000 SNF assemblies discharged up to 2013, 59% of which are BWR assemblies. There are 8 MOX assemblies, all with a PWR lattice design.
- The number of assemblies discharged each year has remained nearly constant since 1990. The average annual discharge rate is ~4,100 assemblies per year for BWR and ~3,300 assemblies per year for PWR.
- The most widely used BWR lattice configuration is 8 × 8 (historically) and 10 × 10 (currently), followed by 9 × 9 and 7 × 7. The most widely used PWR lattice configuration is 17 × 17, followed by 15 × 15, 16 × 16, and 14 × 14.
- In general, the median burnup and enrichment of the SNF has increased steadily over time, although enrichment is limited to less than 5% by NRC regulations, which in turn limits the maximum burnup a fuel assembly can achieve.
- Among all discharged assemblies, the median enrichment is 3.21% for BWR and 3.93% for PWR, and the median burnup is 35 GWd/MTU for BWR and 42 GWd/MTU for PWR.
- Approximately 84% of the BWR assemblies and 65% of the PWR assemblies have burnups less than 45 GWd/MTU. Only 19 BWR assemblies and 1307 PWR assemblies have burnups above 55 GWd/MTU, accounting for 0.54% of all BWR and PWR assemblies in the database.
- Dividing all assemblies into three groups based on their discharge year provides a good platform to assess the evolution of the considered fuel parameters. It can be seen that on average, higher enrichment and burnup are observed in more recently discharged fuel.
- The median burnup and enrichment of each group are identified and used as representative input parameters to generate the reference solutions.
- Two representative MOX cases are identified to represent the 8 MOX assemblies in the database that were discharged from two different reactors.

ORIGEN calculations were performed for each representative case for BWR, PWR and MOX assemblies using new ORIGEN libraries based on ENDF/B-VII.0 cross section data. Calculations were also performed for extended BWR and PWR burnup cases. The total activity, decay heat, gamma heat, photon emission, neutron flux, and Pu content are illustrated in this report; the activity and nuclide concentrations for a list of significant nuclides are included in the appendixes. The following observations can be made regarding these results:

- Neutron emission/flux has the highest dependence on fuel burnup, followed by activity, gamma heat, decay heat, photon emission, and Pu total. Gamma heat, decay heat, and photon emission have similar dependence on burnup.
- Activity, gamma heat, decay heat and photon emission all decrease rapidly with cooling time by over 3 orders of magnitude in 200 years after discharge.

- Neutron flux decreases by nearly 2 orders of magnitude over 200 years due to the relatively longer half-lives of the top emitters. Pu total decreases by only 10–20% in 200 years after discharge, although ^{238}Pu and ^{241}Pu decease dramatically over time.
- MOX fuel produces results similar to UO_2 fuel in activity, gamma heat, photon emission, and decay heat. However, there is much more Pu and higher neutron emission/flux in spent MOX fuel than in UO_2 fuel.

The survey of the GC-859 database provides a complete picture for the distribution and evolution of the fuel parameters of fuel assemblies in the US commercial fuel inventory. It helps the regulator and other stakeholders to form overall strategies towards the final disposal of US SNF. The reference solutions generated in this work provide specific values for each of the integral quantities under representative scenarios, and these quantities are important considerations in the design, regulation, and operations of the SNF storage, transportation, and disposal systems.

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APPENDIX A. BWR RESULTS

Table A.1. Total activity (Ci/MTU) for BWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
BWR-1 (22GWd/MTU)	4.64E+07	3.45E+07	4.54E+06	1.58E+06	3.82E+05	2.61E+05	8.50E+04	2.71E+04	5.23E+03
BWR-2 (33GWd/MTU)	4.73E+07	3.53E+07	5.01E+06	1.94E+06	5.37E+05	3.77E+05	1.24E+05	3.96E+04	7.48E+03
BWR-3 (44GWd/MTU)	4.74E+07	3.54E+07	5.35E+06	2.20E+06	6.80E+05	4.88E+05	1.63E+05	5.21E+04	9.56E+03
BWR-Ext (72GWd/MTU)	5.02E+07	3.78E+07	5.95E+06	2.76E+06	9.94E+05	7.29E+05	2.49E+05	8.00E+04	1.42E+04

Table A.2. Total gamma heat (W/MTU) for BWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
BWR-1 (22GWd/MTU)	1.04E+05	7.04E+04	7.09E+03	1.36E+03	3.75E+02	2.23E+02	7.52E+01	2.39E+01	2.70E+00
BWR-2 (33GWd/MTU)	1.06E+05	7.20E+04	7.84E+03	1.96E+03	5.99E+02	3.41E+02	1.11E+02	3.54E+01	3.96E+00
BWR-3 (44GWd/MTU)	1.07E+05	7.31E+04	8.53E+03	2.51E+03	8.13E+02	4.56E+02	1.46E+02	4.64E+01	5.17E+00
BWR-Ext (72GWd/MTU)	1.12E+05	7.83E+04	1.03E+04	4.09E+03	1.39E+03	7.42E+02	2.31E+02	7.30E+01	8.02E+00

Table A.3. Total decay heat (W/MTU) for BWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
BWR-1 (22GWd/MTU)	1.97E+05	1.30E+05	1.80E+04	6.23E+03	1.07E+03	6.91E+02	3.36E+02	1.82E+02	1.04E+02
BWR-2 (33GWd/MTU)	2.01E+05	1.35E+05	2.07E+04	7.95E+03	1.63E+03	1.07E+03	5.05E+02	2.68E+02	1.46E+02
BWR-3 (44GWd/MTU)	2.03E+05	1.37E+05	2.27E+04	9.29E+03	2.18E+03	1.48E+03	6.78E+02	3.50E+02	1.83E+02
BWR-Ext (72GWd/MTU)	2.13E+05	1.48E+05	2.76E+04	1.31E+04	3.91E+03	2.71E+03	1.15E+03	5.57E+02	2.66E+02

Table A.4. Total photon emission (photon/sec/MTU) for BWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
BWR-1 (22GWd/MTU)	2.11E+18	1.53E+18	1.23E+17	3.85E+16	6.54E+15	3.87E+15	1.40E+15	4.80E+14	9.67E+13
BWR-2 (33GWd/MTU)	2.14E+18	1.56E+18	1.36E+17	4.85E+16	9.74E+15	5.78E+15	2.06E+15	7.00E+14	1.38E+14
BWR-3 (44GWd/MTU)	2.13E+18	1.56E+18	1.46E+17	5.61E+16	1.28E+16	7.69E+15	2.71E+15	9.16E+14	1.74E+14
BWR-Ext (72GWd/MTU)	2.27E+18	1.68E+18	1.69E+17	7.60E+16	2.04E+16	1.21E+16	4.15E+15	1.39E+15	2.48E+14

Table A.5. Total neutron emission (neutron/sec/MTU) for BWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
BWR-1 (22GWd/MTU)	2.51E+08	2.51E+08	2.00E+08	1.21E+08	7.49E+07	6.29E+07	1.82E+07	7.29E+06	4.94E+06
BWR-2 (33GWd/MTU)	6.48E+08	6.47E+08	5.43E+08	3.80E+08	2.68E+08	2.23E+08	5.63E+07	1.62E+07	8.48E+06
BWR-3 (44GWd/MTU)	1.09E+09	1.09E+09	9.41E+08	7.05E+08	5.23E+08	4.34E+08	1.06E+08	2.79E+07	1.33E+07
BWR-Ext (72GWd/MTU)	4.06E+09	4.06E+09	3.76E+09	3.27E+09	2.58E+09	2.12E+09	5.14E+08	1.38E+08	7.14E+07

Table A.6. Neutron flux (neutron/cm^2-sec/MTU) for BWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
BWR-1 (22GWd/MTU)	1.52E+04	1.52E+04	1.21E+04	7.32E+03	4.53E+03	3.81E+03	1.10E+03	4.41E+02	2.99E+02
BWR-2 (33GWd/MTU)	3.92E+04	3.91E+04	3.29E+04	2.30E+04	1.62E+04	1.35E+04	3.41E+03	9.80E+02	5.13E+02
BWR-3 (44GWd/MTU)	6.59E+04	6.59E+04	5.69E+04	4.27E+04	3.16E+04	2.63E+04	6.41E+03	1.69E+03	8.05E+02
BWR-Ext (72GWd/MTU)	2.46E+05	2.46E+05	2.27E+05	1.98E+05	1.56E+05	1.28E+05	3.11E+04	8.35E+03	4.32E+03

Table A.7. Pu total (gram/MTU) for BWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
BWR-1 (22GWd/MTU)	7.06E+03	7.07E+03	7.11E+03	7.09E+03	6.96E+03	6.82E+03	6.38E+03	6.29E+03	6.24E+03
BWR-2 (33GWd/MTU)	8.55E+03	8.56E+03	8.60E+03	8.57E+03	8.39E+03	8.21E+03	7.61E+03	7.48E+03	7.40E+03
BWR-3 (44GWd/MTU)	9.70E+03	9.71E+03	9.75E+03	9.71E+03	9.50E+03	9.29E+03	8.57E+03	8.41E+03	8.30E+03
BWR-Ext (72GWd/MTU)	1.19E+04	1.19E+04	1.19E+04	1.19E+04	1.16E+04	1.14E+04	1.05E+04	1.03E+04	1.01E+04

Table A.8. Nuclide activities (Ci/MTU) for BWR-1 (22 GWd/MTU)

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	8.44E+01	8.47E+01	1.16E+02	2.12E+02	6.61E+02	1.11E+03	2.40E+03	2.43E+03	2.09E+03
ba137m	6.64E+04	6.64E+04	6.61E+04	6.49E+04	5.92E+04	5.28E+04	2.10E+04	6.64E+03	6.64E+02
ba139	1.08E+05	7.96E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.11E+06	1.06E+06	8.43E+03	2.72E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.06E+06	1.04E+06	1.56E+05	4.44E+02	1.34E-11	1.69E-28	0.00E+00	0.00E+00	0.00E+00
ce143	8.87E+05	5.95E+05	2.05E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	7.81E+05	7.80E+05	6.28E+05	3.22E+05	9.22E+03	1.09E+02	4.08E-14	0.00E+00	0.00E+00
cm242	2.30E+04	2.29E+04	1.58E+04	4.89E+03	1.15E+01	1.67E+00	1.37E+00	1.07E+00	6.56E-01
cm244	6.19E+02	6.19E+02	6.14E+02	5.96E+02	5.12E+02	4.22E+02	9.15E+01	1.35E+01	2.95E-01
cs134	7.40E+04	7.39E+04	6.81E+04	5.29E+04	1.38E+04	2.59E+03	3.85E-03	2.01E-10	5.44E-25
cs136	2.16E+04	2.07E+04	1.91E+02	9.77E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	7.02E+04	7.02E+04	6.98E+04	6.86E+04	6.25E+04	5.57E+04	2.22E+04	7.02E+03	7.01E+02
i131	6.56E+05	6.19E+05	2.92E+02	1.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	9.22E+05	7.75E+05	3.37E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.16E+06	6.17E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	8.37E+04	3.31E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	7.52E+05	1.01E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	6.76E+03	6.76E+03	6.65E+03	6.34E+03	4.90E+03	3.55E+03	2.70E+02	1.08E+01	1.72E-02
kr85m	7.47E+04	3.94E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
kr87	2.08E+04	6.57E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.21E+05	1.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.15E+06	1.13E+06	9.71E+03	3.13E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	4.76E+05	1.65E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.17E+05	2.00E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.15E+06	9.39E+05	1.69E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.04E+06	1.04E+06	6.60E+05	4.36E+04	6.10E-03	1.60E-11	0.00E+00	0.00E+00	0.00E+00
nb97	9.44E+05	4.04E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	8.40E+05	3.82E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	4.14E+05	3.93E+05	1.43E+03	4.12E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
np239	1.36E+07	1.08E+07	7.79E+00	7.79E+00	7.79E+00	7.79E+00	7.76E+00	7.72E+00	7.65E+00
pr143	9.77E+05	9.67E+05	1.10E+04	8.70E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	7.81E+05	7.80E+05	6.28E+05	3.22E+05	9.22E+03	1.09E+02	4.08E-14	0.00E+00	0.00E+00
pr144m	7.46E+03	7.45E+03	6.00E+03	3.07E+03	8.80E+01	1.04E+00	3.89E-16	0.00E+00	0.00E+00
pu238	9.05E+02	9.07E+02	9.48E+02	9.98E+02	9.91E+02	9.53E+02	6.95E+02	4.69E+02	2.13E+02
pu239	2.55E+02	2.56E+02	2.59E+02	2.59E+02	2.59E+02	2.59E+02	2.59E+02	2.58E+02	2.58E+02
pu240	4.17E+02	4.17E+02	4.17E+02	4.17E+02	4.17E+02	4.17E+02	4.16E+02	4.14E+02	4.10E+02
pu241	8.16E+04	8.16E+04	8.06E+04	7.77E+04	6.40E+04	5.03E+04	7.23E+03	6.41E+02	5.07E+00
rb86	8.48E+02	8.24E+02	3.00E+01	1.08E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.36E+05	1.31E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.05E+06	1.03E+06	2.14E+05	1.66E+03	1.05E-08	1.06E-22	0.00E+00	0.00E+00	0.00E+00
rh105	6.76E+05	4.99E+05	3.28E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	3.54E+05	3.54E+05	2.99E+05	1.79E+05	1.18E+04	3.92E+02	5.92E-10	9.89E-25	0.00E+00
ru103	1.06E+06	1.04E+06	2.16E+05	1.68E+03	1.07E-08	1.07E-22	0.00E+00	0.00E+00	0.00E+00
ru105	3.61E+05	1.86E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	3.54E+05	3.54E+05	2.99E+05	1.79E+05	1.18E+04	3.92E+02	5.92E-10	9.89E-25	0.00E+00
sr89	5.69E+05	5.63E+05	1.66E+05	3.82E+03	7.66E-06	1.03E-16	0.00E+00	0.00E+00	0.00E+00
sr90	5.02E+04	5.02E+04	4.99E+04	4.90E+04	4.45E+04	3.94E+04	1.51E+04	4.52E+03	4.08E+02
sr91	5.10E+05	1.30E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.22E+05	1.72E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
tc99m	1.05E+06	9.02E+05	1.63E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	5.88E+04	5.45E+04	2.58E+03	4.49E+02	4.17E-02	3.80E-07	0.00E+00	0.00E+00	0.00E+00
te127m	4.28E+03	4.30E+03	2.63E+03	4.58E+02	4.25E-02	3.88E-07	0.00E+00	0.00E+00	0.00E+00
te129	1.19E+05	2.47E+04	3.11E+03	1.07E+01	8.88E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	3.14E+04	3.09E+04	4.93E+03	1.69E+01	1.41E-12	6.28E-29	0.00E+00	0.00E+00	0.00E+00
te131	3.18E+04	2.08E+04	9.53E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.18E+05	7.92E+04	3.63E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	8.93E+05	7.52E+05	3.27E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	1.27E+06	1.23E+06	1.07E+01	1.74E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	5.23E+05	3.20E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	1.29E+05	1.74E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	5.23E+04	5.19E+04	4.99E+04	4.90E+04	4.45E+04	3.95E+04	1.51E+04	4.53E+03	4.08E+02
y91	7.45E+05	7.41E+05	2.58E+05	9.94E+03	3.06E-04	1.25E-13	0.00E+00	0.00E+00	0.00E+00
y91m	3.28E+05	8.36E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	5.57E+05	2.54E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	6.64E+05	1.82E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.05E+06	1.04E+06	3.97E+05	2.02E+04	2.77E-03	7.27E-12	0.00E+00	0.00E+00	0.00E+00
zr97	8.83E+05	4.02E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total[a]	4.64E+07	3.45E+07	4.54E+06	1.58E+06	3.82E+05	2.61E+05	8.50E+04	2.71E+04	5.23E+03
Subtotal[b]	93.5%	95.1%	96.5%	92.4%	88.5%	95.0%	99.6%	99.3%	98.7%

[a] Total includes contributions from all actinides and fission products in the fuel.
[b] Subtotal is the percent contribution of nuclides listed in the table to the total.

Table A.9. Nuclide activities (Ci/MTU) for BWR-2 (33 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	1.47E+02	1.48E+02	1.91E+02	3.20E+02	9.29E+02	1.54E+03	3.29E+03	3.32E+03	2.85E+03
ba137m	9.83E+04	9.83E+04	9.77E+04	9.60E+04	8.76E+04	7.81E+04	3.11E+04	9.82E+03	9.82E+02
ba139	1.07E+05	7.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.10E+06	1.05E+06	8.33E+03	2.69E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.05E+06	1.03E+06	1.54E+05	4.38E+02	1.32E-11	1.67E-28	0.00E+00	0.00E+00	0.00E+00
ce143	8.70E+05	5.84E+05	2.01E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	8.37E+05	8.36E+05	6.73E+05	3.45E+05	9.88E+03	1.17E+02	4.37E-14	0.00E+00	0.00E+00
cm242	4.60E+04	4.59E+04	3.15E+04	9.79E+03	2.27E+01	2.96E+00	2.42E+00	1.89E+00	1.16E+00
cm244	2.29E+03	2.29E+03	2.27E+03	2.20E+03	1.89E+03	1.56E+03	3.38E+02	4.99E+01	1.09E+00
cs134	1.35E+05	1.35E+05	1.25E+05	9.67E+04	2.53E+04	4.73E+03	7.04E-03	3.67E-10	9.95E-25
cs136	3.20E+04	3.07E+04	2.82E+02	1.45E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.04E+05	1.04E+05	1.03E+05	1.01E+05	9.25E+04	8.24E+04	3.28E+04	1.04E+04	1.04E+03
i131	6.58E+05	6.21E+05	2.92E+02	1.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	9.22E+05	7.75E+05	3.37E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.16E+06	6.14E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	8.27E+04	3.26E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	7.50E+05	1.01E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	9.55E+03	9.55E+03	9.40E+03	8.96E+03	6.92E+03	5.02E+03	3.82E+02	1.53E+01	2.44E-02
kr85m	7.07E+04	3.74E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	1.95E+04	6.18E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.14E+05	1.10E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.15E+06	1.13E+06	9.60E+03	3.10E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	4.70E+05	1.63E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.16E+05	1.97E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.14E+06	9.36E+05	1.68E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.04E+06	1.04E+06	6.50E+05	4.29E+04	5.99E-03	1.58E-11	0.00E+00	0.00E+00	0.00E+00
nb97	9.32E+05	3.99E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	8.29E+05	3.77E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	4.12E+05	3.92E+05	1.42E+03	4.11E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
np239	1.36E+07	1.07E+07	1.96E+01	1.96E+01	1.96E+01	1.96E+01	1.96E+01	1.95E+01	1.93E+01
pr143	9.57E+05	9.48E+05	1.08E+04	8.53E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	8.37E+05	8.36E+05	6.73E+05	3.45E+05	9.88E+03	1.17E+02	4.37E-14	0.00E+00	0.00E+00
pr144m	7.99E+03	7.98E+03	6.43E+03	3.29E+03	9.43E+01	1.11E+00	4.17E-16	0.00E+00	0.00E+00
pu238	2.11E+03	2.11E+03	2.19E+03	2.29E+03	2.27E+03	2.18E+03	1.59E+03	1.07E+03	4.87E+02
pu239	2.78E+02	2.79E+02	2.82E+02	2.82E+02	2.82E+02	2.82E+02	2.82E+02	2.81E+02	2.80E+02
pu240	5.38E+02	5.38E+02	5.38E+02	5.38E+02	5.39E+02	5.39E+02	5.41E+02	5.38E+02	5.33E+02
pu241	1.11E+05	1.11E+05	1.09E+05	1.05E+05	8.68E+04	6.81E+04	9.80E+03	8.69E+02	7.02E+00
rb86	1.30E+03	1.26E+03	4.60E+01	1.66E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.27E+05	1.23E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.09E+06	1.07E+06	2.22E+05	1.73E+03	1.09E-08	1.10E-22	0.00E+00	0.00E+00	0.00E+00
rh105	7.17E+05	5.29E+05	3.47E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	4.48E+05	4.48E+05	3.79E+05	2.27E+05	1.49E+04	4.97E+02	7.49E-10	1.25E-24	0.00E+00
ru103	1.10E+06	1.08E+06	2.25E+05	1.75E+03	1.11E-08	1.11E-22	0.00E+00	0.00E+00	0.00E+00
ru105	3.82E+05	1.97E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	4.48E+05	4.48E+05	3.79E+05	2.27E+05	1.49E+04	4.97E+02	7.49E-10	1.25E-24	0.00E+00
sr89	5.34E+05	5.28E+05	1.56E+05	3.58E+03	7.18E-06	9.64E-17	0.00E+00	0.00E+00	0.00E+00
sr90	7.27E+04	7.27E+04	7.22E+04	7.09E+04	6.44E+04	5.71E+04	2.18E+04	6.55E+03	5.91E+02
sr91	4.82E+05	1.23E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.12E+05	1.64E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.05E+06	8.99E+05	1.62E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	6.02E+04	5.58E+04	2.70E+03	4.69E+02	4.36E-02	3.97E-07	0.00E+00	0.00E+00	0.00E+00
te127m	4.48E+03	4.51E+03	2.75E+03	4.79E+02	4.45E-02	4.06E-07	0.00E+00	0.00E+00	0.00E+00
te129	1.22E+05	2.52E+04	3.18E+03	1.09E+01	9.08E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	3.21E+04	3.16E+04	5.04E+03	1.73E+01	1.44E-12	6.42E-29	0.00E+00	0.00E+00	0.00E+00
te131	3.20E+04	2.10E+04	9.60E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.19E+05	7.99E+04	3.66E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	8.92E+05	7.52E+05	3.27E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	1.27E+06	1.23E+06	1.07E+01	1.73E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	5.33E+05	3.22E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
xe135m	1.29E+05	1.73E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	7.59E+04	7.53E+04	7.23E+04	7.10E+04	6.45E+04	5.71E+04	2.18E+04	6.55E+03	5.91E+02
y91	7.08E+05	7.04E+05	2.46E+05	9.45E+03	2.91E-04	1.19E-13	0.00E+00	0.00E+00	0.00E+00
y91m	3.10E+05	7.90E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	5.31E+05	2.42E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	6.39E+05	1.75E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.03E+06	1.02E+06	3.90E+05	1.99E+04	2.72E-03	7.15E-12	0.00E+00	0.00E+00	0.00E+00
zr97	8.71E+05	3.97E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	4.73E+07	3.53E+07	5.01E+06	1.94E+06	5.37E+05	3.77E+05	1.24E+05	3.96E+04	7.48E+03
Subtotal	92.4%	94.1%	96.2%	92.3%	90.1%	95.5%	100.0%	99.7%	98.7%

Table A.10. Nuclide activities (Ci/MTU) for BWR-3 (44 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	2.10E+02	2.11E+02	2.62E+02	4.15E+02	1.14E+03	1.86E+03	3.93E+03	3.96E+03	3.40E+03
ba137m	1.29E+05	1.29E+05	1.28E+05	1.26E+05	1.15E+05	1.03E+05	4.08E+04	1.29E+04	1.29E+03
ba139	1.07E+05	7.89E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.10E+06	1.05E+06	8.33E+03	2.69E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.04E+06	1.03E+06	1.54E+05	4.38E+02	1.32E-11	1.67E-28	0.00E+00	0.00E+00	0.00E+00
ce143	8.71E+05	5.84E+05	2.02E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	8.64E+05	8.62E+05	6.94E+05	3.56E+05	1.02E+04	1.20E+02	4.51E-14	0.00E+00	0.00E+00
cm242	6.53E+04	6.53E+04	4.48E+04	1.39E+04	3.22E+01	4.23E+00	3.47E+00	2.71E+00	1.66E+00
cm244	4.48E+03	4.48E+03	4.43E+03	4.31E+03	3.70E+03	3.05E+03	6.61E+02	9.77E+01	2.13E+00
cs134	1.94E+05	1.94E+05	1.79E+05	1.39E+05	3.63E+04	6.79E+03	1.01E-02	5.27E-10	1.43E-24
cs136	4.35E+04	4.17E+04	3.84E+02	1.97E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.36E+05	1.36E+05	1.36E+05	1.33E+05	1.22E+05	1.08E+05	4.31E+04	1.36E+04	1.36E+03
i131	6.55E+05	6.18E+05	2.91E+02	1.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	9.19E+05	7.72E+05	3.36E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.15E+06	6.13E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	8.28E+04	3.27E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	7.49E+05	1.01E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.24E+04	1.24E+04	1.22E+04	1.16E+04	8.98E+03	6.51E+03	4.95E+02	1.98E+01	3.16E-02
kr85m	7.08E+04	3.74E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	1.95E+04	6.18E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.14E+05	1.10E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.16E+06	1.13E+06	9.59E+03	3.10E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	4.69E+05	1.63E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.15E+05	1.97E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.14E+06	9.36E+05	1.68E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.04E+06	1.03E+06	6.50E+05	4.28E+04	5.98E-03	1.57E-11	0.00E+00	0.00E+00	0.00E+00
nb97	9.31E+05	3.98E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	8.28E+05	3.77E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	4.14E+05	3.94E+05	1.43E+03	4.13E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
np239	1.30E+07	1.03E+07	3.10E+01	3.10E+01	3.10E+01	3.09E+01	3.08E+01	3.07E+01	3.04E+01
pr143	9.58E+05	9.49E+05	1.08E+04	8.54E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	8.64E+05	8.62E+05	6.95E+05	3.56E+05	1.02E+04	1.20E+02	4.51E-14	0.00E+00	0.00E+00
pr144m	8.25E+03	8.23E+03	6.63E+03	3.40E+03	9.74E+01	1.15E+00	4.30E-16	0.00E+00	0.00E+00
pu238	3.69E+03	3.69E+03	3.80E+03	3.94E+03	3.88E+03	3.73E+03	2.72E+03	1.84E+03	8.34E+02
pu239	3.01E+02	3.02E+02	3.05E+02	3.05E+02	3.05E+02	3.05E+02	3.04E+02	3.04E+02	3.03E+02
pu240	6.11E+02	6.11E+02	6.11E+02	6.11E+02	6.13E+02	6.14E+02	6.18E+02	6.17E+02	6.10E+02
pu241	1.31E+05	1.31E+05	1.30E+05	1.25E+05	1.03E+05	8.07E+04	1.16E+04	1.03E+03	8.54E+00
rb86	1.75E+03	1.70E+03	6.20E+01	2.23E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.27E+05	1.23E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.09E+06	1.07E+06	2.22E+05	1.73E+03	1.09E-08	1.10E-22	0.00E+00	0.00E+00	0.00E+00
rh105	7.20E+05	5.31E+05	3.49E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	4.85E+05	4.84E+05	4.10E+05	2.46E+05	1.62E+04	5.38E+02	8.11E-10	1.36E-24	0.00E+00
ru103	1.10E+06	1.08E+06	2.25E+05	1.75E+03	1.11E-08	1.11E-22	0.00E+00	0.00E+00	0.00E+00
ru105	3.82E+05	1.96E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	4.85E+05	4.84E+05	4.10E+05	2.46E+05	1.62E+04	5.38E+02	8.11E-10	1.36E-24	0.00E+00
sr89	5.32E+05	5.27E+05	1.55E+05	3.57E+03	7.16E-06	9.61E-17	0.00E+00	0.00E+00	0.00E+00
sr90	9.68E+04	9.68E+04	9.62E+04	9.45E+04	8.58E+04	7.61E+04	2.91E+04	8.73E+03	7.87E+02
sr91	4.82E+05	1.23E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.12E+05	1.64E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.05E+06	8.99E+05	1.62E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	5.99E+04	5.54E+04	2.79E+03	4.86E+02	4.52E-02	4.12E-07	0.00E+00	0.00E+00	0.00E+00
te127m	4.66E+03	4.69E+03	2.85E+03	4.96E+02	4.61E-02	4.20E-07	0.00E+00	0.00E+00	0.00E+00
te129	1.21E+05	2.50E+04	3.16E+03	1.09E+01	9.01E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	3.18E+04	3.14E+04	5.00E+03	1.72E+01	1.43E-12	6.37E-29	0.00E+00	0.00E+00	0.00E+00
te131	3.16E+04	2.07E+04	9.48E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.17E+05	7.88E+04	3.61E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	8.89E+05	7.49E+05	3.26E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	1.27E+06	1.23E+06	1.07E+01	1.74E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	5.54E+05	3.27E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
xe135m	1.29E+05	1.73E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	1.01E+05	1.00E+05	9.63E+04	9.45E+04	8.59E+04	7.61E+04	2.91E+04	8.73E+03	7.87E+02
y91	7.06E+05	7.02E+05	2.45E+05	9.42E+03	2.90E-04	1.18E-13	0.00E+00	0.00E+00	0.00E+00
y91m	3.10E+05	7.91E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	5.31E+05	2.42E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	6.38E+05	1.75E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.03E+06	1.02E+06	3.89E+05	1.98E+04	2.71E-03	7.14E-12	0.00E+00	0.00E+00	0.00E+00
zr97	8.70E+05	3.96E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	4.74E+07	3.54E+07	5.35E+06	2.20E+06	6.80E+05	4.88E+05	1.63E+05	5.21E+04	9.56E+03
Subtotal	91.8%	93.5%	95.9%	92.3%	91.0%	95.9%	99.4%	99.6%	98.5%

Table A.11. Nuclide activities (Ci/MTU) for BWR-Ext (72 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	2.88E+02	2.89E+02	3.52E+02	5.42E+02	1.44E+03	2.33E+03	4.91E+03	4.95E+03	4.25E+03
ba137m	2.03E+05	2.03E+05	2.02E+05	1.99E+05	1.81E+05	1.62E+05	6.43E+04	2.03E+04	2.03E+03
ba139	1.04E+05	7.67E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.06E+06	1.02E+06	8.04E+03	2.60E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.01E+06	9.91E+05	1.49E+05	4.22E+02	1.28E-11	1.61E-28	0.00E+00	0.00E+00	0.00E+00
ce143	8.22E+05	5.52E+05	1.90E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	8.23E+05	8.21E+05	6.61E+05	3.39E+05	9.71E+03	1.15E+02	4.29E-14	0.00E+00	0.00E+00
cm242	1.13E+05	1.13E+05	7.75E+04	2.41E+04	5.41E+01	5.70E+00	4.67E+00	3.65E+00	2.23E+00
cm244	2.16E+04	2.16E+04	2.14E+04	2.08E+04	1.78E+04	1.47E+04	3.19E+03	4.71E+02	1.03E+01
cs134	3.74E+05	3.74E+05	3.45E+05	2.68E+05	7.00E+04	1.31E+04	1.95E-02	1.02E-09	2.75E-24
cs136	7.86E+04	7.54E+04	6.94E+02	3.55E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	2.15E+05	2.15E+05	2.14E+05	2.10E+05	1.91E+05	1.71E+05	6.79E+04	2.15E+04	2.15E+03
i131	6.62E+05	6.25E+05	2.94E+02	1.42E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	9.20E+05	7.72E+05	3.36E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.14E+06	6.04E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	7.95E+04	3.13E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	7.44E+05	1.00E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.70E+04	1.70E+04	1.67E+04	1.59E+04	1.23E+04	8.93E+03	6.79E+02	2.71E+01	4.33E-02
kr85m	6.00E+04	3.17E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	1.61E+04	5.10E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	9.29E+04	8.98E+02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.15E+06	1.12E+06	9.26E+03	2.99E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	4.52E+05	1.57E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.10E+05	1.88E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.13E+06	9.26E+05	1.66E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	9.55E+05	9.55E+05	6.00E+05	3.95E+04	5.53E-03	1.45E-11	0.00E+00	0.00E+00	0.00E+00
nb97	8.98E+05	3.84E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	7.98E+05	3.64E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	4.10E+05	3.90E+05	1.42E+03	4.09E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
np239	1.44E+07	1.14E+07	8.77E+01	8.77E+01	8.76E+01	8.76E+01	8.73E+01	8.69E+01	8.61E+01
pr143	9.03E+05	8.94E+05	1.02E+04	8.05E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	8.23E+05	8.21E+05	6.62E+05	3.39E+05	9.71E+03	1.15E+02	4.29E-14	0.00E+00	0.00E+00
pr144m	7.86E+03	7.84E+03	6.32E+03	3.24E+03	9.27E+01	1.09E+00	4.10E-16	0.00E+00	0.00E+00
pu238	9.23E+03	9.24E+03	9.43E+03	9.64E+03	9.46E+03	9.10E+03	6.63E+03	4.47E+03	2.03E+03
pu239	3.02E+02	3.03E+02	3.06E+02	3.06E+02	3.06E+02	3.06E+02	3.06E+02	3.06E+02	3.05E+02
pu240	7.82E+02	7.82E+02	7.83E+02	7.84E+02	7.92E+02	8.00E+02	8.28E+02	8.32E+02	8.24E+02
pu241	1.63E+05	1.63E+05	1.61E+05	1.55E+05	1.28E+05	1.00E+05	1.44E+04	1.28E+03	1.28E+01
rb86	3.14E+03	3.05E+03	1.11E+02	4.01E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.04E+05	1.00E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.19E+06	1.17E+06	2.43E+05	1.89E+03	1.19E-08	1.20E-22	0.00E+00	0.00E+00	0.00E+00
rh105	8.25E+05	6.09E+05	4.00E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	6.42E+05	6.41E+05	5.43E+05	3.25E+05	2.14E+04	7.11E+02	1.07E-09	1.79E-24	0.00E+00
ru103	1.20E+06	1.18E+06	2.45E+05	1.91E+03	1.21E-08	1.21E-22	0.00E+00	0.00E+00	0.00E+00
ru105	4.42E+05	2.27E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	6.42E+05	6.41E+05	5.43E+05	3.25E+05	2.14E+04	7.11E+02	1.07E-09	1.79E-24	0.00E+00
sr89	4.31E+05	4.27E+05	1.26E+05	2.89E+03	5.80E-06	7.78E-17	0.00E+00	0.00E+00	0.00E+00
sr90	1.41E+05	1.41E+05	1.40E+05	1.38E+05	1.25E+05	1.11E+05	4.23E+04	1.27E+04	1.15E+03
sr91	4.06E+05	1.03E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	1.84E+05	1.42E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.04E+06	8.90E+05	1.61E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	6.42E+04	5.93E+04	2.81E+03	4.89E+02	4.54E-02	4.14E-07	0.00E+00	0.00E+00	0.00E+00
te127m	4.66E+03	4.69E+03	2.87E+03	4.99E+02	4.64E-02	4.23E-07	0.00E+00	0.00E+00	0.00E+00
te129	1.29E+05	2.67E+04	3.37E+03	1.16E+01	9.61E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	3.39E+04	3.35E+04	5.34E+03	1.83E+01	1.52E-12	6.79E-29	0.00E+00	0.00E+00	0.00E+00
te131	3.30E+04	2.16E+04	9.92E-16	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.23E+05	8.25E+04	3.78E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	8.89E+05	7.49E+05	3.26E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	1.26E+06	1.22E+06	1.06E+01	1.72E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	5.28E+05	3.19E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
xe135m	1.28E+05	1.72E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	1.48E+05	1.47E+05	1.40E+05	1.38E+05	1.25E+05	1.11E+05	4.23E+04	1.27E+04	1.15E+03
y91	5.91E+05	5.88E+05	2.05E+05	7.89E+03	2.43E-04	9.90E-14	0.00E+00	0.00E+00	0.00E+00
y91m	2.61E+05	6.65E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	4.60E+05	2.10E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	5.71E+05	1.56E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	9.50E+05	9.42E+05	3.60E+05	1.83E+04	2.51E-03	6.60E-12	0.00E+00	0.00E+00	0.00E+00
zr97	8.39E+05	3.82E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	5.02E+07	3.78E+07	5.95E+06	2.76E+06	9.94E+05	7.29E+05	2.49E+05	8.00E+04	1.42E+04
Subtotal	89.6%	91.5%	96.0%	93.5%	93.1%	96.7%	99.6%	99.5%	98.6%

Table A.12. Nuclide mass (gram/MTU) for BWR-1 (22 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	5.23E+01	5.24E+01	5.24E+01	5.24E+01	5.24E+01	5.24E+01	5.24E+01	5.24E+01	5.24E+01
am241	2.46E+01	2.47E+01	3.39E+01	6.17E+01	1.93E+02	3.23E+02	7.01E+02	7.07E+02	6.08E+02
am242	4.53E-02	1.99E-02	2.62E-06	2.61E-06	2.56E-06	2.49E-06	2.05E-06	1.60E-06	9.81E-07
am242m	2.03E-01	2.03E-01	2.03E-01	2.02E-01	1.98E-01	1.93E-01	1.59E-01	1.24E-01	7.60E-02
am243	3.90E+01	3.90E+01	3.90E+01	3.90E+01	3.90E+01	3.90E+01	3.88E+01	3.87E+01	3.83E+01
ba137	2.61E+01	2.61E+01	3.07E+01	4.45E+01	1.14E+02	1.92E+02	5.79E+02	7.54E+02	8.26E+02
ba137m	1.24E-04	1.24E-04	1.23E-04	1.21E-04	1.10E-04	9.81E-05	3.91E-05	1.24E-05	1.23E-06
ba138	8.68E+02	8.68E+02	8.68E+02	8.68E+02	8.68E+02	8.68E+02	8.68E+02	8.68E+02	8.68E+02
ba139	6.64E-03	4.89E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.52E+01	1.45E+01	1.15E-01	3.72E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	8.03E+02	8.03E+02	8.20E+02	8.20E+02	8.20E+02	8.20E+02	8.20E+02	8.20E+02	8.20E+02
ce141	3.71E+01	3.66E+01	5.48E+00	1.56E-02	4.70E-16	5.92E-33	0.00E+00	0.00E+00	0.00E+00
ce142	7.51E+02	7.51E+02	7.51E+02	7.51E+02	7.51E+02	7.51E+02	7.51E+02	7.51E+02	7.51E+02
ce143	1.34E+00	8.97E-01	3.09E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	2.45E+02	2.45E+02	1.97E+02	1.01E+02	2.90E+00	3.42E-02	1.28E-17	0.00E+00	0.00E+00
cm242	6.93E+00	6.93E+00	4.75E+00	1.48E+00	3.48E-03	5.05E-04	4.14E-04	3.24E-04	1.98E-04
cm243	1.04E-01	1.04E-01	1.03E-01	1.01E-01	9.22E-02	8.19E-02	3.16E-02	9.61E-03	8.89E-04
cm244	7.65E+00	7.65E+00	7.58E+00	7.36E+00	6.32E+00	5.22E+00	1.13E+00	1.67E-01	3.64E-03
cm245	2.55E-01	2.55E-01	2.55E-01	2.55E-01	2.55E-01	2.54E-01	2.54E-01	2.53E-01	2.50E-01
cs133	7.88E+02	7.88E+02	7.95E+02	7.95E+02	7.95E+02	7.95E+02	7.95E+02	7.95E+02	7.95E+02
cs134	5.72E+01	5.72E+01	5.27E+01	4.09E+01	1.07E+01	2.00E+00	2.98E-06	1.55E-13	4.21E-28
cs136	2.96E-01	2.84E-01	2.61E-03	1.34E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	8.08E+02	8.08E+02	8.04E+02	7.90E+02	7.21E+02	6.42E+02	2.56E+02	8.08E+01	8.08E+00
eu151	8.36E-03	8.48E-03	2.23E-02	6.47E-02	2.86E-01	5.53E-01	2.36E+00	3.95E+00	5.78E+00
eu153	7.23E+01	7.24E+01	7.28E+01	7.28E+01	7.28E+01	7.28E+01	7.28E+01	7.28E+01	7.28E+01
eu154	1.15E+01	1.15E+01	1.13E+01	1.06E+01	7.71E+00	5.15E+00	2.06E-01	3.67E-03	1.17E-06
eu155	4.71E+00	4.71E+00	4.54E+00	4.07E+00	2.27E+00	1.10E+00	3.22E-03	2.21E-06	1.03E-12
gd155	3.37E-02	3.52E-02	2.00E-01	6.72E-01	2.47E+00	3.65E+00	4.74E+00	4.74E+00	4.74E+00
i131	5.28E+00	4.98E+00	2.35E-03	1.14E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
i132	8.91E-02	7.49E-02	3.26E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.03E+00	5.45E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	3.13E-03	1.24E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	2.13E-01	2.86E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.73E+01	1.73E+01	1.70E+01	1.62E+01	1.25E+01	9.08E+00	6.91E-01	2.76E-02	4.40E-05
kr85m	9.07E-03	4.79E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	7.33E-04	2.32E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	9.67E-03	9.35E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	8.15E+02	8.15E+02	8.15E+02	8.15E+02	8.15E+02	8.15E+02	8.15E+02	8.15E+02	8.15E+02
la140	2.07E+00	2.04E+00	1.75E-02	5.63E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	8.40E-02	2.91E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	8.07E-03	1.38E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	6.25E+02	6.25E+02	6.25E+02	6.25E+02	6.25E+02	6.25E+02	6.25E+02	6.25E+02	6.25E+02
mo95	4.41E+02	4.42E+02	4.82E+02	5.15E+02	5.17E+02	5.17E+02	5.17E+02	5.17E+02	5.17E+02
mo97	5.39E+02	5.39E+02	5.39E+02	5.39E+02	5.39E+02	5.39E+02	5.39E+02	5.39E+02	5.39E+02
mo98	5.51E+02	5.51E+02	5.51E+02	5.51E+02	5.51E+02	5.51E+02	5.51E+02	5.51E+02	5.51E+02
mo99	2.39E+00	1.96E+00	3.51E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	2.97E-04	2.97E-04	3.45E-04	4.91E-04	1.19E-03	1.91E-03	4.38E-03	4.86E-03	4.92E-03
nb95	2.65E+01	2.65E+01	1.68E+01	1.11E+00	1.55E-07	4.08E-16	0.00E+00	0.00E+00	0.00E+00
nb97	3.51E-02	1.50E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	4.24E-04	1.93E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	5.38E+02	5.39E+02	5.54E+02	5.54E+02	5.54E+02	5.54E+02	5.54E+02	5.54E+02	5.54E+02
nd144	6.16E+02	6.16E+02	6.64E+02	7.60E+02	8.58E+02	8.61E+02	8.61E+02	8.61E+02	8.61E+02
nd145	4.63E+02	4.63E+02	4.63E+02	4.63E+02	4.63E+02	4.63E+02	4.63E+02	4.63E+02	4.63E+02
nd147	5.11E+00	4.86E+00	1.76E-02	5.09E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	2.48E+02	2.48E+02	2.48E+02	2.48E+02	2.48E+02	2.48E+02	2.48E+02	2.48E+02	2.48E+02
np237	2.11E+02	2.12E+02	2.16E+02	2.16E+02	2.17E+02	2.19E+02	2.55E+02	3.11E+02	4.15E+02
np239	5.85E+01	4.64E+01	3.36E-05	3.36E-05	3.36E-05	3.36E-05	3.34E-05	3.33E-05	3.30E-05
pm147	1.47E+02	1.47E+02	1.42E+02	1.17E+02	4.06E+01	1.08E+01	2.81E-04	5.18E-10	1.77E-21
pr141	7.13E+02	7.14E+02	7.45E+02	7.50E+02	7.50E+02	7.50E+02	7.50E+02	7.50E+02	7.50E+02

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pr143	1.45E+01	1.44E+01	1.63E-01	1.29E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.03E-02	1.03E-02	8.31E-03	4.26E-03	1.22E-04	1.44E-06	5.39E-22	0.00E+00	0.00E+00
pr144m	4.11E-05	4.10E-05	3.31E-05	1.69E-05	4.85E-07	5.72E-09	2.15E-24	0.00E+00	0.00E+00
pu238	5.28E+01	5.29E+01	5.53E+01	5.82E+01	5.78E+01	5.56E+01	4.06E+01	2.73E+01	1.24E+01
pu239	4.12E+03	4.13E+03	4.17E+03	4.17E+03	4.17E+03	4.17E+03	4.17E+03	4.16E+03	4.15E+03
pu240	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.84E+03	1.83E+03	1.82E+03	1.80E+03
pu241	7.86E+02	7.86E+02	7.76E+02	7.49E+02	6.17E+02	4.84E+02	6.96E+01	6.17E+00	4.88E-02
pu242	2.74E+02	2.74E+02	2.74E+02	2.74E+02	2.74E+02	2.74E+02	2.74E+02	2.74E+02	2.73E+02
rb86	1.04E-02	1.01E-02	3.69E-04	1.33E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.13E-03	1.09E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	3.19E+02	3.19E+02	3.45E+02	3.51E+02	3.51E+02	3.51E+02	3.51E+02	3.51E+02	3.51E+02
rh103m	3.21E-02	3.17E-02	6.58E-03	5.11E-05	3.24E-16	3.25E-30	0.00E+00	0.00E+00	0.00E+00
rh105	8.00E-01	5.91E-01	3.88E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.00E-04	9.98E-05	8.46E-05	5.06E-05	3.33E-06	1.11E-07	1.67E-19	2.79E-34	0.00E+00
ru101	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02	5.28E+02
ru103	3.27E+01	3.22E+01	6.70E+00	5.21E-02	3.30E-13	3.31E-27	0.00E+00	0.00E+00	0.00E+00
ru105	5.37E-02	2.76E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	1.07E+02	1.07E+02	9.03E+01	5.41E+01	3.56E+00	1.18E-01	1.79E-13	2.98E-28	0.00E+00
sb125	6.03E+00	6.03E+00	5.73E+00	4.74E+00	1.74E+00	4.95E-01	2.15E-05	7.58E-11	9.43E-22
sm147	5.76E+01	5.77E+01	6.71E+01	9.28E+01	1.69E+02	1.99E+02	2.10E+02	2.10E+02	2.10E+02
sm149	1.43E+00	1.60E+00	2.21E+00	2.21E+00	2.21E+00	2.21E+00	2.21E+00	2.21E+00	2.21E+00
sm150	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02
sm151	7.19E+00	7.25E+00	7.34E+00	7.29E+00	7.07E+00	6.81E+00	5.00E+00	3.41E+00	1.58E+00
sm152	8.57E+01	8.57E+01	8.57E+01	8.57E+01	8.57E+01	8.57E+01	8.57E+01	8.57E+01	8.57E+01
sr89	1.96E+01	1.94E+01	5.72E+00	1.32E-01	2.64E-10	3.54E-21	0.00E+00	0.00E+00	0.00E+00
sr90	3.64E+02	3.63E+02	3.61E+02	3.55E+02	3.22E+02	2.86E+02	1.09E+02	3.28E+01	2.96E+00
sr91	1.43E-01	3.63E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	1.77E-02	1.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	5.54E+02	5.55E+02	5.57E+02	5.57E+02	5.57E+02	5.57E+02	5.57E+02	5.56E+02	5.56E+02
tc99m	2.00E-01	1.71E-01	3.09E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te125m	7.22E-02	7.22E-02	7.55E-02	6.60E-02	2.42E-02	6.90E-03	3.00E-07	1.06E-12	1.32E-23
te127	2.23E-02	2.06E-02	9.77E-04	1.70E-04	1.58E-08	1.44E-13	0.00E+00	0.00E+00	0.00E+00
te127m	4.53E-01	4.56E-01	2.79E-01	4.85E-02	4.51E-06	4.11E-11	0.00E+00	0.00E+00	0.00E+00
te129	5.70E-03	1.18E-03	1.48E-04	5.10E-07	4.24E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.04E+00	1.03E+00	1.64E-01	5.62E-04	4.67E-17	2.08E-33	0.00E+00	0.00E+00	0.00E+00
te131	5.53E-04	3.62E-04	1.66E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.64E-01	1.10E-01	5.05E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	2.89E+00	2.44E+00	1.06E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.41E+02	1.41E+02	1.41E+02	1.41E+02	1.43E+02	1.45E+02	1.60E+02	1.73E+02	1.87E+02
u235	7.21E+03	7.21E+03	7.21E+03	7.21E+03	7.21E+03	7.21E+03	7.22E+03	7.22E+03	7.23E+03
u236	2.74E+03	2.74E+03	2.74E+03	2.74E+03	2.74E+03	2.75E+03	2.75E+03	2.76E+03	2.78E+03
u238	9.60E+05	9.60E+05	9.60E+05	9.60E+05	9.60E+05	9.60E+05	9.60E+05	9.60E+05	9.60E+05
xe132	6.92E+02	6.93E+02	6.95E+02	6.95E+02	6.95E+02	6.95E+02	6.95E+02	6.95E+02	6.95E+02
xe133	6.78E+00	6.57E+00	5.72E-05	9.29E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	1.01E+03	1.01E+03	1.01E+03	1.01E+03	1.01E+03	1.01E+03	1.01E+03	1.01E+03	1.01E+03
xe135	2.06E-01	1.26E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	1.42E-03	1.91E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03	1.56E+03
y90	9.62E-02	9.54E-02	9.17E-02	9.00E-02	8.18E-02	7.25E-02	2.77E-02	8.31E-03	7.50E-04
y91	3.04E+01	3.02E+01	1.05E+01	4.05E-01	1.25E-08	5.09E-18	0.00E+00	0.00E+00	0.00E+00
y91m	7.88E-03	2.01E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	5.78E-02	2.64E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	2.01E-01	5.50E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	4.79E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02
zr95	4.88E+01	4.84E+01	1.85E+01	9.41E-01	1.29E-07	3.39E-16	0.00E+00	0.00E+00	0.00E+00
zr97	4.57E-01	2.08E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	99.4%	99.4%	99.3%	99.3%	99.3%	99.3%	99.3%	99.3%	99.3%

Table A.13. Nuclide mass (gram/MTU) for BWR-2 (33 GWd/MTU)

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	7.89E+01	7.90E+01	7.90E+01	7.90E+01	7.90E+01	7.90E+01	7.90E+01	7.90E+01	7.90E+01
am241	4.29E+01	4.31E+01	5.55E+01	9.32E+01	2.71E+02	4.48E+02	9.59E+02	9.67E+02	8.31E+02
am242	7.52E-02	3.31E-02	4.62E-06	4.60E-06	4.52E-06	4.41E-06	3.62E-06	2.83E-06	1.73E-06
am242m	3.59E-01	3.59E-01	3.58E-01	3.57E-01	3.50E-01	3.41E-01	2.81E-01	2.19E-01	1.34E-01
am243	9.83E+01	9.83E+01	9.83E+01	9.83E+01	9.83E+01	9.83E+01	9.79E+01	9.74E+01	9.65E+01
ba137	5.62E+01	5.62E+01	6.29E+01	8.34E+01	1.86E+02	3.02E+02	8.74E+02	1.13E+03	1.24E+03
ba137m	1.83E-04	1.83E-04	1.82E-04	1.79E-04	1.63E-04	1.45E-04	5.78E-05	1.83E-05	1.83E-06
ba138	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03	1.30E+03
ba139	6.58E-03	4.84E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.50E+01	1.44E+01	1.14E-01	3.68E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	1.21E+03	1.21E+03	1.23E+03	1.23E+03	1.23E+03	1.23E+03	1.23E+03	1.23E+03	1.23E+03
ce141	3.67E+01	3.61E+01	5.42E+00	1.54E-02	4.65E-16	5.85E-33	0.00E+00	0.00E+00	0.00E+00
ce142	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
ce143	1.31E+00	8.80E-01	3.03E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	2.63E+02	2.62E+02	2.11E+02	1.08E+02	3.10E+00	3.66E-02	1.37E-17	0.00E+00	0.00E+00
cm242	1.39E+01	1.39E+01	9.51E+00	2.95E+00	6.84E-03	8.92E-04	7.31E-04	5.72E-04	3.50E-04
cm243	2.86E-01	2.86E-01	2.85E-01	2.80E-01	2.54E-01	2.26E-01	8.71E-02	2.65E-02	2.45E-03
cm244	2.83E+01	2.83E+01	2.80E+01	2.72E+01	2.34E+01	1.93E+01	4.18E+00	6.17E-01	1.35E-02
cm245	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.21E+00	1.20E+00	1.19E+00
cs133	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03
cs134	1.05E+02	1.05E+02	9.63E+01	7.48E+01	1.96E+01	3.66E+00	5.45E-06	2.84E-13	7.70E-28
cs136	4.38E-01	4.20E-01	3.87E-03	1.98E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.20E+03	1.20E+03	1.19E+03	1.17E+03	1.07E+03	9.50E+02	3.78E+02	1.20E+02	1.20E+01
eu151	1.11E-02	1.12E-02	2.84E-02	8.12E-02	3.57E-01	6.90E-01	2.94E+00	4.93E+00	7.21E+00
eu153	1.15E+02	1.15E+02	1.15E+02	1.15E+02	1.15E+02	1.15E+02	1.15E+02	1.15E+02	1.15E+02
eu154	2.07E+01	2.07E+01	2.03E+01	1.91E+01	1.38E+01	9.25E+00	3.69E-01	6.58E-03	2.09E-06
eu155	7.85E+00	7.85E+00	7.57E+00	6.78E+00	3.79E+00	1.83E+00	5.37E-03	3.68E-06	1.72E-12
gd155	6.35E-02	6.60E-02	3.40E-01	1.13E+00	4.12E+00	6.08E+00	7.91E+00	7.91E+00	7.91E+00
i131	5.29E+00	4.99E+00	2.35E-03	1.14E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	8.91E-02	7.49E-02	3.25E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
i133	1.02E+00	5.42E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	3.09E-03	1.22E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	2.12E-01	2.86E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	2.44E+01	2.44E+01	2.40E+01	2.29E+01	1.77E+01	1.28E+01	9.76E-01	3.90E-02	6.22E-05
kr85m	8.59E-03	4.54E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	6.89E-04	2.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	9.07E-03	8.77E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	1.22E+03	1.22E+03	1.22E+03	1.22E+03	1.22E+03	1.22E+03	1.22E+03	1.22E+03	1.22E+03
la140	2.06E+00	2.03E+00	1.73E-02	5.57E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	8.29E-02	2.88E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	7.94E-03	1.35E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	9.36E+02	9.36E+02	9.36E+02	9.36E+02	9.36E+02	9.36E+02	9.36E+02	9.36E+02	9.36E+02
mo95	6.82E+02	6.82E+02	7.21E+02	7.54E+02	7.56E+02	7.56E+02	7.56E+02	7.56E+02	7.56E+02
mo97	8.03E+02	8.04E+02	8.04E+02	8.04E+02	8.04E+02	8.04E+02	8.04E+02	8.04E+02	8.04E+02
mo98	8.25E+02	8.25E+02	8.25E+02	8.25E+02	8.25E+02	8.25E+02	8.25E+02	8.25E+02	8.25E+02
mo99	2.38E+00	1.95E+00	3.50E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	6.29E-04	6.29E-04	6.99E-04	9.08E-04	1.91E-03	2.95E-03	6.50E-03	7.19E-03	7.28E-03
nb95	2.63E+01	2.63E+01	1.66E+01	1.09E+00	1.52E-07	4.01E-16	0.00E+00	0.00E+00	0.00E+00
nb97	3.46E-02	1.48E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	4.18E-04	1.90E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	7.33E+02	7.34E+02	7.49E+02	7.49E+02	7.49E+02	7.49E+02	7.49E+02	7.49E+02	7.49E+02
nd144	1.10E+03	1.10E+03	1.15E+03	1.25E+03	1.36E+03	1.36E+03	1.36E+03	1.36E+03	1.36E+03
nd145	6.66E+02	6.66E+02	6.66E+02	6.66E+02	6.66E+02	6.66E+02	6.66E+02	6.66E+02	6.66E+02
nd147	5.10E+00	4.85E+00	1.76E-02	5.08E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02
np237	3.59E+02	3.59E+02	3.65E+02	3.65E+02	3.66E+02	3.69E+02	4.18E+02	4.96E+02	6.37E+02
np239	5.84E+01	4.63E+01	8.47E-05	8.47E-05	8.46E-05	8.46E-05	8.43E-05	8.39E-05	8.31E-05
pm147	1.73E+02	1.73E+02	1.67E+02	1.37E+02	4.75E+01	1.27E+01	3.29E-04	6.07E-10	2.07E-21
pr141	1.08E+03	1.08E+03	1.11E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03	1.12E+03
pr143	1.42E+01	1.41E+01	1.60E-01	1.27E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.11E-02	1.11E-02	8.90E-03	4.56E-03	1.31E-04	1.54E-06	5.78E-22	0.00E+00	0.00E+00
pr144m	4.41E-05	4.40E-05	3.54E-05	1.81E-05	5.20E-07	6.13E-09	2.30E-24	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pu238	1.23E+02	1.23E+02	1.28E+02	1.34E+02	1.32E+02	1.27E+02	9.27E+01	6.25E+01	2.84E+01
pu239	4.48E+03	4.50E+03	4.54E+03	4.54E+03	4.54E+03	4.54E+03	4.54E+03	4.53E+03	4.52E+03
pu240	2.37E+03	2.37E+03	2.37E+03	2.37E+03	2.37E+03	2.38E+03	2.38E+03	2.37E+03	2.35E+03
pu241	1.07E+03	1.07E+03	1.05E+03	1.02E+03	8.36E+02	6.56E+02	9.44E+01	8.36E+00	6.76E-02
pu242	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.07E+02
rb86	1.59E-02	1.55E-02	5.65E-04	2.03E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.06E-03	1.02E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	4.45E+02	4.46E+02	4.72E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02	4.79E+02
rh103m	3.33E-02	3.29E-02	6.82E-03	5.31E-05	3.36E-16	3.37E-30	0.00E+00	0.00E+00	0.00E+00
rh105	8.49E-01	6.26E-01	4.11E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.27E-04	1.26E-04	1.07E-04	6.41E-05	4.22E-06	1.40E-07	2.12E-19	3.54E-34	0.00E+00
ru101	7.83E+02	7.83E+02	7.83E+02	7.83E+02	7.83E+02	7.83E+02	7.83E+02	7.83E+02	7.83E+02
ru103	3.39E+01	3.35E+01	6.95E+00	5.40E-02	3.42E-13	3.44E-27	0.00E+00	0.00E+00	0.00E+00
ru105	5.69E-02	2.92E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	1.35E+02	1.35E+02	1.14E+02	6.85E+01	4.50E+00	1.50E-01	2.26E-13	3.78E-28	0.00E+00
sb125	8.08E+00	8.08E+00	7.65E+00	6.33E+00	2.32E+00	6.61E-01	2.87E-05	1.01E-10	1.26E-21
sm147	9.94E+01	9.95E+01	1.11E+02	1.41E+02	2.30E+02	2.65E+02	2.77E+02	2.77E+02	2.77E+02
sm149	1.59E+00	1.77E+00	2.41E+00	2.41E+00	2.41E+00	2.41E+00	2.41E+00	2.41E+00	2.41E+00
sm150	2.81E+02	2.81E+02	2.81E+02	2.81E+02	2.81E+02	2.81E+02	2.81E+02	2.81E+02	2.81E+02
sm151	9.00E+00	9.06E+00	9.14E+00	9.09E+00	8.81E+00	8.48E+00	6.23E+00	4.24E+00	1.97E+00
sm152	1.13E+02	1.13E+02	1.13E+02	1.13E+02	1.13E+02	1.13E+02	1.13E+02	1.13E+02	1.13E+02
sr89	1.84E+01	1.82E+01	5.36E+00	1.23E-01	2.47E-10	3.32E-21	0.00E+00	0.00E+00	0.00E+00
sr90	5.26E+02	5.26E+02	5.23E+02	5.14E+02	4.67E+02	4.14E+02	1.58E+02	4.75E+01	4.28E+00
sr91	1.35E-01	3.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	1.69E-02	1.31E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	8.09E+02	8.09E+02	8.11E+02	8.11E+02	8.11E+02	8.11E+02	8.11E+02	8.11E+02	8.11E+02
tc99m	1.99E-01	1.70E-01	3.08E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	1.00E-01	1.00E-01	1.02E-01	8.82E-02	3.24E-02	9.22E-03	4.01E-07	1.41E-12	1.76E-23
te127	2.28E-02	2.11E-02	1.02E-03	1.78E-04	1.65E-08	1.51E-13	0.00E+00	0.00E+00	0.00E+00
te127m	4.75E-01	4.78E-01	2.92E-01	5.08E-02	4.72E-06	4.30E-11	0.00E+00	0.00E+00	0.00E+00
te129	5.81E-03	1.20E-03	1.52E-04	5.22E-07	4.33E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.06E+00	1.05E+00	1.67E-01	5.75E-04	4.77E-17	2.13E-33	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te131	5.57E-04	3.65E-04	1.67E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.65E-01	1.11E-01	5.09E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	2.89E+00	2.43E+00	1.06E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.57E+02	1.57E+02	1.58E+02	1.58E+02	1.63E+02	1.68E+02	2.01E+02	2.31E+02	2.65E+02
u235	6.53E+03	6.53E+03	6.53E+03	6.53E+03	6.53E+03	6.53E+03	6.54E+03	6.55E+03	6.56E+03
u236	3.95E+03	3.95E+03	3.95E+03	3.95E+03	3.95E+03	3.95E+03	3.96E+03	3.97E+03	4.00E+03
u238	9.46E+05	9.46E+05	9.46E+05	9.46E+05	9.46E+05	9.46E+05	9.46E+05	9.46E+05	9.46E+05
xe132	1.08E+03	1.08E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03
xe133	6.76E+00	6.55E+00	5.70E-05	9.25E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	1.52E+03	1.52E+03	1.52E+03	1.52E+03	1.52E+03	1.52E+03	1.52E+03	1.52E+03	1.52E+03
xe135	2.10E-01	1.27E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	1.41E-03	1.90E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03	2.29E+03
y90	1.40E-01	1.38E-01	1.33E-01	1.30E-01	1.18E-01	1.05E-01	4.01E-02	1.20E-02	1.09E-03
y91	2.89E+01	2.87E+01	1.00E+01	3.85E-01	1.19E-08	4.83E-18	0.00E+00	0.00E+00	0.00E+00
y91m	7.45E-03	1.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	5.52E-02	2.52E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	1.93E-01	5.29E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	7.08E+02	7.08E+02	7.08E+02	7.08E+02	7.08E+02	7.08E+02	7.08E+02	7.08E+02	7.08E+02
zr95	4.80E+01	4.76E+01	1.82E+01	9.25E-01	1.27E-07	3.33E-16	0.00E+00	0.00E+00	0.00E+00
zr97	4.51E-01	2.06E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	99.0%	99.0%	99.0%	99.0%	99.0%	99.0%	98.9%	98.9%	98.9%

Table A.14. Nuclide mass (gram/MTU) for BWR-3 (44 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	9.84E+01	9.84E+01	9.84E+01	9.84E+01	9.84E+01	9.84E+01	9.84E+01	9.84E+01	9.84E+01
am241	6.13E+01	6.14E+01	7.62E+01	1.21E+02	3.31E+02	5.41E+02	1.15E+03	1.15E+03	9.92E+02
am242	9.79E-02	4.30E-02	6.62E-06	6.59E-06	6.46E-06	6.31E-06	5.18E-06	4.05E-06	2.48E-06
am242m	5.13E-01	5.13E-01	5.13E-01	5.11E-01	5.01E-01	4.89E-01	4.02E-01	3.14E-01	1.92E-01
am243	1.55E+02	1.55E+02	1.55E+02	1.55E+02	1.55E+02	1.55E+02	1.54E+02	1.54E+02	1.52E+02
ba137	9.71E+01	9.72E+01	1.06E+02	1.33E+02	2.68E+02	4.20E+02	1.17E+03	1.51E+03	1.65E+03
ba137m	2.40E-04	2.40E-04	2.39E-04	2.35E-04	2.14E-04	1.91E-04	7.59E-05	2.40E-05	2.40E-06
ba138	1.74E+03	1.74E+03	1.74E+03	1.74E+03	1.74E+03	1.74E+03	1.74E+03	1.74E+03	1.74E+03
ba139	6.59E-03	4.84E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.50E+01	1.44E+01	1.14E-01	3.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	1.63E+03	1.63E+03	1.65E+03	1.65E+03	1.65E+03	1.65E+03	1.65E+03	1.65E+03	1.65E+03
ce141	3.66E+01	3.61E+01	5.41E+00	1.54E-02	4.64E-16	5.84E-33	0.00E+00	0.00E+00	0.00E+00
ce142	1.50E+03	1.50E+03	1.50E+03	1.50E+03	1.50E+03	1.50E+03	1.50E+03	1.50E+03	1.50E+03
ce143	1.31E+00	8.80E-01	3.04E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	2.71E+02	2.71E+02	2.18E+02	1.12E+02	3.20E+00	3.78E-02	1.42E-17	0.00E+00	0.00E+00
cm242	1.97E+01	1.97E+01	1.35E+01	4.20E+00	9.73E-03	1.28E-03	1.05E-03	8.18E-04	5.01E-04
cm243	4.85E-01	4.85E-01	4.82E-01	4.74E-01	4.31E-01	3.82E-01	1.48E-01	4.49E-02	4.15E-03
cm244	5.53E+01	5.53E+01	5.48E+01	5.32E+01	4.57E+01	3.77E+01	8.17E+00	1.21E+00	2.63E-02
cm245	2.77E+00	2.77E+00	2.77E+00	2.77E+00	2.77E+00	2.77E+00	2.76E+00	2.75E+00	2.72E+00
cs133	1.47E+03	1.47E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03
cs134	1.50E+02	1.50E+02	1.38E+02	1.08E+02	2.81E+01	5.25E+00	7.83E-06	4.08E-13	1.11E-27
cs136	5.96E-01	5.71E-01	5.26E-03	2.69E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.57E+03	1.57E+03	1.56E+03	1.54E+03	1.40E+03	1.25E+03	4.97E+02	1.57E+02	1.57E+01
eu151	1.53E-02	1.55E-02	3.66E-02	1.02E-01	4.41E-01	8.50E-01	3.62E+00	6.07E+00	8.87E+00
eu153	1.51E+02	1.51E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02	1.52E+02
eu154	2.96E+01	2.96E+01	2.91E+01	2.73E+01	1.98E+01	1.33E+01	5.29E-01	9.42E-03	3.00E-06
eu155	1.07E+01	1.07E+01	1.03E+01	9.23E+00	5.15E+00	2.49E+00	7.31E-03	5.00E-06	2.34E-12
gd155	1.03E-01	1.07E-01	4.79E-01	1.55E+00	5.63E+00	8.30E+00	1.08E+01	1.08E+01	1.08E+01
i131	5.27E+00	4.97E+00	2.34E-03	1.13E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	8.88E-02	7.46E-02	3.24E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
i133	1.02E+00	5.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	3.10E-03	1.22E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	2.12E-01	2.85E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	3.17E+01	3.17E+01	3.12E+01	2.97E+01	2.30E+01	1.66E+01	1.27E+00	5.06E-02	8.07E-05
kr85m	8.60E-03	4.54E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	6.89E-04	2.18E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	9.08E-03	8.78E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03
la140	2.08E+00	2.04E+00	1.73E-02	5.57E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	8.28E-02	2.87E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	7.93E-03	1.35E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03
mo95	9.27E+02	9.27E+02	9.66E+02	9.99E+02	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
mo97	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03	1.07E+03
mo98	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03
mo99	2.38E+00	1.95E+00	3.50E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	1.09E-03	1.09E-03	1.18E-03	1.45E-03	2.77E-03	4.12E-03	8.76E-03	9.65E-03	9.77E-03
nb95	2.63E+01	2.63E+01	1.65E+01	1.09E+00	1.52E-07	4.01E-16	0.00E+00	0.00E+00	0.00E+00
nb97	3.46E-02	1.48E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	4.18E-04	1.90E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	9.38E+02	9.39E+02	9.54E+02	9.54E+02	9.54E+02	9.54E+02	9.54E+02	9.54E+02	9.54E+02
nd144	1.60E+03	1.60E+03	1.66E+03	1.76E+03	1.87E+03	1.87E+03	1.87E+03	1.87E+03	1.87E+03
nd145	8.71E+02	8.71E+02	8.71E+02	8.71E+02	8.71E+02	8.71E+02	8.71E+02	8.71E+02	8.71E+02
nd147	5.12E+00	4.87E+00	1.77E-02	5.10E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02	4.91E+02
np237	5.28E+02	5.28E+02	5.35E+02	5.35E+02	5.36E+02	5.40E+02	5.99E+02	6.91E+02	8.60E+02
np239	5.59E+01	4.43E+01	1.34E-04	1.34E-04	1.33E-04	1.33E-04	1.33E-04	1.32E-04	1.31E-04
pm147	1.93E+02	1.93E+02	1.86E+02	1.52E+02	5.30E+01	1.41E+01	3.66E-04	6.76E-10	2.31E-21
pr141	1.45E+03	1.45E+03	1.48E+03	1.49E+03	1.49E+03	1.49E+03	1.49E+03	1.49E+03	1.49E+03
pr143	1.42E+01	1.41E+01	1.60E-01	1.27E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.14E-02	1.14E-02	9.19E-03	4.71E-03	1.35E-04	1.59E-06	5.96E-22	0.00E+00	0.00E+00
pr144m	4.55E-05	4.54E-05	3.66E-05	1.87E-05	5.37E-07	6.33E-09	2.37E-24	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pu238	2.15E+02	2.15E+02	2.22E+02	2.30E+02	2.27E+02	2.18E+02	1.59E+02	1.07E+02	4.87E+01
pu239	4.85E+03	4.86E+03	4.91E+03	4.91E+03	4.91E+03	4.91E+03	4.90E+03	4.89E+03	4.88E+03
pu240	2.69E+03	2.69E+03	2.69E+03	2.69E+03	2.70E+03	2.71E+03	2.72E+03	2.72E+03	2.69E+03
pu241	1.26E+03	1.26E+03	1.25E+03	1.20E+03	9.90E+02	7.77E+02	1.12E+02	9.91E+00	8.23E-02
pu242	6.80E+02	6.80E+02	6.80E+02	6.80E+02	6.80E+02	6.80E+02	6.80E+02	6.80E+02	6.80E+02
rb86	2.15E-02	2.09E-02	7.61E-04	2.74E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.06E-03	1.02E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	5.49E+02	5.50E+02	5.76E+02	5.83E+02	5.83E+02	5.83E+02	5.83E+02	5.83E+02	5.83E+02
rh103m	3.33E-02	3.29E-02	6.83E-03	5.31E-05	3.36E-16	3.37E-30	0.00E+00	0.00E+00	0.00E+00
rh105	8.52E-01	6.28E-01	4.13E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.37E-04	1.37E-04	1.16E-04	6.94E-05	4.56E-06	1.52E-07	2.29E-19	3.83E-34	0.00E+00
ru101	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.03E+03
ru103	3.39E+01	3.35E+01	6.95E+00	5.40E-02	3.42E-13	3.44E-27	0.00E+00	0.00E+00	0.00E+00
ru105	5.67E-02	2.92E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	1.46E+02	1.46E+02	1.24E+02	7.41E+01	4.87E+00	1.62E-01	2.45E-13	4.09E-28	0.00E+00
sb125	9.39E+00	9.39E+00	8.89E+00	7.36E+00	2.69E+00	7.68E-01	3.34E-05	1.18E-10	1.46E-21
sm147	1.45E+02	1.45E+02	1.58E+02	1.91E+02	2.90E+02	3.29E+02	3.43E+02	3.43E+02	3.43E+02
sm149	1.82E+00	2.01E+00	2.66E+00	2.66E+00	2.66E+00	2.66E+00	2.66E+00	2.66E+00	2.66E+00
sm150	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02	3.69E+02
sm151	1.11E+01	1.12E+01	1.13E+01	1.12E+01	1.09E+01	1.04E+01	7.67E+00	5.22E+00	2.42E+00
sm152	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02	1.35E+02
sr89	1.83E+01	1.81E+01	5.35E+00	1.23E-01	2.47E-10	3.31E-21	0.00E+00	0.00E+00	0.00E+00
sr90	7.01E+02	7.01E+02	6.97E+02	6.85E+02	6.22E+02	5.51E+02	2.11E+02	6.32E+01	5.70E+00
sr91	1.35E-01	3.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	1.69E-02	1.30E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	1.06E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03
tc99m	2.00E-01	1.71E-01	3.08E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	1.19E-01	1.19E-01	1.19E-01	1.02E-01	3.76E-02	1.07E-02	4.65E-07	1.64E-12	2.04E-23
te127	2.27E-02	2.10E-02	1.06E-03	1.84E-04	1.71E-08	1.56E-13	0.00E+00	0.00E+00	0.00E+00
te127m	4.94E-01	4.97E-01	3.02E-01	5.26E-02	4.88E-06	4.45E-11	0.00E+00	0.00E+00	0.00E+00
te129	5.77E-03	1.19E-03	1.51E-04	5.18E-07	4.30E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.06E+00	1.04E+00	1.66E-01	5.71E-04	4.74E-17	2.11E-33	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te131	5.50E-04	3.60E-04	1.65E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.63E-01	1.10E-01	5.02E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	2.88E+00	2.43E+00	1.05E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.91E+02	1.91E+02	1.92E+02	1.93E+02	2.00E+02	2.09E+02	2.67E+02	3.18E+02	3.75E+02
u235	7.42E+03	7.42E+03	7.42E+03	7.42E+03	7.42E+03	7.42E+03	7.42E+03	7.43E+03	7.44E+03
u236	5.49E+03	5.49E+03	5.49E+03	5.49E+03	5.49E+03	5.49E+03	5.50E+03	5.52E+03	5.55E+03
u238	9.31E+05	9.31E+05	9.31E+05	9.31E+05	9.31E+05	9.31E+05	9.31E+05	9.31E+05	9.31E+05
xe132	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03
xe133	6.77E+00	6.55E+00	5.70E-05	9.26E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03
xe135	2.18E-01	1.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	1.41E-03	1.90E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	2.96E+03	2.96E+03	2.96E+03	2.96E+03	2.96E+03	2.96E+03	2.96E+03	2.96E+03	2.96E+03
y90	1.86E-01	1.84E-01	1.77E-01	1.74E-01	1.58E-01	1.40E-01	5.34E-02	1.60E-02	1.45E-03
y91	2.88E+01	2.86E+01	9.98E+00	3.84E-01	1.18E-08	4.82E-18	0.00E+00	0.00E+00	0.00E+00
y91m	7.45E-03	1.90E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	5.51E-02	2.52E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	1.93E-01	5.28E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	9.50E+02	9.50E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.50E+02
zr95	4.79E+01	4.75E+01	1.81E+01	9.23E-01	1.26E-07	3.32E-16	0.00E+00	0.00E+00	0.00E+00
zr97	4.51E-01	2.05E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	98.6%	98.6%	98.6%	98.6%	98.6%	98.6%	98.5%	98.5%	98.5%

Table A.15. Nuclide mass (gram/MTU) for BWR-Ext (72 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02	1.69E+02
am241	8.40E+01	8.42E+01	1.03E+02	1.58E+02	4.20E+02	6.80E+02	1.43E+03	1.44E+03	1.24E+03
am242	1.47E-01	6.47E-02	8.91E-06	8.88E-06	8.71E-06	8.50E-06	6.98E-06	5.46E-06	3.34E-06
am242m	6.92E-01	6.92E-01	6.91E-01	6.88E-01	6.75E-01	6.58E-01	5.41E-01	4.23E-01	2.59E-01
am243	4.39E+02	4.39E+02	4.39E+02	4.39E+02	4.39E+02	4.39E+02	4.37E+02	4.35E+02	4.31E+02
ba137	2.47E+02	2.47E+02	2.61E+02	3.03E+02	5.16E+02	7.56E+02	1.94E+03	2.47E+03	2.70E+03
ba137m	3.78E-04	3.78E-04	3.76E-04	3.69E-04	3.37E-04	3.00E-04	1.20E-04	3.78E-05	3.78E-06
ba138	2.81E+03	2.81E+03	2.81E+03	2.81E+03	2.81E+03	2.81E+03	2.81E+03	2.81E+03	2.81E+03
ba139	6.40E-03	4.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.45E+01	1.39E+01	1.10E-01	3.55E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	2.67E+03	2.67E+03	2.69E+03	2.69E+03	2.69E+03	2.69E+03	2.69E+03	2.69E+03	2.69E+03
ce141	3.53E+01	3.48E+01	5.22E+00	1.48E-02	4.47E-16	5.63E-33	0.00E+00	0.00E+00	0.00E+00
ce142	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03	2.40E+03
ce143	1.24E+00	8.31E-01	2.87E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	2.59E+02	2.58E+02	2.08E+02	1.06E+02	3.05E+00	3.60E-02	1.35E-17	0.00E+00	0.00E+00
cm242	3.41E+01	3.41E+01	2.34E+01	7.26E+00	1.63E-02	1.72E-03	1.41E-03	1.10E-03	6.74E-04
cm243	1.21E+00	1.21E+00	1.20E+00	1.18E+00	1.07E+00	9.51E-01	3.67E-01	1.12E-01	1.03E-02
cm244	2.67E+02	2.67E+02	2.64E+02	2.57E+02	2.20E+02	1.82E+02	3.94E+01	5.82E+00	1.27E-01
cm245	1.60E+01	1.60E+01	1.60E+01	1.60E+01	1.60E+01	1.60E+01	1.60E+01	1.59E+01	1.58E+01
cs133	2.15E+03	2.15E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03
cs134	2.90E+02	2.89E+02	2.67E+02	2.07E+02	5.42E+01	1.01E+01	1.51E-05	7.86E-13	2.13E-27
cs136	1.08E+00	1.03E+00	9.51E-03	4.87E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	2.48E+03	2.47E+03	2.46E+03	2.42E+03	2.21E+03	1.97E+03	7.82E+02	2.47E+02	2.47E+01
eu151	1.63E-02	1.65E-02	4.22E-02	1.21E-01	5.34E-01	1.03E+00	4.39E+00	7.37E+00	1.08E+01
eu153	2.34E+02	2.34E+02	2.35E+02	2.35E+02	2.35E+02	2.35E+02	2.35E+02	2.35E+02	2.35E+02
eu154	4.98E+01	4.98E+01	4.89E+01	4.60E+01	3.33E+01	2.23E+01	8.89E-01	1.59E-02	5.04E-06
eu155	1.80E+01	1.80E+01	1.74E+01	1.56E+01	8.71E+00	4.20E+00	1.24E-02	8.45E-06	3.96E-12
gd155	1.75E-01	1.81E-01	8.10E-01	2.62E+00	9.51E+00	1.40E+01	1.82E+01	1.82E+01	1.82E+01
i131	5.32E+00	5.03E+00	2.37E-03	1.15E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	8.89E-02	7.46E-02	3.24E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
i133	1.00E+00	5.33E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	2.97E-03	1.17E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	2.10E-01	2.83E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	4.34E+01	4.34E+01	4.28E+01	4.07E+01	3.15E+01	2.28E+01	1.74E+00	6.94E-02	1.11E-04
kr85m	7.29E-03	3.85E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	5.68E-04	1.80E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	7.41E-03	7.16E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
la140	2.08E+00	2.02E+00	1.67E-02	5.38E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	7.97E-02	2.77E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	7.57E-03	1.29E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03	2.03E+03
mo95	1.45E+03	1.45E+03	1.48E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03
mo97	1.71E+03	1.71E+03	1.71E+03	1.71E+03	1.71E+03	1.71E+03	1.71E+03	1.71E+03	1.71E+03
mo98	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03	1.80E+03
mo99	2.36E+00	1.93E+00	3.46E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	2.63E-03	2.63E-03	2.76E-03	3.16E-03	5.05E-03	7.01E-03	1.37E-02	1.50E-02	1.52E-02
nb95	2.43E+01	2.43E+01	1.53E+01	1.01E+00	1.41E-07	3.70E-16	0.00E+00	0.00E+00	0.00E+00
nb97	3.34E-02	1.43E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	4.03E-04	1.83E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	1.13E+03	1.13E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03	1.14E+03
nd144	3.09E+03	3.09E+03	3.14E+03	3.24E+03	3.35E+03	3.35E+03	3.35E+03	3.35E+03	3.35E+03
nd145	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
nd147	5.07E+00	4.82E+00	1.75E-02	5.05E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02
np237	8.99E+02	9.00E+02	9.08E+02	9.08E+02	9.10E+02	9.15E+02	9.89E+02	1.10E+03	1.32E+03
np239	6.20E+01	4.91E+01	3.78E-04	3.78E-04	3.78E-04	3.78E-04	3.76E-04	3.74E-04	3.71E-04
pm147	1.94E+02	1.95E+02	1.87E+02	1.53E+02	5.33E+01	1.42E+01	3.69E-04	6.81E-10	2.32E-21
pr141	2.32E+03	2.32E+03	2.35E+03	2.35E+03	2.35E+03	2.35E+03	2.35E+03	2.35E+03	2.35E+03
pr143	1.34E+01	1.33E+01	1.51E-01	1.20E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.09E-02	1.09E-02	8.75E-03	4.48E-03	1.29E-04	1.52E-06	5.68E-22	0.00E+00	0.00E+00
pr144m	4.33E-05	4.32E-05	3.48E-05	1.78E-05	5.11E-07	6.03E-09	2.26E-24	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pu238	5.39E+02	5.39E+02	5.50E+02	5.63E+02	5.52E+02	5.31E+02	3.87E+02	2.61E+02	1.19E+02
pu239	4.87E+03	4.88E+03	4.93E+03	4.93E+03	4.93E+03	4.93E+03	4.93E+03	4.92E+03	4.91E+03
pu240	3.44E+03	3.44E+03	3.45E+03	3.45E+03	3.49E+03	3.52E+03	3.65E+03	3.66E+03	3.63E+03
pu241	1.57E+03	1.57E+03	1.55E+03	1.50E+03	1.23E+03	9.67E+02	1.39E+02	1.23E+01	1.23E-01
pu242	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03
rb86	3.86E-02	3.74E-02	1.37E-03	4.92E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	8.63E-04	8.34E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	7.33E+02	7.33E+02	7.62E+02	7.70E+02	7.70E+02	7.70E+02	7.70E+02	7.70E+02	7.70E+02
rh103m	3.64E-02	3.59E-02	7.45E-03	5.80E-05	3.67E-16	3.69E-30	0.00E+00	0.00E+00	0.00E+00
rh105	9.77E-01	7.21E-01	4.74E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.81E-04	1.81E-04	1.53E-04	9.18E-05	6.03E-06	2.01E-07	3.03E-19	5.06E-34	0.00E+00
ru101	1.63E+03	1.63E+03	1.63E+03	1.63E+03	1.63E+03	1.63E+03	1.63E+03	1.63E+03	1.63E+03
ru103	3.71E+01	3.65E+01	7.59E+00	5.90E-02	3.74E-13	3.75E-27	0.00E+00	0.00E+00	0.00E+00
ru105	6.57E-02	3.38E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	1.94E+02	1.93E+02	1.64E+02	9.80E+01	6.45E+00	2.15E-01	3.24E-13	5.41E-28	0.00E+00
sb125	1.26E+01	1.26E+01	1.19E+01	9.83E+00	3.60E+00	1.03E+00	4.46E-05	1.57E-10	1.96E-21
sm147	2.15E+02	2.15E+02	2.27E+02	2.61E+02	3.61E+02	4.00E+02	4.14E+02	4.14E+02	4.14E+02
sm149	1.74E+00	1.93E+00	2.62E+00	2.62E+00	2.62E+00	2.62E+00	2.62E+00	2.62E+00	2.62E+00
sm150	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02
sm151	1.35E+01	1.36E+01	1.37E+01	1.36E+01	1.32E+01	1.27E+01	9.33E+00	6.35E+00	2.94E+00
sm152	1.78E+02	1.78E+02	1.78E+02	1.78E+02	1.78E+02	1.78E+02	1.78E+02	1.78E+02	1.78E+02
sr89	1.49E+01	1.47E+01	4.33E+00	9.96E-02	2.00E-10	2.68E-21	0.00E+00	0.00E+00	0.00E+00
sr90	1.02E+03	1.02E+03	1.02E+03	9.97E+02	9.05E+02	8.03E+02	3.07E+02	9.21E+01	8.30E+00
sr91	1.14E-01	2.89E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	1.46E-02	1.13E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	1.58E+03	1.58E+03	1.59E+03	1.59E+03	1.59E+03	1.59E+03	1.59E+03	1.59E+03	1.59E+03
tc99m	1.98E-01	1.69E-01	3.05E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	1.62E-01	1.62E-01	1.61E-01	1.37E-01	5.02E-02	1.43E-02	6.22E-07	2.19E-12	2.73E-23
te127	2.43E-02	2.25E-02	1.06E-03	1.85E-04	1.72E-08	1.57E-13	0.00E+00	0.00E+00	0.00E+00
te127m	4.94E-01	4.97E-01	3.04E-01	5.29E-02	4.91E-06	4.48E-11	0.00E+00	0.00E+00	0.00E+00
te129	6.15E-03	1.27E-03	1.61E-04	5.52E-07	4.59E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.13E+00	1.11E+00	1.77E-01	6.08E-04	5.05E-17	2.25E-33	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te131	5.75E-04	3.77E-04	1.73E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.70E-01	1.15E-01	5.25E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	2.88E+00	2.43E+00	1.05E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.68E+02	1.68E+02	1.69E+02	1.73E+02	1.90E+02	2.11E+02	3.52E+02	4.76E+02	6.16E+02
u235	3.43E+03	3.43E+03	3.43E+03	3.43E+03	3.43E+03	3.43E+03	3.44E+03	3.44E+03	3.46E+03
u236	7.40E+03	7.40E+03	7.40E+03	7.40E+03	7.40E+03	7.40E+03	7.42E+03	7.44E+03	7.48E+03
u238	9.01E+05	9.01E+05	9.01E+05	9.01E+05	9.01E+05	9.01E+05	9.01E+05	9.01E+05	9.01E+05
xe132	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03
xe133	6.70E+00	6.49E+00	5.65E-05	9.17E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03	3.28E+03
xe135	2.08E-01	1.26E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	1.40E-03	1.89E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	4.81E+03	4.81E+03	4.81E+03	4.81E+03	4.81E+03	4.81E+03	4.81E+03	4.81E+03	4.81E+03
y90	2.73E-01	2.70E-01	2.57E-01	2.53E-01	2.30E-01	2.04E-01	7.78E-02	2.34E-02	2.11E-03
y91	2.41E+01	2.40E+01	8.36E+00	3.22E-01	9.90E-09	4.04E-18	0.00E+00	0.00E+00	0.00E+00
y91m	6.27E-03	1.60E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	4.78E-02	2.18E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	1.72E-01	4.72E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03	1.48E+03
zr95	4.43E+01	4.39E+01	1.67E+01	8.53E-01	1.17E-07	3.07E-16	0.00E+00	0.00E+00	0.00E+00
zr97	4.35E-01	1.98E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	97.6%	97.6%	97.6%	97.6%	97.6%	97.6%	97.5%	97.5%	97.5%

APPENDIX B. PWR RESULTS

Table B.1. Total activity (Ci/MTU) for PWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
PWR-1 (28GWd/MTU)	7.38E+07	5.47E+07	6.76E+06	2.26E+06	5.14E+05	3.46E+05	1.11E+05	3.54E+04	7.17E+03
PWR-2 (39GWd/MTU)	7.49E+07	5.58E+07	7.42E+06	2.71E+06	6.84E+05	4.69E+05	1.52E+05	4.85E+04	9.71E+03
PWR-3 (47GWd/MTU)	7.53E+07	5.61E+07	7.79E+06	2.98E+06	8.02E+05	5.56E+05	1.81E+05	5.81E+04	1.15E+04
PWR-Ext (72GWd/MTU)	7.88E+07	5.91E+07	8.60E+06	3.68E+06	1.13E+06	7.97E+05	2.64E+05	8.53E+04	1.65E+04

Table B.2. Total gamma heat (W/MTU) for PWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
PWR-1 (28GWd/MTU)	1.65E+05	1.12E+05	1.10E+04	2.07E+03	5.37E+02	2.98E+02	9.63E+01	3.07E+01	3.52E+00
PWR-2 (39GWd/MTU)	1.67E+05	1.14E+05	1.20E+04	2.84E+03	8.01E+02	4.26E+02	1.33E+02	4.23E+01	4.83E+00
PWR-3 (47GWd/MTU)	1.69E+05	1.15E+05	1.27E+04	3.37E+03	9.90E+02	5.18E+02	1.59E+02	5.06E+01	5.76E+00
PWR-Ext (72GWd/MTU)	1.75E+05	1.22E+05	1.49E+04	5.25E+03	1.64E+03	8.09E+02	2.39E+02	7.57E+01	8.51E+00

Table B.3. Total decay heat (W/MTU) for PWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
PWR-1 (28GWd/MTU)	3.11E+05	2.06E+05	2.70E+04	9.09E+03	1.49E+03	9.29E+02	4.57E+02	2.55E+02	1.49E+02
PWR-2 (39GWd/MTU)	3.16E+05	2.12E+05	3.07E+04	1.14E+04	2.14E+03	1.36E+03	6.48E+02	3.55E+02	2.01E+02
PWR-3 (47GWd/MTU)	3.19E+05	2.15E+05	3.28E+04	1.27E+04	2.63E+03	1.69E+03	7.91E+02	4.27E+02	2.35E+02
PWR-Ext (72GWd/MTU)	3.32E+05	2.29E+05	3.92E+04	1.74E+04	4.47E+03	2.95E+03	1.28E+03	6.55E+02	3.35E+02

Table B.4. Total photon emission (photon/s/MTU) for PWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
PWR-1 (28GWd/MTU)	3.38E+18	2.45E+18	1.85E+17	5.64E+16	9.06E+15	5.07E+15	1.81E+15	6.26E+14	1.35E+14
PWR-2 (39GWd/MTU)	3.41E+18	2.49E+18	2.05E+17	6.97E+16	1.27E+16	7.09E+15	2.47E+15	8.54E+14	1.81E+14
PWR-3 (47GWd/MTU)	3.41E+18	2.49E+18	2.16E+17	7.76E+16	1.53E+16	8.57E+15	2.96E+15	1.02E+15	2.12E+14
PWR-Ext (72GWd/MTU)	3.57E+18	2.64E+18	2.47E+17	1.03E+17	2.36E+16	1.29E+16	4.32E+15	1.47E+15	2.93E+14

Table B.5. Total neutron emission (neutron/s/MTU) for PWR fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
PWR-1 (28GWd/MTU)	4.17E+08	4.17E+08	3.44E+08	2.31E+08	1.58E+08	1.32E+08	3.50E+07	1.16E+07	6.83E+06
PWR-2 (39GWd/MTU)	9.43E+08	9.43E+08	8.08E+08	5.98E+08	4.40E+08	3.66E+08	8.99E+07	2.40E+07	1.15E+07
PWR-3 (47GWd/MTU)	1.37E+09	1.37E+09	1.19E+09	9.17E+08	6.91E+08	5.74E+08	1.39E+08	3.53E+07	1.60E+07
PWR-Ext (72GWd/MTU)	4.46E+09	4.46E+09	4.12E+09	3.54E+09	2.81E+09	2.31E+09	5.59E+08	1.45E+08	7.15E+07

Table B.6. Neutron flux (neutron/cm^2-sec/MTU) for PWR fuel

Group ID	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
PWR-1 (28GWd/MTU)	2.39E+04	2.39E+04	1.97E+04	1.32E+04	9.04E+03	7.55E+03	2.00E+03	6.64E+02	3.91E+02
PWR-2 (39GWd/MTU)	5.39E+04	5.39E+04	4.62E+04	3.42E+04	2.52E+04	2.09E+04	5.14E+03	1.37E+03	6.58E+02
PWR-3 (47GWd/MTU)	7.84E+04	7.84E+04	6.81E+04	5.25E+04	3.95E+04	3.28E+04	7.95E+03	2.02E+03	9.15E+02
PWR-Ext (72GWd/MTU)	2.55E+05	2.55E+05	2.36E+05	2.02E+05	1.61E+05	1.32E+05	3.20E+04	8.29E+03	4.09E+03

Table B.7. Pu total (gram/MTU) for PWR fuel

Group ID	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
PWR-1 (28GWd/MTU)	9.13E+03	9.15E+03	9.22E+03	9.18E+03	8.98E+03	8.78E+03	8.13E+03	7.99E+03	7.92E+03
PWR-2 (39GWd/MTU)	1.08E+04	1.08E+04	1.09E+04	1.08E+04	1.06E+04	1.03E+04	9.48E+03	9.30E+03	9.19E+03
PWR-3 (47GWd/MTU)	1.19E+04	1.19E+04	1.19E+04	1.19E+04	1.16E+04	1.13E+04	1.03E+04	1.01E+04	9.99E+03
PWR-Ext (72GWd/MTU)	1.43E+04	1.43E+04	1.44E+04	1.43E+04	1.40E+04	1.37E+04	1.25E+04	1.22E+04	1.19E+04

Table B.8. Nuclide activities (Ci/MTU) for PWR-1 (28 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	9.96E+01	1.00E+02	1.47E+02	2.90E+02	9.63E+02	1.63E+03	3.57E+03	3.61E+03	3.10E+03
ba137m	8.49E+04	8.49E+04	8.44E+04	8.29E+04	7.56E+04	6.74E+04	2.68E+04	8.48E+03	8.48E+02
ba139	1.71E+05	1.26E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.75E+06	1.68E+06	1.33E+04	4.29E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.66E+06	1.63E+06	2.45E+05	6.95E+02	2.10E-11	2.64E-28	0.00E+00	0.00E+00	0.00E+00
ce143	1.39E+06	9.35E+05	3.22E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	1.14E+06	1.14E+06	9.20E+05	4.71E+05	1.35E+04	1.59E+02	5.97E-14	0.00E+00	0.00E+00
cm242	3.23E+04	3.23E+04	2.22E+04	6.88E+03	1.65E+01	2.64E+00	2.17E+00	1.69E+00	1.04E+00
cm244	1.33E+03	1.33E+03	1.32E+03	1.28E+03	1.10E+03	9.10E+02	1.97E+02	2.91E+01	6.35E-01
cs134	1.23E+05	1.23E+05	1.13E+05	8.80E+04	2.30E+04	4.30E+03	6.41E-03	3.34E-10	9.06E-25
cs136	3.64E+04	3.49E+04	3.21E+02	1.65E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	8.96E+04	8.96E+04	8.91E+04	8.76E+04	7.99E+04	7.12E+04	2.83E+04	8.96E+03	8.96E+02
i131	1.04E+06	9.80E+05	4.61E+02	2.23E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.46E+06	1.23E+06	5.33E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.83E+06	9.71E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	1.32E+05	5.21E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	1.19E+06	1.60E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	8.68E+03	8.68E+03	8.55E+03	8.14E+03	6.29E+03	4.56E+03	3.47E+02	1.39E+01	2.21E-02
kr85m	1.16E+05	6.13E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	3.22E+04	1.02E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
kr88	1.88E+05	1.82E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.81E+06	1.78E+06	1.53E+04	4.94E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	7.51E+05	2.61E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.85E+05	3.15E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.81E+06	1.49E+06	2.67E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.59E+06	1.59E+06	1.02E+06	6.76E+04	9.45E-03	2.49E-11	0.00E+00	0.00E+00	0.00E+00
nb97	1.49E+06	6.37E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	1.33E+06	6.04E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	6.51E+05	6.19E+05	2.25E+03	6.49E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
np239	2.20E+07	1.74E+07	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.33E+01	1.32E+01	1.31E+01
pr143	1.53E+06	1.52E+06	1.72E+04	1.36E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.14E+06	1.14E+06	9.20E+05	4.71E+05	1.35E+04	1.59E+02	5.97E-14	0.00E+00	0.00E+00
pr144m	1.09E+04	1.09E+04	8.78E+03	4.50E+03	1.29E+02	1.52E+00	5.70E-16	0.00E+00	0.00E+00
pu238	1.58E+03	1.59E+03	1.65E+03	1.72E+03	1.70E+03	1.63E+03	1.19E+03	8.03E+02	3.65E+02
pu239	3.35E+02	3.37E+02	3.41E+02	3.41E+02	3.41E+02	3.41E+02	3.41E+02	3.40E+02	3.39E+02
pu240	4.74E+02	4.74E+02	4.74E+02	4.74E+02	4.75E+02	4.75E+02	4.75E+02	4.73E+02	4.68E+02
pu241	1.22E+05	1.22E+05	1.21E+05	1.16E+05	9.58E+04	7.52E+04	1.08E+04	9.58E+02	7.66E+00
rb86	1.65E+03	1.60E+03	5.84E+01	2.10E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	2.10E+05	2.03E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.66E+06	1.63E+06	3.39E+05	2.64E+03	1.67E-08	1.68E-22	0.00E+00	0.00E+00	0.00E+00
rh105	1.07E+06	7.88E+05	5.17E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	5.07E+05	5.07E+05	4.29E+05	2.57E+05	1.69E+04	5.62E+02	8.48E-10	1.42E-24	0.00E+00
ru103	1.67E+06	1.65E+06	3.43E+05	2.67E+03	1.69E-08	1.70E-22	0.00E+00	0.00E+00	0.00E+00
ru105	5.83E+05	3.00E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	5.07E+05	5.07E+05	4.29E+05	2.57E+05	1.69E+04	5.62E+02	8.48E-10	1.42E-24	0.00E+00
sr89	8.80E+05	8.70E+05	2.57E+05	5.90E+03	1.18E-05	1.59E-16	0.00E+00	0.00E+00	0.00E+00
sr90	6.37E+04	6.37E+04	6.33E+04	6.22E+04	5.65E+04	5.01E+04	1.91E+04	5.75E+03	5.18E+02
sr91	7.93E+05	2.02E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	3.47E+05	2.68E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.68E+06	1.43E+06	2.58E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	9.45E+04	8.69E+04	4.09E+03	7.12E+02	6.61E-02	6.02E-07	0.00E+00	0.00E+00	0.00E+00
te127m	6.78E+03	6.82E+03	4.18E+03	7.27E+02	6.75E-02	6.15E-07	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te129	1.90E+05	3.91E+04	4.93E+03	1.69E+01	1.41E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	4.97E+04	4.90E+04	7.81E+03	2.69E+01	2.23E-12	9.95E-29	0.00E+00	0.00E+00	0.00E+00
te131	5.02E+04	3.29E+04	1.51E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.86E+05	1.25E+05	5.74E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	1.41E+06	1.19E+06	5.17E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	2.11E+06	2.04E+06	1.77E+01	2.87E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	8.08E+05	5.02E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.04E+05	2.75E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	6.65E+04	6.60E+04	6.34E+04	6.22E+04	5.65E+04	5.01E+04	1.91E+04	5.75E+03	5.18E+02
y91	1.15E+06	1.15E+06	4.00E+05	1.54E+04	4.74E-04	1.93E-13	0.00E+00	0.00E+00	0.00E+00
y91m	5.09E+05	1.30E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	8.68E+05	3.96E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	1.04E+06	2.85E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.63E+06	1.61E+06	6.15E+05	3.13E+04	4.29E-03	1.13E-11	0.00E+00	0.00E+00	0.00E+00
zr97	1.39E+06	6.34E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total[a]	7.38E+07	5.47E+07	6.76E+06	2.26E+06	5.14E+05	3.46E+05	1.11E+05	3.54E+04	7.17E+03
Subtotal[b]	93.0%	94.5%	97.0%	93.4%	89.3%	95.1%	99.1%	99.4%	98.6%

[a] Total includes contributions from all actinides and fission products in the fuel.
[b] Subtotal is the percent contribution of nuclides listed in the table to the total.

Table B.9. Nuclide activities (Ci/MTU) for PWR-2 (39 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	1.59E+02	1.60E+02	2.21E+02	4.06E+02	1.28E+03	2.15E+03	4.66E+03	4.70E+03	4.04E+03
ba137m	1.17E+05	1.17E+05	1.17E+05	1.14E+05	1.04E+05	9.30E+04	3.70E+04	1.17E+04	1.17E+03
ba139	1.70E+05	1.25E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.73E+06	1.66E+06	1.32E+04	4.25E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.64E+06	1.62E+06	2.43E+05	6.90E+02	2.08E-11	2.62E-28	0.00E+00	0.00E+00	0.00E+00
ce143	1.37E+06	9.21E+05	3.18E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	1.25E+06	1.25E+06	1.01E+06	5.15E+05	1.48E+04	1.74E+02	6.52E-14	0.00E+00	0.00E+00
cm242	5.85E+04	5.85E+04	4.01E+04	1.25E+04	2.95E+01	4.40E+00	3.61E+00	2.82E+00	1.73E+00
cm244	3.77E+03	3.77E+03	3.74E+03	3.63E+03	3.11E+03	2.57E+03	5.57E+02	8.23E+01	1.80E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
cs134	2.04E+05	2.04E+05	1.88E+05	1.46E+05	3.81E+04	7.13E+03	1.06E-02	5.53E-10	1.50E-24
cs136	5.10E+04	4.90E+04	4.51E+02	2.31E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.24E+05	1.24E+05	1.23E+05	1.21E+05	1.10E+05	9.82E+04	3.91E+04	1.24E+04	1.24E+03
i131	1.04E+06	9.81E+05	4.62E+02	2.23E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.46E+06	1.23E+06	5.33E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.82E+06	9.67E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	1.31E+05	5.16E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	1.19E+06	1.60E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.16E+04	1.16E+04	1.14E+04	1.09E+04	8.39E+03	6.08E+03	4.63E+02	1.85E+01	2.95E-02
kr85m	1.11E+05	5.88E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	3.07E+04	9.71E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.79E+05	1.73E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.81E+06	1.78E+06	1.52E+04	4.89E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	7.43E+05	2.58E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.82E+05	3.11E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.81E+06	1.48E+06	2.66E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.61E+06	1.61E+06	1.02E+06	6.73E+04	9.40E-03	2.47E-11	0.00E+00	0.00E+00	0.00E+00
nb97	1.48E+06	6.31E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	1.31E+06	5.98E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	6.50E+05	6.18E+05	2.24E+03	6.48E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
np239	2.18E+07	1.73E+07	2.75E+01	2.75E+01	2.75E+01	2.75E+01	2.74E+01	2.73E+01	2.70E+01
pr143	1.51E+06	1.49E+06	1.69E+04	1.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.25E+06	1.25E+06	1.01E+06	5.15E+05	1.48E+04	1.74E+02	6.52E-14	0.00E+00	0.00E+00
pr144m	1.19E+04	1.19E+04	9.59E+03	4.91E+03	1.41E+02	1.66E+00	6.23E-16	0.00E+00	0.00E+00
pu238	3.20E+03	3.21E+03	3.32E+03	3.44E+03	3.39E+03	3.26E+03	2.38E+03	1.61E+03	7.30E+02
pu239	3.68E+02	3.69E+02	3.74E+02	3.74E+02	3.74E+02	3.74E+02	3.73E+02	3.73E+02	3.72E+02
pu240	5.83E+02	5.83E+02	5.83E+02	5.83E+02	5.84E+02	5.85E+02	5.89E+02	5.87E+02	5.81E+02
pu241	1.58E+05	1.58E+05	1.56E+05	1.51E+05	1.24E+05	9.75E+04	1.40E+04	1.24E+03	1.02E+01
rb86	2.32E+03	2.25E+03	8.22E+01	2.96E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	2.00E+05	1.93E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.71E+06	1.69E+06	3.51E+05	2.73E+03	1.73E-08	1.73E-22	0.00E+00	0.00E+00	0.00E+00
rh105	1.12E+06	8.26E+05	5.43E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
rh106	6.34E+05	6.33E+05	5.36E+05	3.21E+05	2.11E+04	7.03E+02	1.06E-09	1.77E-24	0.00E+00
ru103	1.73E+06	1.71E+06	3.55E+05	2.76E+03	1.75E-08	1.75E-22	0.00E+00	0.00E+00	0.00E+00
ru105	6.09E+05	3.13E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	6.34E+05	6.33E+05	5.36E+05	3.21E+05	2.11E+04	7.03E+02	1.06E-09	1.77E-24	0.00E+00
sr89	8.41E+05	8.32E+05	2.45E+05	5.64E+03	1.13E-05	1.52E-16	0.00E+00	0.00E+00	0.00E+00
sr90	8.62E+04	8.62E+04	8.57E+04	8.42E+04	7.65E+04	6.78E+04	2.59E+04	7.78E+03	7.01E+02
sr91	7.59E+05	1.93E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	3.34E+05	2.58E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.67E+06	1.42E+06	2.57E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	9.65E+04	8.86E+04	4.34E+03	7.56E+02	7.02E-02	6.40E-07	0.00E+00	0.00E+00	0.00E+00
te127m	7.23E+03	7.27E+03	4.44E+03	7.72E+02	7.17E-02	6.53E-07	0.00E+00	0.00E+00	0.00E+00
te129	1.93E+05	3.98E+04	5.03E+03	1.73E+01	1.44E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	5.07E+04	5.00E+04	7.97E+03	2.74E+01	2.27E-12	1.01E-28	0.00E+00	0.00E+00	0.00E+00
te131	5.05E+04	3.30E+04	1.51E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.87E+05	1.26E+05	5.77E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	1.41E+06	1.19E+06	5.17E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	2.10E+06	2.03E+06	1.76E+01	2.86E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	8.30E+05	5.07E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.04E+05	2.74E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	9.01E+04	8.94E+04	8.57E+04	8.42E+04	7.65E+04	6.78E+04	2.59E+04	7.78E+03	7.01E+02
y91	1.12E+06	1.11E+06	3.87E+05	1.49E+04	4.59E-04	1.87E-13	0.00E+00	0.00E+00	0.00E+00
y91m	4.87E+05	1.24E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	8.36E+05	3.82E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	1.01E+06	2.76E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.62E+06	1.60E+06	6.12E+05	3.12E+04	4.26E-03	1.12E-11	0.00E+00	0.00E+00	0.00E+00
zr97	1.38E+06	6.28E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.49E+07	5.58E+07	7.42E+06	2.71E+06	6.84E+05	4.69E+05	1.52E+05	4.85E+04	9.71E+03
Subtotal	92.1%	93.7%	96.9%	93.7%	90.5%	95.5%	99.3%	99.6%	98.6%

Table B.10. Nuclide activities (Ci/MTU) for PWR-3 (47 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	2.03E+02	2.04E+02	2.74E+02	4.83E+02	1.47E+03	2.46E+03	5.30E+03	5.35E+03	4.59E+03
ba137m	1.40E+05	1.40E+05	1.39E+05	1.37E+05	1.25E+05	1.11E+05	4.43E+04	1.40E+04	1.40E+03
ba139	1.69E+05	1.25E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.73E+06	1.66E+06	1.32E+04	4.24E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.64E+06	1.62E+06	2.42E+05	6.88E+02	2.08E-11	2.62E-28	0.00E+00	0.00E+00	0.00E+00
ce143	1.37E+06	9.19E+05	3.17E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	1.30E+06	1.30E+06	1.04E+06	5.35E+05	1.53E+04	1.81E+02	6.78E-14	0.00E+00	0.00E+00
cm242	7.62E+04	7.61E+04	5.23E+04	1.62E+04	3.85E+01	5.77E+00	4.73E+00	3.70E+00	2.26E+00
cm244	5.93E+03	5.93E+03	5.88E+03	5.71E+03	4.90E+03	4.05E+03	8.76E+02	1.29E+02	2.82E+00
cs134	2.63E+05	2.63E+05	2.42E+05	1.88E+05	4.91E+04	9.18E+03	1.37E-02	7.13E-10	1.93E-24
cs136	6.30E+04	6.04E+04	5.56E+02	2.85E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.48E+05	1.48E+05	1.47E+05	1.45E+05	1.32E+05	1.18E+05	4.68E+04	1.48E+04	1.48E+03
i131	1.04E+06	9.79E+05	4.61E+02	2.23E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.46E+06	1.22E+06	5.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.82E+06	9.66E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	1.31E+05	5.16E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	1.19E+06	1.60E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.37E+04	1.37E+04	1.35E+04	1.29E+04	9.96E+03	7.22E+03	5.49E+02	2.19E+01	3.50E-02
kr85m	1.11E+05	5.85E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	3.05E+04	9.66E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.78E+05	1.72E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.81E+06	1.78E+06	1.51E+04	4.88E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	7.41E+05	2.57E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.82E+05	3.10E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.81E+06	1.48E+06	2.66E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.62E+06	1.62E+06	1.02E+06	6.73E+04	9.40E-03	2.47E-11	0.00E+00	0.00E+00	0.00E+00
nb97	1.47E+06	6.30E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	1.31E+06	5.97E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	6.51E+05	6.20E+05	2.25E+03	6.49E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
np239	2.13E+07	1.69E+07	3.74E+01	3.74E+01	3.74E+01	3.74E+01	3.73E+01	3.71E+01	3.67E+01

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pr143	1.50E+06	1.49E+06	1.69E+04	1.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.30E+06	1.30E+06	1.04E+06	5.35E+05	1.53E+04	1.81E+02	6.78E-14	0.00E+00	0.00E+00
pr144m	1.24E+04	1.24E+04	9.97E+03	5.11E+03	1.46E+02	1.73E+00	6.47E-16	0.00E+00	0.00E+00
pu238	4.68E+03	4.69E+03	4.83E+03	4.98E+03	4.91E+03	4.72E+03	3.44E+03	2.32E+03	1.06E+03
pu239	3.91E+02	3.93E+02	3.97E+02	3.97E+02	3.97E+02	3.97E+02	3.97E+02	3.96E+02	3.95E+02
pu240	6.38E+02	6.38E+02	6.38E+02	6.38E+02	6.40E+02	6.42E+02	6.48E+02	6.47E+02	6.41E+02
pu241	1.79E+05	1.79E+05	1.77E+05	1.71E+05	1.41E+05	1.10E+05	1.59E+04	1.41E+03	1.19E+01
rb86	2.81E+03	2.73E+03	9.95E+01	3.59E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.98E+05	1.92E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.72E+06	1.70E+06	3.52E+05	2.74E+03	1.73E-08	1.74E-22	0.00E+00	0.00E+00	0.00E+00
rh105	1.13E+06	8.34E+05	5.48E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	6.87E+05	6.86E+05	5.81E+05	3.48E+05	2.29E+04	7.62E+02	1.15E-09	1.92E-24	0.00E+00
ru103	1.74E+06	1.72E+06	3.56E+05	2.77E+03	1.75E-08	1.76E-22	0.00E+00	0.00E+00	0.00E+00
ru105	6.12E+05	3.15E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	6.87E+05	6.86E+05	5.81E+05	3.48E+05	2.29E+04	7.62E+02	1.15E-09	1.92E-24	0.00E+00
sr89	8.35E+05	8.26E+05	2.44E+05	5.61E+03	1.12E-05	1.51E-16	0.00E+00	0.00E+00	0.00E+00
sr90	1.04E+05	1.04E+05	1.03E+05	1.01E+05	9.19E+04	8.14E+04	3.11E+04	9.34E+03	8.42E+02
sr91	7.54E+05	1.92E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	3.32E+05	2.57E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.67E+06	1.42E+06	2.57E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	9.64E+04	8.86E+04	4.51E+03	7.84E+02	7.28E-02	6.64E-07	0.00E+00	0.00E+00	0.00E+00
te127m	7.52E+03	7.56E+03	4.60E+03	8.00E+02	7.43E-02	6.77E-07	0.00E+00	0.00E+00	0.00E+00
te129	1.93E+05	3.98E+04	5.02E+03	1.73E+01	1.43E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	5.06E+04	4.99E+04	7.96E+03	2.74E+01	2.27E-12	1.01E-28	0.00E+00	0.00E+00	0.00E+00
te131	5.02E+04	3.28E+04	1.51E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.86E+05	1.25E+05	5.74E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	1.41E+06	1.19E+06	5.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	2.10E+06	2.03E+06	1.76E+01	2.86E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	8.53E+05	5.12E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.04E+05	2.74E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	1.08E+05	1.07E+05	1.03E+05	1.01E+05	9.19E+04	8.15E+04	3.11E+04	9.34E+03	8.43E+02
y91	1.11E+06	1.11E+06	3.85E+05	1.48E+04	4.56E-04	1.86E-13	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
y91m	4.85E+05	1.24E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	8.32E+05	3.80E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	1.00E+06	2.75E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.62E+06	1.60E+06	6.12E+05	3.12E+04	4.26E-03	1.12E-11	0.00E+00	0.00E+00	0.00E+00
zr97	1.38E+06	6.27E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.53E+07	5.61E+07	7.79E+06	2.98E+06	8.02E+05	5.56E+05	1.81E+05	5.81E+04	1.15E+04
Subtotal	91.5%	93.2%	96.7%	93.3%	90.9%	95.9%	100.0%	99.5%	98.3%

Table B.11. Nuclide activities (Ci/MTU) for PWR-Ext (72 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	2.89E+02	2.90E+02	3.77E+02	6.40E+02	1.88E+03	3.11E+03	6.68E+03	6.73E+03	5.79E+03
ba137m	2.10E+05	2.10E+05	2.09E+05	2.05E+05	1.87E+05	1.67E+05	6.64E+04	2.10E+04	2.10E+03
ba139	1.65E+05	1.22E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.68E+06	1.61E+06	1.28E+04	4.12E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.59E+06	1.57E+06	2.35E+05	6.67E+02	2.02E-11	2.54E-28	0.00E+00	0.00E+00	0.00E+00
ce143	1.31E+06	8.76E+05	3.02E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	1.29E+06	1.29E+06	1.04E+06	5.33E+05	1.53E+04	1.80E+02	6.75E-14	0.00E+00	0.00E+00
cm242	1.37E+05	1.37E+05	9.38E+04	2.91E+04	6.70E+01	8.34E+00	6.83E+00	5.34E+00	3.27E+00
cm244	2.37E+04	2.37E+04	2.35E+04	2.29E+04	1.96E+04	1.62E+04	3.51E+03	5.18E+02	1.13E+01
cs134	4.83E+05	4.83E+05	4.45E+05	3.46E+05	9.03E+04	1.69E+04	2.52E-02	1.31E-09	3.56E-24
cs136	1.04E+05	9.98E+04	9.19E+02	4.71E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	2.22E+05	2.22E+05	2.21E+05	2.17E+05	1.98E+05	1.76E+05	7.01E+04	2.22E+04	2.22E+03
i131	1.05E+06	9.87E+05	4.65E+02	2.25E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.46E+06	1.22E+06	5.31E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.80E+06	9.54E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	1.26E+05	4.98E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	1.18E+06	1.59E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.85E+04	1.85E+04	1.82E+04	1.74E+04	1.34E+04	9.73E+03	7.40E+02	2.96E+01	4.72E-02
kr85m	9.66E+04	5.10E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	2.60E+04	8.22E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
kr88	1.50E+05	1.45E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.80E+06	1.76E+06	1.47E+04	4.75E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	7.19E+05	2.49E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.75E+05	2.98E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.79E+06	1.47E+06	2.64E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.53E+06	1.53E+06	9.58E+05	6.32E+04	8.83E-03	2.32E-11	0.00E+00	0.00E+00	0.00E+00
nb97	1.43E+06	6.11E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	1.27E+06	5.79E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	6.45E+05	6.14E+05	2.23E+03	6.43E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
np239	2.29E+07	1.81E+07	9.38E+01	9.38E+01	9.38E+01	9.38E+01	9.34E+01	9.30E+01	9.21E+01
pr143	1.43E+06	1.42E+06	1.61E+04	1.28E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.29E+06	1.29E+06	1.04E+06	5.33E+05	1.53E+04	1.80E+02	6.75E-14	0.00E+00	0.00E+00
pr144m	1.24E+04	1.23E+04	9.93E+03	5.08E+03	1.46E+02	1.72E+00	6.44E-16	0.00E+00	0.00E+00
pu238	1.09E+04	1.09E+04	1.12E+04	1.15E+04	1.12E+04	1.08E+04	7.88E+03	5.31E+03	2.41E+03
pu239	4.06E+02	4.08E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.11E+02
pu240	8.03E+02	8.03E+02	8.03E+02	8.05E+02	8.14E+02	8.23E+02	8.54E+02	8.58E+02	8.50E+02
pu241	2.25E+05	2.25E+05	2.22E+05	2.14E+05	1.77E+05	1.39E+05	1.99E+04	1.77E+03	1.84E+01
rb86	4.54E+03	4.41E+03	1.61E+02	5.80E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.68E+05	1.62E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.85E+06	1.83E+06	3.80E+05	2.95E+03	1.87E-08	1.88E-22	0.00E+00	0.00E+00	0.00E+00
rh105	1.27E+06	9.36E+05	6.15E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	9.21E+05	9.20E+05	7.79E+05	4.67E+05	3.07E+04	1.02E+03	1.54E-09	2.57E-24	0.00E+00
ru103	1.87E+06	1.85E+06	3.84E+05	2.98E+03	1.89E-08	1.90E-22	0.00E+00	0.00E+00	0.00E+00
ru105	6.91E+05	3.56E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	9.21E+05	9.20E+05	7.79E+05	4.67E+05	3.07E+04	1.02E+03	1.54E-09	2.57E-24	0.00E+00
sr89	7.01E+05	6.94E+05	2.05E+05	4.70E+03	9.43E-06	1.27E-16	0.00E+00	0.00E+00	0.00E+00
sr90	1.44E+05	1.44E+05	1.43E+05	1.40E+05	1.28E+05	1.13E+05	4.32E+04	1.30E+04	1.17E+03
sr91	6.54E+05	1.66E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.95E+05	2.28E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.67E+06	1.41E+06	2.55E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	1.02E+05	9.39E+04	4.63E+03	8.05E+02	7.48E-02	6.82E-07	0.00E+00	0.00E+00	0.00E+00
te127m	7.71E+03	7.75E+03	4.73E+03	8.22E+02	7.63E-02	6.96E-07	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te129	2.03E+05	4.20E+04	5.30E+03	1.82E+01	1.51E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	5.34E+04	5.26E+04	8.39E+03	2.89E+01	2.40E-12	1.07E-28	0.00E+00	0.00E+00	0.00E+00
te131	5.19E+04	3.40E+04	1.56E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	1.93E+05	1.30E+05	5.95E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	1.41E+06	1.19E+06	5.16E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	2.08E+06	2.01E+06	1.74E+01	2.83E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	8.31E+05	5.05E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.03E+05	2.73E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	1.51E+05	1.50E+05	1.43E+05	1.41E+05	1.28E+05	1.13E+05	4.32E+04	1.30E+04	1.17E+03
y91	9.60E+05	9.55E+05	3.33E+05	1.28E+04	3.95E-04	1.61E-13	0.00E+00	0.00E+00	0.00E+00
y91m	4.20E+05	1.07E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	7.38E+05	3.37E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	9.13E+05	2.50E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.52E+06	1.51E+06	5.74E+05	2.93E+04	4.00E-03	1.05E-11	0.00E+00	0.00E+00	0.00E+00
zr97	1.34E+06	6.09E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.88E+07	5.91E+07	8.60E+06	3.68E+06	1.13E+06	7.97E+05	2.64E+05	8.53E+04	1.65E+04
Subtotal	89.7%	91.5%	96.7%	94.3%	92.9%	96.4%	99.6%	99.4%	98.2%

Table B.12. Nuclide mass (gram/MTU) for PWR-1 (28 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	6.56E+01	6.57E+01	6.58E+01	6.58E+01	6.58E+01	6.58E+01	6.58E+01	6.58E+01	6.58E+01
am241	2.91E+01	2.92E+01	4.30E+01	8.45E+01	2.81E+02	4.76E+02	1.04E+03	1.05E+03	9.04E+02
am242	7.01E-02	3.08E-02	4.14E-06	4.12E-06	4.04E-06	3.94E-06	3.24E-06	2.53E-06	1.55E-06
am242m	3.21E-01	3.21E-01	3.21E-01	3.19E-01	3.13E-01	3.06E-01	2.51E-01	1.96E-01	1.20E-01
am243	6.66E+01	6.66E+01	6.66E+01	6.66E+01	6.66E+01	6.66E+01	6.63E+01	6.60E+01	6.54E+01
ba137	2.74E+01	2.75E+01	3.33E+01	5.09E+01	1.40E+02	2.40E+02	7.33E+02	9.57E+02	1.05E+03
ba137m	1.58E-04	1.58E-04	1.57E-04	1.54E-04	1.41E-04	1.25E-04	4.99E-05	1.58E-05	1.58E-06
ba138	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03
ba139	1.05E-02	7.71E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	2.39E+01	2.29E+01	1.82E-01	5.86E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ce140	1.01E+03	1.02E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03
ce141	5.81E+01	5.73E+01	8.59E+00	2.44E-02	7.37E-16	9.28E-33	0.00E+00	0.00E+00	0.00E+00
ce142	9.55E+02	9.55E+02	9.55E+02	9.55E+02	9.55E+02	9.55E+02	9.55E+02	9.55E+02	9.55E+02
ce143	2.10E+00	1.41E+00	4.86E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	3.59E+02	3.59E+02	2.89E+02	1.48E+02	4.24E+00	5.00E-02	1.88E-17	0.00E+00	0.00E+00
cm242	9.74E+00	9.74E+00	6.69E+00	2.08E+00	4.99E-03	7.98E-04	6.54E-04	5.11E-04	3.13E-04
cm243	1.74E-01	1.74E-01	1.73E-01	1.70E-01	1.54E-01	1.37E-01	5.28E-02	1.61E-02	1.49E-03
cm244	1.65E+01	1.65E+01	1.63E+01	1.59E+01	1.36E+01	1.12E+01	2.43E+00	3.60E-01	7.84E-03
cm245	8.07E-01	8.07E-01	8.07E-01	8.07E-01	8.06E-01	8.06E-01	8.03E-01	8.00E-01	7.94E-01
cs133	9.71E+02	9.72E+02	9.84E+02	9.84E+02	9.84E+02	9.84E+02	9.84E+02	9.84E+02	9.84E+02
cs134	9.53E+01	9.52E+01	8.77E+01	6.81E+01	1.78E+01	3.33E+00	4.96E-06	2.58E-13	7.01E-28
cs136	4.99E-01	4.78E-01	4.40E-03	2.26E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.03E+03	1.03E+03	1.03E+03	1.01E+03	9.20E+02	8.20E+02	3.26E+02	1.03E+02	1.03E+01
eu151	9.62E-03	9.80E-03	2.99E-02	9.16E-02	4.14E-01	8.02E-01	3.43E+00	5.76E+00	8.42E+00
eu153	9.59E+01	9.61E+01	9.68E+01	9.68E+01	9.68E+01	9.68E+01	9.68E+01	9.68E+01	9.68E+01
eu154	1.86E+01	1.86E+01	1.82E+01	1.72E+01	1.24E+01	8.32E+00	3.32E-01	5.92E-03	1.88E-06
eu155	6.35E+00	6.35E+00	6.13E+00	5.49E+00	3.06E+00	1.48E+00	4.35E-03	2.98E-06	1.39E-12
gd155	3.87E-02	4.07E-02	2.62E-01	8.99E-01	3.32E+00	4.91E+00	6.38E+00	6.39E+00	6.39E+00
i131	8.35E+00	7.88E+00	3.71E-03	1.80E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.41E-01	1.19E-01	5.15E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.61E+00	8.57E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	4.93E-03	1.95E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	3.36E-01	4.53E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	2.22E+01	2.22E+01	2.19E+01	2.08E+01	1.61E+01	1.17E+01	8.87E-01	3.54E-02	5.66E-05
kr85m	1.41E-02	7.45E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	1.14E-03	3.60E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.50E-02	1.45E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03	1.04E+03
la140	3.26E+00	3.21E+00	2.75E-02	8.88E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	1.32E-01	4.59E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.27E-02	2.16E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02	7.93E+02

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
mo95	5.34E+02	5.35E+02	5.96E+02	6.48E+02	6.51E+02	6.51E+02	6.51E+02	6.51E+02	6.51E+02
mo97	6.86E+02	6.87E+02	6.87E+02	6.87E+02	6.87E+02	6.87E+02	6.87E+02	6.87E+02	6.87E+02
mo98	7.00E+02	7.00E+02	7.00E+02	7.00E+02	7.00E+02	7.00E+02	7.00E+02	7.00E+02	7.00E+02
mo99	3.78E+00	3.09E+00	5.55E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	3.12E-04	3.12E-04	3.74E-04	5.60E-04	1.45E-03	2.37E-03	5.53E-03	6.14E-03	6.22E-03
nb95	4.05E+01	4.05E+01	2.59E+01	1.72E+00	2.40E-07	6.33E-16	0.00E+00	0.00E+00	0.00E+00
nb97	5.54E-02	2.37E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	6.69E-04	3.05E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	6.91E+02	6.92E+02	7.15E+02	7.15E+02	7.15E+02	7.15E+02	7.15E+02	7.15E+02	7.15E+02
nd144	7.19E+02	7.19E+02	7.89E+02	9.30E+02	1.07E+03	1.08E+03	1.08E+03	1.08E+03	1.08E+03
nd145	5.78E+02	5.78E+02	5.78E+02	5.78E+02	5.78E+02	5.78E+02	5.78E+02	5.78E+02	5.78E+02
nd147	8.04E+00	7.65E+00	2.78E-02	8.02E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	3.16E+02	3.16E+02	3.16E+02	3.16E+02	3.16E+02	3.16E+02	3.16E+02	3.16E+02	3.16E+02
np237	3.31E+02	3.32E+02	3.40E+02	3.40E+02	3.42E+02	3.45E+02	3.99E+02	4.82E+02	6.36E+02
np239	9.47E+01	7.50E+01	5.74E-05	5.74E-05	5.73E-05	5.73E-05	5.71E-05	5.68E-05	5.63E-05
pm147	1.78E+02	1.79E+02	1.75E+02	1.43E+02	4.98E+01	1.33E+01	3.44E-04	6.36E-10	2.17E-21
pr141	8.91E+02	8.92E+02	9.40E+02	9.49E+02	9.49E+02	9.49E+02	9.49E+02	9.49E+02	9.49E+02
pr143	2.27E+01	2.25E+01	2.55E-01	2.03E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.51E-02	1.51E-02	1.22E-02	6.23E-03	1.79E-04	2.11E-06	7.90E-22	0.00E+00	0.00E+00
pr144m	6.02E-05	6.01E-05	4.84E-05	2.48E-05	7.11E-07	8.38E-09	3.14E-24	0.00E+00	0.00E+00
pu238	9.23E+01	9.26E+01	9.62E+01	1.00E+02	9.90E+01	9.52E+01	6.95E+01	4.68E+01	2.13E+01
pu239	5.40E+03	5.42E+03	5.50E+03	5.50E+03	5.50E+03	5.50E+03	5.49E+03	5.48E+03	5.47E+03
pu240	2.09E+03	2.09E+03	2.09E+03	2.09E+03	2.09E+03	2.09E+03	2.09E+03	2.08E+03	2.06E+03
pu241	1.18E+03	1.18E+03	1.16E+03	1.12E+03	9.23E+02	7.24E+02	1.04E+02	9.23E+00	7.37E-02
pu242	3.72E+02	3.72E+02	3.72E+02	3.72E+02	3.72E+02	3.72E+02	3.72E+02	3.72E+02	3.72E+02
rb86	2.02E-02	1.96E-02	7.16E-04	2.58E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.75E-03	1.69E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	3.83E+02	3.84E+02	4.24E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02
rh103m	5.09E-02	5.02E-02	1.04E-02	8.10E-05	5.13E-16	5.15E-30	0.00E+00	0.00E+00	0.00E+00
rh105	1.26E+00	9.33E-01	6.13E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.43E-04	1.43E-04	1.21E-04	7.26E-05	4.77E-06	1.59E-07	2.40E-19	4.00E-34	0.00E+00
ru101	6.65E+02	6.65E+02	6.65E+02	6.65E+02	6.65E+02	6.65E+02	6.65E+02	6.65E+02	6.65E+02

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ru103	5.18E+01	5.11E+01	1.06E+01	8.25E-02	5.22E-13	5.25E-27	0.00E+00	0.00E+00	0.00E+00
ru105	8.67E-02	4.46E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	1.53E+02	1.53E+02	1.29E+02	7.75E+01	5.10E+00	1.70E-01	2.56E-13	4.27E-28	0.00E+00
sb125	8.12E+00	8.12E+00	7.73E+00	6.40E+00	2.34E+00	6.67E-01	2.90E-05	1.02E-10	1.27E-21
sm147	5.56E+01	5.57E+01	6.72E+01	9.88E+01	1.92E+02	2.29E+02	2.42E+02	2.42E+02	2.42E+02
sm149	2.20E+00	2.49E+00	3.51E+00	3.51E+00	3.51E+00	3.51E+00	3.51E+00	3.51E+00	3.51E+00
sm150	2.45E+02	2.45E+02	2.45E+02	2.45E+02	2.45E+02	2.45E+02	2.45E+02	2.45E+02	2.45E+02
sm151	1.05E+01	1.06E+01	1.07E+01	1.06E+01	1.03E+01	9.91E+00	7.28E+00	4.96E+00	2.30E+00
sm152	9.62E+01	9.62E+01	9.62E+01	9.62E+01	9.62E+01	9.62E+01	9.62E+01	9.62E+01	9.62E+01
sr89	3.03E+01	3.00E+01	8.84E+00	2.03E-01	4.07E-10	5.47E-21	0.00E+00	0.00E+00	0.00E+00
sr90	4.62E+02	4.62E+02	4.59E+02	4.51E+02	4.09E+02	3.63E+02	1.39E+02	4.16E+01	3.75E+00
sr91	2.22E-01	5.64E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.76E-02	2.13E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	6.93E+02	6.94E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02	6.97E+02
tc99m	3.18E-01	2.71E-01	4.89E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	9.44E-02	9.46E-02	1.01E-01	8.90E-02	3.27E-02	9.31E-03	4.05E-07	1.43E-12	1.78E-23
te127	3.58E-02	3.29E-02	1.55E-03	2.70E-04	2.50E-08	2.28E-13	0.00E+00	0.00E+00	0.00E+00
te127m	7.18E-01	7.23E-01	4.43E-01	7.70E-02	7.15E-06	6.52E-11	0.00E+00	0.00E+00	0.00E+00
te129	9.08E-03	1.87E-03	2.35E-04	8.09E-07	6.72E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.65E+00	1.63E+00	2.59E-01	8.91E-04	7.40E-17	3.30E-33	0.00E+00	0.00E+00	0.00E+00
te131	8.74E-04	5.72E-04	2.62E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	2.59E-01	1.74E-01	7.98E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	4.57E+00	3.85E+00	1.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.65E+02	1.65E+02	1.65E+02	1.66E+02	1.69E+02	1.73E+02	1.98E+02	2.20E+02	2.45E+02
u235	9.00E+03	9.00E+03	9.00E+03	9.00E+03	9.00E+03	9.00E+03	9.01E+03	9.02E+03	9.03E+03
u236	3.56E+03	3.56E+03	3.56E+03	3.56E+03	3.56E+03	3.56E+03	3.57E+03	3.58E+03	3.60E+03
u238	9.49E+05	9.49E+05	9.49E+05	9.49E+05	9.49E+05	9.49E+05	9.49E+05	9.49E+05	9.49E+05
xe132	9.00E+02	9.01E+02	9.05E+02	9.05E+02	9.05E+02	9.05E+02	9.05E+02	9.05E+02	9.05E+02
xe133	1.13E+01	1.09E+01	9.43E-05	1.53E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03	1.29E+03
xe135	3.18E-01	1.98E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.24E-03	3.02E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
xe136	2.01E+03	2.01E+03	2.01E+03	2.01E+03	2.01E+03	2.01E+03	2.01E+03	2.01E+03	2.01E+03
y90	1.22E-01	1.21E-01	1.16E-01	1.14E-01	1.04E-01	9.21E-02	3.52E-02	1.06E-02	9.52E-04
y91	4.70E+01	4.68E+01	1.63E+01	6.28E-01	1.93E-08	7.88E-18	0.00E+00	0.00E+00	0.00E+00
y91m	1.23E-02	3.12E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	9.01E-02	4.11E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	3.13E-01	8.59E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02
zr95	7.57E+01	7.50E+01	2.86E+01	1.46E+00	2.00E-07	5.25E-16	0.00E+00	0.00E+00	0.00E+00
zr97	7.22E-01	3.29E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	99.2%	99.2%	99.2%	99.2%	99.1%	99.1%	99.1%	99.1%	99.1%

Table B.13. Nuclide mass (gram/MTU) for PWR-2 (39 GWd/MTU)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	9.19E+01	9.20E+01	9.21E+01	9.21E+01	9.21E+01	9.21E+01	9.21E+01	9.21E+01	9.21E+01
am241	4.64E+01	4.66E+01	6.45E+01	1.18E+02	3.73E+02	6.26E+02	1.36E+03	1.37E+03	1.18E+03
am242	1.06E-01	4.66E-02	6.89E-06	6.86E-06	6.73E-06	6.56E-06	5.39E-06	4.22E-06	2.58E-06
am242m	5.34E-01	5.34E-01	5.34E-01	5.32E-01	5.21E-01	5.09E-01	4.18E-01	3.27E-01	2.00E-01
am243	1.38E+02	1.38E+02	1.38E+02	1.38E+02	1.38E+02	1.38E+02	1.37E+02	1.37E+02	1.35E+02
ba137	5.11E+01	5.11E+01	5.91E+01	8.35E+01	2.06E+02	3.44E+02	1.03E+03	1.33E+03	1.46E+03
ba137m	2.18E-04	2.18E-04	2.16E-04	2.13E-04	1.94E-04	1.73E-04	6.88E-05	2.18E-05	2.18E-06
ba138	1.53E+03	1.53E+03	1.53E+03	1.53E+03	1.53E+03	1.53E+03	1.53E+03	1.53E+03	1.53E+03
ba139	1.04E-02	7.65E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	2.37E+01	2.27E+01	1.80E-01	5.81E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	1.40E+03	1.40E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03
ce141	5.77E+01	5.68E+01	8.52E+00	2.42E-02	7.31E-16	9.20E-33	0.00E+00	0.00E+00	0.00E+00
ce142	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03
ce143	2.07E+00	1.39E+00	4.78E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	3.93E+02	3.92E+02	3.16E+02	1.62E+02	4.63E+00	5.47E-02	2.05E-17	0.00E+00	0.00E+00
cm242	1.77E+01	1.77E+01	1.21E+01	3.76E+00	8.91E-03	1.33E-03	1.09E-03	8.52E-04	5.21E-04
cm243	4.11E-01	4.11E-01	4.09E-01	4.02E-01	3.65E-01	3.24E-01	1.25E-01	3.80E-02	3.52E-03

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
cm244	4.66E+01	4.66E+01	4.62E+01	4.48E+01	3.85E+01	3.18E+01	6.88E+00	1.02E+00	2.22E-02
cm245	2.92E+00	2.92E+00	2.92E+00	2.92E+00	2.92E+00	2.91E+00	2.90E+00	2.89E+00	2.87E+00
cs133	1.30E+03	1.30E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03
cs134	1.58E+02	1.58E+02	1.45E+02	1.13E+02	2.95E+01	5.51E+00	8.22E-06	4.28E-13	1.16E-27
cs136	6.99E-01	6.71E-01	6.18E-03	3.16E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.43E+03	1.43E+03	1.42E+03	1.39E+03	1.27E+03	1.13E+03	4.51E+02	1.43E+02	1.42E+01
eu151	1.27E-02	1.30E-02	3.76E-02	1.14E-01	5.10E-01	9.88E-01	4.22E+00	7.08E+00	1.04E+01
eu153	1.38E+02	1.38E+02	1.39E+02	1.39E+02	1.39E+02	1.39E+02	1.39E+02	1.39E+02	1.39E+02
eu154	3.02E+01	3.02E+01	2.96E+01	2.79E+01	2.02E+01	1.35E+01	5.39E-01	9.61E-03	3.06E-06
eu155	9.69E+00	9.68E+00	9.34E+00	8.37E+00	4.67E+00	2.26E+00	6.63E-03	4.54E-06	2.13E-12
gd155	6.91E-02	7.21E-02	4.10E-01	1.38E+00	5.08E+00	7.50E+00	9.75E+00	9.75E+00	9.75E+00
i131	8.36E+00	7.89E+00	3.72E-03	1.80E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.41E-01	1.18E-01	5.15E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.61E+00	8.53E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	4.89E-03	1.93E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	3.36E-01	4.52E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	2.96E+01	2.96E+01	2.91E+01	2.78E+01	2.15E+01	1.56E+01	1.18E+00	4.73E-02	7.54E-05
kr85m	1.35E-02	7.14E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	1.08E-03	3.43E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.43E-02	1.38E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03	1.43E+03
la140	3.25E+00	3.20E+00	2.73E-02	8.80E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	1.31E-01	4.54E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.25E-02	2.14E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03	1.10E+03
mo95	7.68E+02	7.69E+02	8.30E+02	8.82E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02	8.85E+02
mo97	9.50E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02
mo98	9.74E+02	9.74E+02	9.74E+02	9.74E+02	9.74E+02	9.74E+02	9.74E+02	9.74E+02	9.74E+02
mo99	3.77E+00	3.09E+00	5.54E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	5.72E-04	5.73E-04	6.56E-04	9.07E-04	2.11E-03	3.35E-03	7.61E-03	8.43E-03	8.54E-03
nb95	4.10E+01	4.10E+01	2.59E+01	1.71E+00	2.39E-07	6.30E-16	0.00E+00	0.00E+00	0.00E+00
nb97	5.49E-02	2.35E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
nb97m	6.62E-04	3.02E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	9.02E+02	9.03E+02	9.26E+02	9.26E+02	9.26E+02	9.26E+02	9.26E+02	9.26E+02	9.26E+02
nd144	1.16E+03	1.16E+03	1.24E+03	1.39E+03	1.55E+03	1.55E+03	1.55E+03	1.55E+03	1.55E+03
nd145	7.75E+02	7.76E+02	7.76E+02	7.76E+02	7.76E+02	7.76E+02	7.76E+02	7.76E+02	7.76E+02
nd147	8.03E+00	7.64E+00	2.77E-02	8.01E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	4.37E+02	4.37E+02	4.37E+02	4.37E+02	4.37E+02	4.37E+02	4.37E+02	4.37E+02	4.37E+02
np237	5.13E+02	5.14E+02	5.24E+02	5.24E+02	5.26E+02	5.30E+02	6.00E+02	7.09E+02	9.10E+02
np239	9.39E+01	7.44E+01	1.19E-04	1.19E-04	1.19E-04	1.19E-04	1.18E-04	1.18E-04	1.17E-04
pm147	2.04E+02	2.05E+02	1.99E+02	1.63E+02	5.68E+01	1.52E+01	3.93E-04	7.25E-10	2.47E-21
pr141	1.25E+03	1.25E+03	1.30E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03
pr143	2.24E+01	2.22E+01	2.51E-01	2.00E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.65E-02	1.65E-02	1.33E-02	6.81E-03	1.95E-04	2.30E-06	8.63E-22	0.00E+00	0.00E+00
pr144m	6.58E-05	6.57E-05	5.29E-05	2.71E-05	7.77E-07	9.16E-09	3.43E-24	0.00E+00	0.00E+00
pu238	1.87E+02	1.87E+02	1.94E+02	2.01E+02	1.98E+02	1.90E+02	1.39E+02	9.37E+01	4.26E+01
pu239	5.93E+03	5.95E+03	6.02E+03	6.02E+03	6.02E+03	6.02E+03	6.01E+03	6.01E+03	5.99E+03
pu240	2.57E+03	2.57E+03	2.57E+03	2.57E+03	2.57E+03	2.58E+03	2.59E+03	2.58E+03	2.56E+03
pu241	1.52E+03	1.52E+03	1.51E+03	1.45E+03	1.20E+03	9.39E+02	1.35E+02	1.20E+01	9.87E-02
pu242	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02	6.05E+02
rb86	2.85E-02	2.76E-02	1.01E-03	3.63E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.66E-03	1.60E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	5.05E+02	5.05E+02	5.47E+02	5.58E+02	5.58E+02	5.58E+02	5.58E+02	5.58E+02	5.58E+02
rh103m	5.26E-02	5.19E-02	1.08E-02	8.38E-05	5.30E-16	5.33E-30	0.00E+00	0.00E+00	0.00E+00
rh105	1.32E+00	9.78E-01	6.42E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.79E-04	1.79E-04	1.51E-04	9.07E-05	5.96E-06	1.99E-07	2.99E-19	5.00E-34	0.00E+00
ru101	9.15E+02	9.15E+02	9.15E+02	9.15E+02	9.15E+02	9.15E+02	9.15E+02	9.15E+02	9.15E+02
ru103	5.36E+01	5.28E+01	1.10E+01	8.53E-02	5.40E-13	5.42E-27	0.00E+00	0.00E+00	0.00E+00
ru105	9.06E-02	4.66E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	1.91E+02	1.91E+02	1.62E+02	9.69E+01	6.37E+00	2.12E-01	3.20E-13	5.34E-28	0.00E+00
sb125	1.06E+01	1.06E+01	1.00E+01	8.29E+00	3.04E+00	8.65E-01	3.76E-05	1.33E-10	1.65E-21
sm147	8.52E+01	8.54E+01	9.85E+01	1.35E+02	2.41E+02	2.83E+02	2.98E+02	2.98E+02	2.98E+02
sm149	2.48E+00	2.78E+00	3.84E+00	3.84E+00	3.84E+00	3.84E+00	3.84E+00	3.84E+00	3.84E+00
sm150	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02	3.44E+02

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
sm151	1.29E+01	1.30E+01	1.31E+01	1.31E+01	1.27E+01	1.22E+01	8.96E+00	6.10E+00	2.83E+00
sm152	1.19E+02	1.19E+02	1.19E+02	1.19E+02	1.19E+02	1.19E+02	1.19E+02	1.19E+02	1.19E+02
sr89	2.90E+01	2.86E+01	8.45E+00	1.94E-01	3.90E-10	5.23E-21	0.00E+00	0.00E+00	0.00E+00
sr90	6.25E+02	6.25E+02	6.21E+02	6.10E+02	5.54E+02	4.91E+02	1.88E+02	5.63E+01	5.08E+00
sr91	2.12E-01	5.40E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.66E-02	2.05E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	9.36E+02	9.37E+02	9.40E+02	9.40E+02	9.40E+02	9.40E+02	9.40E+02	9.40E+02	9.40E+02
tc99m	3.17E-01	2.70E-01	4.88E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	1.28E-01	1.28E-01	1.33E-01	1.15E-01	4.24E-02	1.21E-02	5.24E-07	1.85E-12	2.30E-23
te127	3.65E-02	3.36E-02	1.65E-03	2.86E-04	2.66E-08	2.42E-13	0.00E+00	0.00E+00	0.00E+00
te127m	7.66E-01	7.71E-01	4.70E-01	8.18E-02	7.59E-06	6.92E-11	0.00E+00	0.00E+00	0.00E+00
te129	9.22E-03	1.90E-03	2.40E-04	8.25E-07	6.85E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.68E+00	1.66E+00	2.64E-01	9.08E-04	7.55E-17	3.37E-33	0.00E+00	0.00E+00	0.00E+00
te131	8.78E-04	5.75E-04	2.64E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	2.60E-01	1.75E-01	8.02E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	4.57E+00	3.85E+00	1.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.77E+02	1.77E+02	1.78E+02	1.79E+02	1.85E+02	1.93E+02	2.43E+02	2.88E+02	3.38E+02
u235	8.46E+03	8.46E+03	8.46E+03	8.46E+03	8.46E+03	8.46E+03	8.47E+03	8.48E+03	8.50E+03
u236	4.78E+03	4.78E+03	4.78E+03	4.78E+03	4.78E+03	4.78E+03	4.79E+03	4.80E+03	4.83E+03
u238	9.35E+05	9.35E+05	9.35E+05	9.35E+05	9.35E+05	9.35E+05	9.35E+05	9.35E+05	9.35E+05
xe132	1.30E+03	1.30E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03
xe133	1.12E+01	1.08E+01	9.40E-05	1.53E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03
xe135	3.27E-01	1.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.24E-03	3.01E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	2.75E+03	2.75E+03	2.75E+03	2.75E+03	2.75E+03	2.75E+03	2.75E+03	2.75E+03	2.75E+03
y90	1.66E-01	1.64E-01	1.58E-01	1.55E-01	1.41E-01	1.25E-01	4.76E-02	1.43E-02	1.29E-03
y91	4.55E+01	4.52E+01	1.58E+01	6.07E-01	1.87E-08	7.62E-18	0.00E+00	0.00E+00	0.00E+00
y91m	1.17E-02	2.99E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	8.68E-02	3.96E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	3.04E-01	8.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	8.30E+02	8.31E+02	8.31E+02	8.31E+02	8.31E+02	8.31E+02	8.31E+02	8.31E+02	8.31E+02

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
zr95	7.53E+01	7.47E+01	2.85E+01	1.45E+00	1.99E-07	5.22E-16	0.00E+00	0.00E+00	0.00E+00
zr97	7.15E-01	3.26E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	98.8%	98.8%	98.8%	98.8%	98.8%	98.8%	98.7%	98.7%	98.7%

Table B.14. Nuclide mass (gram/MTU) for PWR-3 (47 GWd/MTU)

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	1.07E+02	1.07E+02	1.07E+02	1.07E+02	1.07E+02	1.07E+02	1.07E+02	1.07E+02	1.07E+02
am241	5.93E+01	5.95E+01	7.97E+01	1.41E+02	4.29E+02	7.16E+02	1.55E+03	1.56E+03	1.34E+03
am242	1.28E-01	5.61E-02	9.03E-06	8.99E-06	8.82E-06	8.60E-06	7.07E-06	5.53E-06	3.38E-06
am242m	7.00E-01	7.00E-01	7.00E-01	6.97E-01	6.83E-01	6.67E-01	5.48E-01	4.29E-01	2.62E-01
am243	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.87E+02	1.86E+02	1.84E+02
ba137	7.27E+01	7.27E+01	8.23E+01	1.12E+02	2.58E+02	4.24E+02	1.24E+03	1.61E+03	1.76E+03
ba137m	2.61E-04	2.61E-04	2.59E-04	2.55E-04	2.32E-04	2.07E-04	8.24E-05	2.61E-05	2.61E-06
ba138	1.85E+03	1.85E+03	1.85E+03	1.85E+03	1.85E+03	1.85E+03	1.85E+03	1.85E+03	1.85E+03
ba139	1.04E-02	7.64E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	2.37E+01	2.27E+01	1.80E-01	5.80E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	1.70E+03	1.70E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03
ce141	5.76E+01	5.67E+01	8.50E+00	2.42E-02	7.30E-16	9.19E-33	0.00E+00	0.00E+00	0.00E+00
ce142	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03
ce143	2.06E+00	1.39E+00	4.78E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	4.08E+02	4.07E+02	3.28E+02	1.68E+02	4.81E+00	5.68E-02	2.13E-17	0.00E+00	0.00E+00
cm242	2.30E+01	2.30E+01	1.58E+01	4.90E+00	1.16E-02	1.74E-03	1.43E-03	1.12E-03	6.83E-04
cm243	6.08E-01	6.08E-01	6.05E-01	5.94E-01	5.40E-01	4.79E-01	1.85E-01	5.63E-02	5.21E-03
cm244	7.33E+01	7.33E+01	7.26E+01	7.05E+01	6.05E+01	5.00E+01	1.08E+01	1.60E+00	3.49E-02
cm245	5.20E+00	5.20E+00	5.20E+00	5.20E+00	5.20E+00	5.20E+00	5.18E+00	5.16E+00	5.12E+00
cs133	1.53E+03	1.54E+03	1.55E+03	1.55E+03	1.55E+03	1.55E+03	1.55E+03	1.55E+03	1.55E+03
cs134	2.03E+02	2.03E+02	1.87E+02	1.45E+02	3.80E+01	7.10E+00	1.06E-05	5.52E-13	1.50E-27
cs136	8.63E-01	8.27E-01	7.62E-03	3.90E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.71E+03	1.71E+03	1.70E+03	1.67E+03	1.52E+03	1.36E+03	5.39E+02	1.71E+02	1.71E+01
eu151	1.59E-02	1.61E-02	4.46E-02	1.32E-01	5.89E-01	1.14E+00	4.87E+00	8.17E+00	1.20E+01

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
eu153	1.64E+02	1.64E+02	1.65E+02	1.65E+02	1.65E+02	1.65E+02	1.65E+02	1.65E+02	1.65E+02
eu154	3.86E+01	3.86E+01	3.79E+01	3.57E+01	2.58E+01	1.73E+01	6.89E-01	1.23E-02	3.91E-06
eu155	1.19E+01	1.19E+01	1.15E+01	1.03E+01	5.76E+00	2.78E+00	8.17E-03	5.59E-06	2.62E-12
gd155	9.75E-02	1.01E-01	5.18E-01	1.72E+00	6.27E+00	9.25E+00	1.20E+01	1.20E+01	1.20E+01
i131	8.35E+00	7.88E+00	3.71E-03	1.79E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.41E-01	1.18E-01	5.14E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.60E+00	8.52E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	4.88E-03	1.93E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	3.35E-01	4.52E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	3.51E+01	3.51E+01	3.46E+01	3.30E+01	2.55E+01	1.85E+01	1.40E+00	5.61E-02	8.96E-05
kr85m	1.35E-02	7.11E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	1.08E-03	3.41E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.42E-02	1.37E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03	1.73E+03
la140	3.26E+00	3.20E+00	2.72E-02	8.79E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	1.31E-01	4.53E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.25E-02	2.13E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	1.33E+03	1.33E+03	1.33E+03	1.33E+03	1.33E+03	1.33E+03	1.33E+03	1.33E+03	1.33E+03
mo95	9.41E+02	9.42E+02	1.00E+03	1.05E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03
mo97	1.14E+03	1.14E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03
mo98	1.17E+03	1.17E+03	1.17E+03	1.17E+03	1.17E+03	1.17E+03	1.17E+03	1.17E+03	1.17E+03
mo99	3.77E+00	3.09E+00	5.54E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	8.13E-04	8.14E-04	9.13E-04	1.21E-03	2.65E-03	4.12E-03	9.19E-03	1.02E-02	1.03E-02
nb95	4.12E+01	4.12E+01	2.60E+01	1.71E+00	2.39E-07	6.30E-16	0.00E+00	0.00E+00	0.00E+00
nb97	5.48E-02	2.34E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	6.61E-04	3.01E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	1.06E+03	1.06E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03
nd144	1.50E+03	1.50E+03	1.58E+03	1.74E+03	1.90E+03	1.91E+03	1.91E+03	1.91E+03	1.91E+03
nd145	9.19E+02	9.19E+02	9.19E+02	9.19E+02	9.19E+02	9.19E+02	9.19E+02	9.19E+02	9.19E+02
nd147	8.05E+00	7.66E+00	2.78E-02	8.02E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	5.25E+02	5.25E+02	5.25E+02	5.25E+02	5.25E+02	5.25E+02	5.25E+02	5.25E+02	5.25E+02
np237	6.60E+02	6.61E+02	6.72E+02	6.73E+02	6.74E+02	6.79E+02	7.59E+02	8.83E+02	1.11E+03

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
np239	9.17E+01	7.26E+01	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.61E-04	1.60E-04	1.58E-04
pm147	2.21E+02	2.21E+02	2.15E+02	1.76E+02	6.12E+01	1.64E+01	4.23E-04	7.82E-10	2.67E-21
pr141	1.52E+03	1.52E+03	1.57E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03	1.58E+03
pr143	2.23E+01	2.21E+01	2.51E-01	1.99E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.72E-02	1.72E-02	1.38E-02	7.07E-03	2.03E-04	2.39E-06	8.96E-22	0.00E+00	0.00E+00
pr144m	6.83E-05	6.82E-05	5.49E-05	2.81E-05	8.07E-07	9.51E-09	3.57E-24	0.00E+00	0.00E+00
pu238	2.73E+02	2.74E+02	2.82E+02	2.91E+02	2.87E+02	2.75E+02	2.01E+02	1.35E+02	6.16E+01
pu239	6.31E+03	6.33E+03	6.40E+03	6.40E+03	6.40E+03	6.40E+03	6.39E+03	6.38E+03	6.37E+03
pu240	2.81E+03	2.81E+03	2.81E+03	2.81E+03	2.82E+03	2.83E+03	2.85E+03	2.85E+03	2.82E+03
pu241	1.73E+03	1.73E+03	1.71E+03	1.65E+03	1.36E+03	1.06E+03	1.53E+02	1.36E+01	1.15E-01
pu242	7.39E+02	7.39E+02	7.39E+02	7.39E+02	7.39E+02	7.39E+02	7.39E+02	7.39E+02	7.39E+02
rb86	3.45E-02	3.35E-02	1.22E-03	4.40E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.65E-03	1.59E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	5.81E+02	5.82E+02	6.24E+02	6.35E+02	6.35E+02	6.35E+02	6.35E+02	6.35E+02	6.35E+02
rh103m	5.29E-02	5.21E-02	1.08E-02	8.41E-05	5.33E-16	5.35E-30	0.00E+00	0.00E+00	0.00E+00
rh105	1.34E+00	9.88E-01	6.49E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.94E-04	1.94E-04	1.64E-04	9.83E-05	6.46E-06	2.15E-07	3.24E-19	5.42E-34	0.00E+00
ru101	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03	1.09E+03
ru103	5.38E+01	5.31E+01	1.10E+01	8.57E-02	5.42E-13	5.45E-27	0.00E+00	0.00E+00	0.00E+00
ru105	9.10E-02	4.68E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	2.07E+02	2.07E+02	1.75E+02	1.05E+02	6.90E+00	2.30E-01	3.47E-13	5.79E-28	0.00E+00
sb125	1.19E+01	1.19E+01	1.13E+01	9.35E+00	3.43E+00	9.76E-01	4.24E-05	1.50E-10	1.86E-21
sm147	1.08E+02	1.08E+02	1.23E+02	1.61E+02	2.76E+02	3.21E+02	3.37E+02	3.37E+02	3.37E+02
sm149	2.74E+00	3.04E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00	4.11E+00
sm150	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02	4.12E+02
sm151	1.49E+01	1.50E+01	1.52E+01	1.51E+01	1.46E+01	1.41E+01	1.03E+01	7.04E+00	3.26E+00
sm152	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02	1.32E+02
sr89	2.88E+01	2.84E+01	8.39E+00	1.93E-01	3.87E-10	5.19E-21	0.00E+00	0.00E+00	0.00E+00
sr90	7.51E+02	7.51E+02	7.46E+02	7.33E+02	6.65E+02	5.90E+02	2.25E+02	6.77E+01	6.10E+00
sr91	2.11E-01	5.37E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.64E-02	2.04E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03	1.11E+03

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
tc99m	3.17E-01	2.70E-01	4.87E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	1.47E-01	1.47E-01	1.50E-01	1.30E-01	4.78E-02	1.36E-02	5.92E-07	2.09E-12	2.60E-23
te127	3.65E-02	3.36E-02	1.71E-03	2.97E-04	2.76E-08	2.51E-13	0.00E+00	0.00E+00	0.00E+00
te127m	7.97E-01	8.01E-01	4.87E-01	8.48E-02	7.88E-06	7.18E-11	0.00E+00	0.00E+00	0.00E+00
te129	9.19E-03	1.90E-03	2.40E-04	8.24E-07	6.84E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.68E+00	1.66E+00	2.64E-01	9.07E-04	7.54E-17	3.36E-33	0.00E+00	0.00E+00	0.00E+00
te131	8.73E-04	5.72E-04	2.62E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	2.58E-01	1.74E-01	7.97E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	4.56E+00	3.84E+00	1.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.96E+02	1.96E+02	1.96E+02	1.98E+02	2.07E+02	2.18E+02	2.91E+02	3.55E+02	4.28E+02
u235	9.00E+03	9.00E+03	9.00E+03	9.00E+03	9.00E+03	9.00E+03	9.00E+03	9.01E+03	9.03E+03
u236	5.86E+03	5.86E+03	5.86E+03	5.86E+03	5.86E+03	5.86E+03	5.87E+03	5.89E+03	5.92E+03
u238	9.23E+05	9.23E+05	9.23E+05	9.23E+05	9.23E+05	9.23E+05	9.23E+05	9.23E+05	9.23E+05
xe132	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03	1.60E+03
xe133	1.12E+01	1.08E+01	9.39E-05	1.53E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03	2.16E+03
xe135	3.36E-01	2.01E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.24E-03	3.01E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03	3.25E+03
y90	1.99E-01	1.97E-01	1.89E-01	1.86E-01	1.69E-01	1.50E-01	5.72E-02	1.72E-02	1.55E-03
y91	4.53E+01	4.50E+01	1.57E+01	6.04E-01	1.86E-08	7.59E-18	0.00E+00	0.00E+00	0.00E+00
y91m	1.17E-02	2.97E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	8.64E-02	3.94E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	3.03E-01	8.30E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03	1.00E+03
zr95	7.53E+01	7.47E+01	2.85E+01	1.45E+00	1.99E-07	5.23E-16	0.00E+00	0.00E+00	0.00E+00
zr97	7.14E-01	3.25E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	98.6%	98.6%	98.6%	98.5%	98.5%	98.5%	98.5%	98.4%	98.4%

Table B.15. Nuclide mass (gram/MTU) for PWR-Ext (72 GWd/MTU)

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	1.74E+02	1.74E+02	1.74E+02	1.74E+02	1.74E+02	1.74E+02	1.74E+02	1.74E+02	1.74E+02
am241	8.43E+01	8.45E+01	1.10E+02	1.87E+02	5.48E+02	9.08E+02	1.95E+03	1.96E+03	1.69E+03
am242	1.93E-01	8.46E-02	1.30E-05	1.30E-05	1.27E-05	1.24E-05	1.02E-05	7.99E-06	4.89E-06
am242m	1.01E+00	1.01E+00	1.01E+00	1.01E+00	9.87E-01	9.63E-01	7.91E-01	6.19E-01	3.79E-01
am243	4.70E+02	4.70E+02	4.70E+02	4.70E+02	4.70E+02	4.70E+02	4.68E+02	4.66E+02	4.61E+02
ba137	1.63E+02	1.63E+02	1.78E+02	2.21E+02	4.41E+02	6.89E+02	1.91E+03	2.46E+03	2.69E+03
ba137m	3.90E-04	3.90E-04	3.88E-04	3.82E-04	3.48E-04	3.10E-04	1.23E-04	3.90E-05	3.90E-06
ba138	2.80E+03	2.80E+03	2.80E+03	2.80E+03	2.80E+03	2.80E+03	2.80E+03	2.80E+03	2.80E+03
ba139	1.02E-02	7.46E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	2.30E+01	2.20E+01	1.75E-01	5.63E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	2.60E+03	2.60E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03	2.63E+03
ce141	5.58E+01	5.50E+01	8.24E+00	2.34E-02	7.07E-16	8.90E-33	0.00E+00	0.00E+00	0.00E+00
ce142	2.39E+03	2.39E+03	2.39E+03	2.39E+03	2.39E+03	2.39E+03	2.39E+03	2.39E+03	2.39E+03
ce143	1.97E+00	1.32E+00	4.55E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	4.06E+02	4.06E+02	3.27E+02	1.67E+02	4.79E+00	5.66E-02	2.12E-17	0.00E+00	0.00E+00
cm242	4.13E+01	4.13E+01	2.83E+01	8.79E+00	2.02E-02	2.52E-03	2.06E-03	1.61E-03	9.87E-04
cm243	1.55E+00	1.55E+00	1.54E+00	1.51E+00	1.37E+00	1.22E+00	4.71E-01	1.43E-01	1.32E-02
cm244	2.93E+02	2.93E+02	2.91E+02	2.82E+02	2.42E+02	2.00E+02	4.33E+01	6.40E+00	1.40E-01
cm245	2.69E+01	2.69E+01	2.69E+01	2.69E+01	2.68E+01	2.68E+01	2.68E+01	2.66E+01	2.64E+01
cs133	2.12E+03	2.12E+03	2.13E+03	2.13E+03	2.13E+03	2.13E+03	2.13E+03	2.13E+03	2.13E+03
cs134	3.74E+02	3.74E+02	3.44E+02	2.67E+02	6.99E+01	1.31E+01	1.95E-05	1.01E-12	2.75E-27
cs136	1.43E+00	1.37E+00	1.26E-02	6.45E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	2.56E+03	2.56E+03	2.54E+03	2.50E+03	2.28E+03	2.03E+03	8.08E+02	2.56E+02	2.55E+01
eu151	1.82E-02	1.85E-02	5.33E-02	1.61E-01	7.19E-01	1.39E+00	5.95E+00	9.99E+00	1.46E+01
eu153	2.40E+02	2.40E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02	2.41E+02
eu154	6.27E+01	6.27E+01	6.15E+01	5.78E+01	4.19E+01	2.80E+01	1.12E+00	1.99E-02	6.34E-06
eu155	1.93E+01	1.93E+01	1.86E+01	1.67E+01	9.29E+00	4.48E+00	1.32E-02	9.02E-06	4.23E-12
gd155	1.72E-01	1.78E-01	8.50E-01	2.78E+00	1.01E+01	1.49E+01	1.94E+01	1.94E+01	1.94E+01
i131	8.41E+00	7.94E+00	3.74E-03	1.81E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.41E-01	1.18E-01	5.14E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
i133	1.58E+00	8.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	4.72E-03	1.86E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	3.34E-01	4.49E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	4.73E+01	4.73E+01	4.66E+01	4.44E+01	3.43E+01	2.49E+01	1.89E+00	7.56E-02	1.21E-04
kr85m	1.17E-02	6.20E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	9.17E-04	2.90E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.20E-02	1.16E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03	2.59E+03
la140	3.24E+00	3.16E+00	2.65E-02	8.54E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	1.27E-01	4.40E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.20E-02	2.05E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03	2.02E+03
mo95	1.40E+03	1.40E+03	1.46E+03	1.50E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03	1.51E+03
mo97	1.72E+03	1.72E+03	1.72E+03	1.72E+03	1.72E+03	1.72E+03	1.72E+03	1.72E+03	1.72E+03
mo98	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03	1.79E+03
mo99	3.74E+00	3.06E+00	5.49E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	1.74E-03	1.75E-03	1.88E-03	2.30E-03	4.30E-03	6.36E-03	1.34E-02	1.48E-02	1.50E-02
nb95	3.88E+01	3.88E+01	2.44E+01	1.61E+00	2.25E-07	5.91E-16	0.00E+00	0.00E+00	0.00E+00
nb97	5.31E-02	2.27E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	6.41E-04	2.92E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	1.31E+03	1.32E+03	1.34E+03	1.34E+03	1.34E+03	1.34E+03	1.34E+03	1.34E+03	1.34E+03
nd144	2.71E+03	2.71E+03	2.79E+03	2.95E+03	3.11E+03	3.12E+03	3.12E+03	3.12E+03	3.12E+03
nd145	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03	1.26E+03
nd147	7.97E+00	7.58E+00	2.75E-02	7.95E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	7.97E+02	7.97E+02	7.97E+02	7.97E+02	7.97E+02	7.97E+02	7.97E+02	7.97E+02	7.97E+02
np237	1.05E+03	1.05E+03	1.06E+03	1.06E+03	1.06E+03	1.07E+03	1.17E+03	1.33E+03	1.61E+03
np239	9.86E+01	7.81E+01	4.05E-04	4.05E-04	4.04E-04	4.04E-04	4.03E-04	4.01E-04	3.97E-04
pm147	2.27E+02	2.28E+02	2.21E+02	1.81E+02	6.29E+01	1.68E+01	4.35E-04	8.03E-10	2.74E-21
pr141	2.29E+03	2.29E+03	2.34E+03	2.35E+03	2.35E+03	2.35E+03	2.35E+03	2.35E+03	2.35E+03
pr143	2.13E+01	2.11E+01	2.39E-01	1.90E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.71E-02	1.71E-02	1.38E-02	7.05E-03	2.02E-04	2.38E-06	8.93E-22	0.00E+00	0.00E+00
pr144m	6.81E-05	6.79E-05	5.47E-05	2.80E-05	8.03E-07	9.48E-09	3.55E-24	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pu238	6.38E+02	6.39E+02	6.53E+02	6.68E+02	6.56E+02	6.30E+02	4.60E+02	3.10E+02	1.41E+02
pu239	6.55E+03	6.57E+03	6.64E+03	6.64E+03	6.64E+03	6.64E+03	6.64E+03	6.63E+03	6.62E+03
pu240	3.53E+03	3.53E+03	3.54E+03	3.55E+03	3.58E+03	3.62E+03	3.76E+03	3.78E+03	3.74E+03
pu241	2.17E+03	2.17E+03	2.14E+03	2.06E+03	1.70E+03	1.33E+03	1.92E+02	1.71E+01	1.77E-01
pu242	1.42E+03	1.42E+03	1.42E+03	1.42E+03	1.42E+03	1.42E+03	1.42E+03	1.42E+03	1.42E+03
rb86	5.57E-02	5.41E-02	1.97E-03	7.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.39E-03	1.35E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	7.63E+02	7.64E+02	8.10E+02	8.21E+02	8.21E+02	8.21E+02	8.21E+02	8.21E+02	8.21E+02
rh103m	5.70E-02	5.62E-02	1.17E-02	9.07E-05	5.74E-16	5.77E-30	0.00E+00	0.00E+00	0.00E+00
rh105	1.50E+00	1.11E+00	7.28E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	2.60E-04	2.60E-04	2.20E-04	1.32E-04	8.66E-06	2.88E-07	4.35E-19	7.27E-34	0.00E+00
ru101	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03	1.62E+03
ru103	5.80E+01	5.72E+01	1.19E+01	9.23E-02	5.85E-13	5.87E-27	0.00E+00	0.00E+00	0.00E+00
ru105	1.03E-01	5.29E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	2.78E+02	2.78E+02	2.35E+02	1.41E+02	9.26E+00	3.08E-01	4.65E-13	7.76E-28	0.00E+00
sb125	1.63E+01	1.63E+01	1.55E+01	1.28E+01	4.69E+00	1.34E+00	5.80E-05	2.05E-10	2.55E-21
sm147	1.52E+02	1.52E+02	1.67E+02	2.07E+02	3.24E+02	3.71E+02	3.87E+02	3.87E+02	3.87E+02
sm149	2.75E+00	3.07E+00	4.20E+00	4.20E+00	4.20E+00	4.20E+00	4.20E+00	4.20E+00	4.20E+00
sm150	6.19E+02	6.19E+02	6.19E+02	6.19E+02	6.19E+02	6.19E+02	6.19E+02	6.19E+02	6.19E+02
sm151	1.83E+01	1.84E+01	1.85E+01	1.84E+01	1.79E+01	1.72E+01	1.26E+01	8.60E+00	3.99E+00
sm152	1.66E+02	1.66E+02	1.66E+02	1.66E+02	1.66E+02	1.66E+02	1.66E+02	1.66E+02	1.66E+02
sr89	2.41E+01	2.39E+01	7.04E+00	1.62E-01	3.25E-10	4.36E-21	0.00E+00	0.00E+00	0.00E+00
sr90	1.04E+03	1.04E+03	1.04E+03	1.02E+03	9.24E+02	8.19E+02	3.13E+02	9.40E+01	8.47E+00
sr91	1.83E-01	4.65E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.35E-02	1.82E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03	1.57E+03
tc99m	3.16E-01	2.68E-01	4.83E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	2.07E-01	2.07E-01	2.08E-01	1.78E-01	6.54E-02	1.86E-02	8.10E-07	2.86E-12	3.55E-23
te127	3.88E-02	3.56E-02	1.75E-03	3.05E-04	2.83E-08	2.58E-13	0.00E+00	0.00E+00	0.00E+00
te127m	8.17E-01	8.21E-01	5.01E-01	8.71E-02	8.09E-06	7.38E-11	0.00E+00	0.00E+00	0.00E+00
te129	9.69E-03	2.00E-03	2.53E-04	8.69E-07	7.22E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.77E+00	1.75E+00	2.79E-01	9.57E-04	7.95E-17	3.55E-33	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te131	9.04E-04	5.92E-04	2.72E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	2.68E-01	1.80E-01	8.26E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	4.56E+00	3.84E+00	1.67E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.64E+02	1.64E+02	1.66E+02	1.69E+02	1.90E+02	2.15E+02	3.83E+02	5.30E+02	6.97E+02
u235	4.82E+03	4.82E+03	4.82E+03	4.82E+03	4.82E+03	4.82E+03	4.83E+03	4.84E+03	4.86E+03
u236	7.34E+03	7.34E+03	7.34E+03	7.34E+03	7.34E+03	7.34E+03	7.36E+03	7.38E+03	7.42E+03
u238	8.97E+05	8.97E+05	8.97E+05	8.97E+05	8.97E+05	8.97E+05	8.97E+05	8.97E+05	8.97E+05
xe132	2.63E+03	2.63E+03	2.64E+03	2.64E+03	2.64E+03	2.64E+03	2.64E+03	2.64E+03	2.64E+03
xe133	1.11E+01	1.07E+01	9.30E-05	1.51E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	3.27E+03	3.27E+03	3.27E+03	3.27E+03	3.27E+03	3.27E+03	3.27E+03	3.27E+03	3.27E+03
xe135	3.27E-01	1.99E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.22E-03	2.99E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	4.96E+03	4.96E+03	4.96E+03	4.96E+03	4.96E+03	4.96E+03	4.96E+03	4.96E+03	4.96E+03
y90	2.77E-01	2.75E-01	2.63E-01	2.58E-01	2.34E-01	2.08E-01	7.94E-02	2.38E-02	2.15E-03
y91	3.91E+01	3.89E+01	1.36E+01	5.22E-01	1.61E-08	6.56E-18	0.00E+00	0.00E+00	0.00E+00
y91m	1.01E-02	2.58E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	7.67E-02	3.50E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	2.76E-01	7.56E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03
zr95	7.07E+01	7.01E+01	2.68E+01	1.36E+00	1.86E-07	4.91E-16	0.00E+00	0.00E+00	0.00E+00
zr97	6.92E-01	3.15E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	97.7%	97.7%	97.7%	97.7%	97.6%	97.6%	97.5%	97.5%	97.5%

APPENDIX C. MOX RESULTS

Table C. 1. Total activity (Ci/MTHM) for MOX fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
MOX-1 (20GWd/MTHM)	6.92E+07	5.09E+07	6.36E+06	2.25E+06	5.79E+05	3.94E+05	1.05E+05	3.62E+04	1.47E+04
MOX-2 (40GWd/MTHM)	7.23E+07	5.38E+07	7.90E+06	3.25E+06	9.03E+05	6.18E+05	1.71E+05	5.68E+04	1.96E+04

Table C.2. Total gamma heat (W/MTHM) for MOX fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
MOX-1 (20GWd/MTHM)	1.56E+05	1.05E+05	9.66E+03	1.64E+03	3.68E+02	2.13E+02	7.17E+01	2.37E+01	3.71E+00
MOX-2 (40GWd/MTHM)	1.60E+05	1.10E+05	1.18E+04	3.11E+03	8.61E+02	4.60E+02	1.41E+02	4.56E+01	6.33E+00

Table C.3. Total decay heat (W/MTHM) for MOX fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
MOX-1 (20GWd/MTHM)	2.92E+05	1.93E+05	2.60E+04	9.09E+03	1.52E+03	1.05E+03	7.38E+02	5.62E+02	4.25E+02
MOX-2 (40GWd/MTHM)	3.05E+05	2.07E+05	3.44E+04	1.39E+04	2.51E+03	1.63E+03	1.01E+03	7.27E+02	5.37E+02

Table C.4. Total photon emission (photon/s/MTHM) for MOX fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
MOX-1 (20GWd/MTHM)	3.11E+18	2.24E+18	1.67E+17	5.03E+16	6.50E+15	3.29E+15	1.34E+15	6.14E+14	2.78E+14
MOX-2 (40GWd/MTHM)	3.21E+18	2.34E+18	2.11E+17	7.84E+16	1.30E+16	6.59E+15	2.40E+15	1.01E+15	3.89E+14

Table C.5. Total neutron emission (neutron/s/MTHM) for MOX fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
MOX-1 (20GWd/MTHM)	1.80E+09	1.80E+09	1.60E+09	1.27E+09	9.87E+08	8.20E+08	1.99E+08	5.13E+07	2.40E+07
MOX-2 (40GWd/MTHM)	2.87E+09	2.87E+09	2.50E+09	1.91E+09	1.44E+09	1.20E+09	2.94E+08	7.98E+07	4.07E+07

Table C.6. Neutron flux (neutrons/cm^2-sec/MTHM) for MOX fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
MOX-1 (20GWd/MTHM)	1.03E+05	1.03E+05	9.13E+04	7.29E+04	5.64E+04	4.69E+04	1.14E+04	2.93E+03	1.37E+03
MOX-2 (40GWd/MTHM)	1.64E+05	1.64E+05	1.43E+05	1.09E+05	8.24E+04	6.85E+04	1.68E+04	4.57E+03	2.33E+03

Table C.7. Pu total (gram/MTHM) for MOX fuel

Group ID	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
MOX-1 (20GWd/MTHM)	2.96E+04	2.96E+04	2.96E+04	2.95E+04	2.90E+04	2.84E+04	2.66E+04	2.62E+04	2.60E+04
MOX-2 (40GWd/MTHM)	2.99E+04	2.99E+04	2.99E+04	2.98E+04	2.91E+04	2.83E+04	2.59E+04	2.55E+04	2.52E+04

Table C.8. Nuclide activity (Ci/MTHM) for MOX-1 (20 GWd/MTHM)

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	4.73E+02	4.74E+02	6.08E+02	1.01E+03	2.92E+03	4.83E+03	1.03E+04	1.04E+04	8.94E+03
ba137m	6.20E+04	6.20E+04	6.16E+04	6.06E+04	5.52E+04	4.92E+04	1.96E+04	6.20E+03	6.20E+02
ba139	1.64E+05	1.21E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.67E+06	1.60E+06	1.27E+04	4.10E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.57E+06	1.55E+06	2.32E+05	6.60E+02	1.99E-11	2.51E-28	0.00E+00	0.00E+00	0.00E+00
ce143	1.27E+06	8.54E+05	2.95E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	8.28E+05	8.26E+05	6.65E+05	3.41E+05	9.77E+03	1.15E+02	4.32E-14	0.00E+00	0.00E+00
cm242	8.64E+04	8.64E+04	5.93E+04	1.84E+04	5.12E+01	1.39E+01	1.14E+01	8.94E+00	5.47E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
cm244	8.49E+03	8.49E+03	8.42E+03	8.18E+03	7.02E+03	5.80E+03	1.26E+03	1.85E+02	4.05E+00
cs134	6.37E+04	6.37E+04	5.87E+04	4.56E+04	1.19E+04	2.23E+03	3.32E-03	1.73E-10	4.69E-25
cs136	4.45E+04	4.27E+04	3.93E+02	2.01E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	6.54E+04	6.54E+04	6.51E+04	6.40E+04	5.83E+04	5.20E+04	2.07E+04	6.54E+03	6.54E+02
i131	1.10E+06	1.04E+06	4.90E+02	2.37E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.51E+06	1.27E+06	5.50E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.83E+06	9.71E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	1.24E+05	4.84E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	1.19E+06	1.61E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	3.94E+03	3.94E+03	3.88E+03	3.70E+03	2.86E+03	2.07E+03	1.58E+02	6.29E+00	1.01E-02
kr85m	8.82E+04	4.66E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	2.34E+04	7.41E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.34E+05	1.30E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.71E+06	1.69E+06	1.46E+04	4.72E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	7.21E+05	2.50E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.74E+05	2.97E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.80E+06	1.47E+06	2.64E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.32E+06	1.32E+06	8.67E+05	5.80E+04	8.12E-03	2.14E-11	0.00E+00	0.00E+00	0.00E+00
nb97	1.43E+06	6.10E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	1.27E+06	5.77E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	6.34E+05	6.03E+05	2.19E+03	6.32E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
np239	1.89E+07	1.50E+07	6.41E+01	6.41E+01	6.41E+01	6.41E+01	6.38E+01	6.35E+01	6.29E+01
pr143	1.40E+06	1.38E+06	1.57E+04	1.25E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	8.28E+05	8.26E+05	6.65E+05	3.41E+05	9.77E+03	1.15E+02	4.32E-14	0.00E+00	0.00E+00
pr144m	7.90E+03	7.89E+03	6.35E+03	3.25E+03	9.33E+01	1.10E+00	4.12E-16	0.00E+00	0.00E+00
pu238	4.27E+03	4.28E+03	4.41E+03	4.59E+03	4.54E+03	4.36E+03	3.19E+03	2.15E+03	9.79E+02
pu239	1.06E+03	1.06E+03	1.07E+03	1.07E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03	1.06E+03
pu240	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.75E+03	1.76E+03	1.75E+03	1.73E+03
pu241	3.47E+05	3.47E+05	3.43E+05	3.30E+05	2.72E+05	2.13E+05	3.07E+04	2.72E+03	2.25E+01
rb86	6.91E+02	6.71E+02	2.45E+01	8.82E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.50E+05	1.45E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	1.93E+06	1.90E+06	3.95E+05	3.07E+03	1.95E-08	1.96E-22	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 days	90 days	1 year	5 years	10 years	50 years	100 years	200 years
rh105	1.43E+06	1.05E+06	6.92E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	7.27E+05	7.26E+05	6.15E+05	3.68E+05	2.42E+04	8.06E+02	1.22E-09	2.03E-24	0.00E+00
ru103	1.95E+06	1.93E+06	4.00E+05	3.11E+03	1.97E-08	1.98E-22	0.00E+00	0.00E+00	0.00E+00
ru105	7.52E+05	3.87E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	7.27E+05	7.26E+05	6.15E+05	3.68E+05	2.42E+04	8.06E+02	1.22E-09	2.03E-24	0.00E+00
sr89	5.89E+05	5.83E+05	1.72E+05	3.95E+03	7.93E-06	1.06E-16	0.00E+00	0.00E+00	0.00E+00
sr90	2.60E+04	2.60E+04	2.59E+04	2.54E+04	2.31E+04	2.05E+04	7.81E+03	2.35E+03	2.12E+02
sr91	6.00E+05	1.53E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.77E+05	2.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.66E+06	1.42E+06	2.56E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	1.19E+05	1.09E+05	6.86E+03	1.19E+03	1.11E-01	1.01E-06	0.00E+00	0.00E+00	0.00E+00
te127m	1.17E+04	1.17E+04	7.00E+03	1.22E+03	1.13E-01	1.03E-06	0.00E+00	0.00E+00	0.00E+00
te129	2.23E+05	4.59E+04	5.78E+03	1.99E+01	1.65E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	5.83E+04	5.75E+04	9.17E+03	3.15E+01	2.62E-12	1.17E-28	0.00E+00	0.00E+00	0.00E+00
te131	5.92E+04	3.89E+04	1.79E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	2.21E+05	1.48E+05	6.80E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	1.46E+06	1.23E+06	5.33E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	2.12E+06	2.04E+06	1.77E+01	2.88E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	1.11E+06	5.73E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.05E+05	2.76E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	2.66E+04	2.65E+04	2.59E+04	2.54E+04	2.31E+04	2.05E+04	7.82E+03	2.35E+03	2.12E+02
y91	8.16E+05	8.12E+05	2.83E+05	1.09E+04	3.36E-04	1.37E-13	0.00E+00	0.00E+00	0.00E+00
y91m	3.86E+05	9.83E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	6.93E+05	3.17E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	8.79E+05	2.41E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.40E+06	1.38E+06	5.28E+05	2.69E+04	3.68E-03	9.69E-12	0.00E+00	0.00E+00	0.00E+00
zr97	1.33E+06	6.07E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total[a]	6.92E+07	5.09E+07	6.36E+06	2.25E+06	5.79E+05	3.94E+05	1.05E+05	3.62E+04	1.47E+04
Subtotal[b]	92.9%	95.3%	97.2%	94.2%	91.9%	96.4%	99.0%	98.9%	98.6%

[a] Total includes contributions from all actinides and fission products in the fuel.
[b] Subtotal is the percent contribution of nuclides listed in the table to the total.

Table C.9. Nuclide activity (Ci/MTHM) for MOX-2 (40 GWd/MTHM)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
am241	6.71E+02	6.73E+02	8.53E+02	1.40E+03	3.97E+03	6.53E+03	1.39E+04	1.40E+04	1.21E+04
ba137m	1.22E+05	1.22E+05	1.21E+05	1.19E+05	1.09E+05	9.69E+04	3.86E+04	1.22E+04	1.22E+03
ba139	1.63E+05	1.20E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	1.65E+06	1.58E+06	1.25E+04	4.04E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce141	1.56E+06	1.54E+06	2.30E+05	6.54E+02	1.98E-11	2.49E-28	0.00E+00	0.00E+00	0.00E+00
ce143	1.24E+06	8.31E+05	2.87E-14	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	1.05E+06	1.05E+06	8.44E+05	4.32E+05	1.24E+04	1.46E+02	5.48E-14	0.00E+00	0.00E+00
cm242	1.60E+05	1.60E+05	1.10E+05	3.40E+04	8.88E+01	2.01E+01	1.64E+01	1.29E+01	7.87E+00
cm244	1.24E+04	1.24E+04	1.22E+04	1.19E+04	1.02E+04	8.43E+03	1.83E+03	2.70E+02	5.88E+00
cs134	2.01E+05	2.00E+05	1.85E+05	1.43E+05	3.75E+04	7.01E+03	1.04E-02	5.44E-10	1.48E-24
cs136	7.70E+04	7.39E+04	6.80E+02	3.48E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.29E+05	1.29E+05	1.28E+05	1.26E+05	1.15E+05	1.02E+05	4.07E+04	1.29E+04	1.29E+03
i131	1.09E+06	1.03E+06	4.84E+02	2.34E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.50E+06	1.25E+06	5.44E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.81E+06	9.61E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	1.22E+05	4.80E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	1.19E+06	1.60E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	6.92E+03	6.92E+03	6.81E+03	6.49E+03	5.01E+03	3.63E+03	2.76E+02	1.10E+01	1.76E-02
kr85m	7.93E+04	4.19E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	2.08E+04	6.57E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.18E+05	1.14E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la140	1.70E+06	1.68E+06	1.44E+04	4.66E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	7.05E+05	2.45E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.70E+05	2.90E+01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo99	1.78E+06	1.46E+06	2.62E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb95	1.40E+06	1.40E+06	8.88E+05	5.87E+04	8.21E-03	2.16E-11	0.00E+00	0.00E+00	0.00E+00
nb97	1.39E+06	5.96E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	1.24E+06	5.64E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd147	6.32E+05	6.01E+05	2.18E+03	6.30E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
np239	1.97E+07	1.56E+07	6.54E+01	6.54E+01	6.54E+01	6.53E+01	6.51E+01	6.48E+01	6.42E+01

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pr143	1.36E+06	1.35E+06	1.53E+04	1.21E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.05E+06	1.05E+06	8.44E+05	4.32E+05	1.24E+04	1.46E+02	5.48E-14	0.00E+00	0.00E+00
pr144m	1.00E+04	1.00E+04	8.05E+03	4.13E+03	1.18E+02	1.40E+00	5.23E-16	0.00E+00	0.00E+00
pu238	3.19E+03	3.19E+03	3.45E+03	3.81E+03	3.86E+03	3.71E+03	2.71E+03	1.83E+03	8.37E+02
pu239	8.76E+02	8.77E+02	8.82E+02	8.82E+02	8.81E+02	8.81E+02	8.80E+02	8.79E+02	8.77E+02
pu240	2.20E+03	2.20E+03	2.20E+03	2.20E+03	2.21E+03	2.21E+03	2.22E+03	2.21E+03	2.19E+03
pu241	4.67E+05	4.67E+05	4.61E+05	4.45E+05	3.66E+05	2.87E+05	4.14E+04	3.67E+03	3.12E+01
rb86	1.35E+03	1.31E+03	4.79E+01	1.72E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.32E+05	1.28E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103m	2.04E+06	2.01E+06	4.17E+05	3.24E+03	2.05E-08	2.06E-22	0.00E+00	0.00E+00	0.00E+00
rh105	1.51E+06	1.11E+06	7.29E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	1.09E+06	1.09E+06	9.20E+05	5.51E+05	3.62E+04	1.21E+03	1.82E-09	3.04E-24	0.00E+00
ru103	2.06E+06	2.03E+06	4.22E+05	3.28E+03	2.08E-08	2.08E-22	0.00E+00	0.00E+00	0.00E+00
ru105	7.96E+05	4.09E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	1.09E+06	1.09E+06	9.20E+05	5.51E+05	3.62E+04	1.21E+03	1.82E-09	3.04E-24	0.00E+00
sr89	5.39E+05	5.33E+05	1.57E+05	3.62E+03	7.25E-06	9.72E-17	0.00E+00	0.00E+00	0.00E+00
sr90	4.58E+04	4.58E+04	4.56E+04	4.47E+04	4.06E+04	3.60E+04	1.38E+04	4.13E+03	3.73E+02
sr91	5.40E+05	1.37E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.54E+05	1.97E+03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99m	1.65E+06	1.40E+06	2.54E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te127	1.17E+05	1.08E+05	6.77E+03	1.18E+03	1.09E-01	9.97E-07	0.00E+00	0.00E+00	0.00E+00
te127m	1.15E+04	1.15E+04	6.91E+03	1.20E+03	1.12E-01	1.02E-06	0.00E+00	0.00E+00	0.00E+00
te129	2.23E+05	4.63E+04	5.86E+03	2.01E+01	1.67E-12	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	5.90E+04	5.82E+04	9.28E+03	3.19E+01	2.65E-12	1.18E-28	0.00E+00	0.00E+00	0.00E+00
te131	5.72E+04	3.76E+04	1.72E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	2.13E+05	1.43E+05	6.57E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	1.44E+06	1.22E+06	5.28E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe133	2.10E+06	2.02E+06	1.75E+01	2.85E-15	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135	1.05E+06	5.58E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.05E+05	2.75E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y90	4.71E+04	4.69E+04	4.56E+04	4.47E+04	4.06E+04	3.60E+04	1.38E+04	4.13E+03	3.73E+02
y91	7.73E+05	7.69E+05	2.68E+05	1.03E+04	3.18E-04	1.30E-13	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
y91m	3.47E+05	8.84E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	6.36E+05	2.90E+04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	8.22E+05	2.25E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr95	1.41E+06	1.40E+06	5.34E+05	2.72E+04	3.72E-03	9.79E-12	0.00E+00	0.00E+00	0.00E+00
zr97	1.30E+06	5.93E+05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	7.23E+07	5.38E+07	7.90E+06	3.25E+06	9.03E+05	6.18E+05	1.71E+05	5.68E+04	1.96E+04
Subtotal	91.8%	94.4%	96.8%	94.2%	92.1%	96.1%	99.4%	99.1%	98.5%

Table C.10. Nuclide mass (gram/MTHM) for MOX-1 (20 GWd/MTHM)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02	1.06E+02
am241	1.38E+02	1.38E+02	1.77E+02	2.95E+02	8.52E+02	1.41E+03	3.01E+03	3.03E+03	2.61E+03
am242	1.86E-01	8.16E-02	2.18E-05	2.17E-05	2.13E-05	2.08E-05	1.71E-05	1.34E-05	8.18E-06
am242m	1.69E+00	1.69E+00	1.69E+00	1.69E+00	1.65E+00	1.61E+00	1.32E+00	1.04E+00	6.34E-01
am243	3.21E+02	3.21E+02	3.21E+02	3.21E+02	3.21E+02	3.21E+02	3.20E+02	3.18E+02	3.15E+02
ba137	1.53E+01	1.54E+01	1.96E+01	3.25E+01	9.73E+01	1.70E+02	5.31E+02	6.94E+02	7.62E+02
ba137m	1.15E-04	1.15E-04	1.15E-04	1.13E-04	1.03E-04	9.15E-05	3.64E-05	1.15E-05	1.15E-06
ba138	7.37E+02	7.37E+02	7.37E+02	7.37E+02	7.37E+02	7.37E+02	7.37E+02	7.37E+02	7.37E+02
ba139	1.01E-02	7.41E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	2.29E+01	2.19E+01	1.74E-01	5.60E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	6.42E+02	6.43E+02	6.67E+02	6.68E+02	6.68E+02	6.68E+02	6.68E+02	6.68E+02	6.68E+02
ce141	5.52E+01	5.44E+01	8.15E+00	2.32E-02	6.99E-16	8.80E-33	0.00E+00	0.00E+00	0.00E+00
ce142	6.11E+02	6.11E+02	6.11E+02	6.11E+02	6.11E+02	6.11E+02	6.11E+02	6.11E+02	6.11E+02
ce143	1.92E+00	1.29E+00	4.44E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	2.60E+02	2.59E+02	2.09E+02	1.07E+02	3.07E+00	3.62E-02	1.36E-17	0.00E+00	0.00E+00
cm242	2.61E+01	2.61E+01	1.79E+01	5.56E+00	1.55E-02	4.21E-03	3.45E-03	2.70E-03	1.65E-03
cm243	4.29E-01	4.29E-01	4.27E-01	4.19E-01	3.81E-01	3.38E-01	1.31E-01	3.97E-02	3.68E-03
cm244	1.05E+02	1.05E+02	1.04E+02	1.01E+02	8.67E+01	7.16E+01	1.55E+01	2.29E+00	5.00E-02
cm245	6.97E+00	6.97E+00	6.97E+00	6.97E+00	6.96E+00	6.96E+00	6.94E+00	6.91E+00	6.85E+00
cs133	7.22E+02	7.23E+02	7.35E+02	7.35E+02	7.35E+02	7.35E+02	7.35E+02	7.35E+02	7.35E+02
cs134	4.93E+01	4.93E+01	4.54E+01	3.53E+01	9.21E+00	1.72E+00	2.57E-06	1.34E-13	3.63E-28

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
cs136	6.10E-01	5.85E-01	5.38E-03	2.76E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	7.54E+02	7.54E+02	7.50E+02	7.37E+02	6.72E+02	5.99E+02	2.38E+02	7.54E+01	7.54E+00
eu151	4.24E-02	4.28E-02	8.30E-02	2.07E-01	8.52E-01	1.63E+00	6.90E+00	1.16E+01	1.69E+01
eu153	8.13E+01	8.15E+01	8.21E+01	8.21E+01	8.21E+01	8.21E+01	8.21E+01	8.21E+01	8.21E+01
eu154	1.60E+01	1.60E+01	1.56E+01	1.47E+01	1.07E+01	7.13E+00	2.84E-01	5.07E-03	1.61E-06
eu155	5.50E+00	5.50E+00	5.31E+00	4.76E+00	2.66E+00	1.28E+00	3.77E-03	2.58E-06	1.21E-12
gd155	7.36E-02	7.53E-02	2.67E-01	8.19E-01	2.92E+00	4.29E+00	5.57E+00	5.58E+00	5.58E+00
i131	8.83E+00	8.34E+00	3.94E-03	1.91E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.46E-01	1.22E-01	5.31E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i133	1.61E+00	8.57E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	4.62E-03	1.81E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	3.38E-01	4.54E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.01E+01	1.01E+01	9.92E+00	9.45E+00	7.30E+00	5.29E+00	4.03E-01	1.61E-02	2.57E-05
kr85m	1.07E-02	5.66E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	8.26E-04	2.62E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	1.07E-02	1.03E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	6.88E+02	6.88E+02	6.88E+02	6.88E+02	6.88E+02	6.88E+02	6.88E+02	6.88E+02	6.88E+02
la140	3.07E+00	3.04E+00	2.63E-02	8.49E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	1.27E-01	4.41E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.20E-02	2.04E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02	5.73E+02
mo95	2.95E+02	2.96E+02	3.47E+02	3.91E+02	3.94E+02	3.94E+02	3.94E+02	3.94E+02	3.94E+02
mo97	4.55E+02	4.55E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02	4.56E+02
mo98	4.86E+02	4.86E+02	4.86E+02	4.86E+02	4.86E+02	4.86E+02	4.86E+02	4.86E+02	4.86E+02
mo99	3.75E+00	3.07E+00	5.51E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	1.24E-04	1.24E-04	1.57E-04	2.58E-04	7.40E-04	1.24E-03	2.94E-03	3.27E-03	3.32E-03
nb95	3.35E+01	3.36E+01	2.21E+01	1.48E+00	2.07E-07	5.44E-16	0.00E+00	0.00E+00	0.00E+00
nb97	5.30E-02	2.27E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	6.39E-04	2.91E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	4.93E+02	4.94E+02	5.16E+02	5.16E+02	5.16E+02	5.16E+02	5.16E+02	5.16E+02	5.16E+02
nd144	2.87E+02	2.88E+02	3.38E+02	4.40E+02	5.44E+02	5.47E+02	5.47E+02	5.47E+02	5.47E+02
nd145	3.73E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02	3.73E+02

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
nd147	7.83E+00	7.45E+00	2.70E-02	7.81E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	2.20E+02	2.20E+02	2.20E+02	2.20E+02	2.20E+02	2.20E+02	2.20E+02	2.20E+02	2.20E+02
np237	1.10E+02	1.10E+02	1.13E+02	1.13E+02	1.17E+02	1.26E+02	2.82E+02	5.24E+02	9.68E+02
np239	8.15E+01	6.46E+01	2.76E-04	2.76E-04	2.76E-04	2.76E-04	2.75E-04	2.74E-04	2.71E-04
pm147	1.48E+02	1.48E+02	1.46E+02	1.20E+02	4.17E+01	1.11E+01	2.88E-04	5.32E-10	1.81E-21
pr141	5.78E+02	5.79E+02	6.25E+02	6.33E+02	6.33E+02	6.33E+02	6.33E+02	6.33E+02	6.33E+02
pr143	2.08E+01	2.06E+01	2.33E-01	1.85E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.10E-02	1.09E-02	8.80E-03	4.51E-03	1.29E-04	1.52E-06	5.71E-22	0.00E+00	0.00E+00
pr144m	4.36E-05	4.35E-05	3.50E-05	1.79E-05	5.14E-07	6.06E-09	2.27E-24	0.00E+00	0.00E+00
pu238	2.49E+02	2.50E+02	2.57E+02	2.68E+02	2.65E+02	2.55E+02	1.86E+02	1.25E+02	5.72E+01
pu239	1.71E+04	1.71E+04	1.72E+04	1.72E+04	1.72E+04	1.72E+04	1.71E+04	1.71E+04	1.71E+04
pu240	7.69E+03	7.69E+03	7.69E+03	7.69E+03	7.70E+03	7.72E+03	7.74E+03	7.71E+03	7.63E+03
pu241	3.34E+03	3.34E+03	3.30E+03	3.18E+03	2.62E+03	2.06E+03	2.96E+02	2.62E+01	2.17E-01
pu242	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03	1.25E+03
rb86	8.48E-03	8.23E-03	3.00E-04	1.08E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.25E-03	1.20E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	4.39E+02	4.40E+02	4.87E+02	4.99E+02	4.99E+02	4.99E+02	4.99E+02	4.99E+02	4.99E+02
rh103m	5.93E-02	5.85E-02	1.22E-02	9.45E-05	5.98E-16	6.01E-30	0.00E+00	0.00E+00	0.00E+00
rh105	1.69E+00	1.25E+00	8.19E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	2.05E-04	2.05E-04	1.74E-04	1.04E-04	6.84E-06	2.28E-07	3.43E-19	5.74E-34	0.00E+00
ru101	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02	5.08E+02
ru103	6.04E+01	5.96E+01	1.24E+01	9.62E-02	6.09E-13	6.12E-27	0.00E+00	0.00E+00	0.00E+00
ru105	1.12E-01	5.75E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	2.19E+02	2.19E+02	1.86E+02	1.11E+02	7.31E+00	2.43E-01	3.67E-13	6.13E-28	0.00E+00
sb125	8.99E+00	8.99E+00	8.57E+00	7.10E+00	2.60E+00	7.41E-01	3.22E-05	1.14E-10	1.41E-21
sm147	3.39E+01	3.40E+01	4.36E+01	7.00E+01	1.48E+02	1.79E+02	1.90E+02	1.90E+02	1.90E+02
sm149	4.67E+00	4.93E+00	5.86E+00	5.86E+00	5.86E+00	5.86E+00	5.86E+00	5.86E+00	5.86E+00
sm150	1.72E+02	1.72E+02	1.72E+02	1.72E+02	1.72E+02	1.72E+02	1.72E+02	1.72E+02	1.72E+02
sm151	2.12E+01	2.13E+01	2.14E+01	2.13E+01	2.07E+01	1.99E+01	1.46E+01	9.94E+00	4.60E+00
sm152	9.61E+01	9.61E+01	9.61E+01	9.61E+01	9.61E+01	9.61E+01	9.61E+01	9.61E+01	9.61E+01
sr89	2.03E+01	2.01E+01	5.92E+00	1.36E-01	2.73E-10	3.66E-21	0.00E+00	0.00E+00	0.00E+00
sr90	1.89E+02	1.89E+02	1.87E+02	1.84E+02	1.67E+02	1.48E+02	5.66E+01	1.70E+01	1.53E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
sr91	1.68E-01	4.27E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.20E-02	1.70E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	5.02E+02	5.03E+02	5.06E+02	5.06E+02	5.06E+02	5.06E+02	5.06E+02	5.06E+02	5.06E+02
tc99m	3.15E-01	2.69E-01	4.85E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	1.03E-01	1.03E-01	1.11E-01	9.87E-02	3.63E-02	1.03E-02	4.49E-07	1.58E-12	1.97E-23
te127	4.50E-02	4.14E-02	2.60E-03	4.52E-04	4.20E-08	3.83E-13	0.00E+00	0.00E+00	0.00E+00
te127m	1.23E+00	1.24E+00	7.42E-01	1.29E-01	1.20E-05	1.09E-10	0.00E+00	0.00E+00	0.00E+00
te129	1.07E-02	2.19E-03	2.76E-04	9.49E-07	7.88E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.93E+00	1.91E+00	3.04E-01	1.05E-03	8.68E-17	3.87E-33	0.00E+00	0.00E+00	0.00E+00
te131	1.03E-03	6.78E-04	3.11E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	3.07E-01	2.06E-01	9.45E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	4.72E+00	3.97E+00	1.73E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	4.92E+01	4.93E+01	4.97E+01	5.13E+01	5.96E+01	6.97E+01	1.38E+02	1.97E+02	2.65E+02
u235	4.45E+03	4.45E+03	4.46E+03	4.46E+03	4.46E+03	4.46E+03	4.48E+03	4.50E+03	4.55E+03
u236	5.30E+02	5.30E+02	5.31E+02	5.31E+02	5.34E+02	5.38E+02	5.70E+02	6.11E+02	6.90E+02
u238	9.44E+05	9.44E+05	9.44E+05	9.44E+05	9.44E+05	9.44E+05	9.44E+05	9.44E+05	9.44E+05
xe132	6.57E+02	6.58E+02	6.62E+02	6.62E+02	6.62E+02	6.62E+02	6.62E+02	6.62E+02	6.62E+02
xe133	1.13E+01	1.09E+01	9.46E-05	1.54E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	8.90E+02	8.90E+02	8.90E+02	8.90E+02	8.90E+02	8.90E+02	8.90E+02	8.90E+02	8.90E+02
xe135	4.35E-01	2.26E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.25E-03	3.03E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03	1.31E+03
y90	4.88E-02	4.86E-02	4.75E-02	4.67E-02	4.24E-02	3.76E-02	1.44E-02	4.31E-03	3.89E-04
y91	3.33E+01	3.31E+01	1.16E+01	4.44E-01	1.37E-08	5.58E-18	0.00E+00	0.00E+00	0.00E+00
y91m	9.27E-03	2.37E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	7.20E-02	3.29E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	2.66E-01	7.28E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	3.22E+02	3.23E+02	3.23E+02	3.23E+02	3.23E+02	3.23E+02	3.23E+02	3.23E+02	3.23E+02
zr95	6.50E+01	6.45E+01	2.46E+01	1.25E+00	1.72E-07	4.51E-16	0.00E+00	0.00E+00	0.00E+00
zr97	6.90E-01	3.14E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	99.4%	99.4%	99.4%	99.4%	99.4%	99.3%	99.3%	99.3%	99.3%

Table C.11. Nuclide mass (gram/MTHM) for MOX-2 (40 GWd/MTHM)

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
ag109	1.98E+02	1.98E+02	1.99E+02	1.99E+02	1.99E+02	1.99E+02	1.99E+02	1.99E+02	1.99E+02
am241	1.96E+02	1.96E+02	2.49E+02	4.08E+02	1.16E+03	1.90E+03	4.06E+03	4.09E+03	3.52E+03
am242	2.87E-01	1.26E-01	3.14E-05	3.13E-05	3.07E-05	2.99E-05	2.46E-05	1.92E-05	1.18E-05
am242m	2.44E+00	2.44E+00	2.43E+00	2.42E+00	2.38E+00	2.32E+00	1.91E+00	1.49E+00	9.12E-01
am243	3.27E+02	3.28E+02	3.28E+02	3.28E+02	3.27E+02	3.27E+02	3.26E+02	3.24E+02	3.21E+02
ba137	5.54E+01	5.55E+01	6.38E+01	8.92E+01	2.17E+02	3.61E+02	1.07E+03	1.39E+03	1.53E+03
ba137m	2.27E-04	2.27E-04	2.26E-04	2.22E-04	2.02E-04	1.80E-04	7.17E-05	2.27E-05	2.27E-06
ba138	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03	1.46E+03
ba139	9.98E-03	7.34E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ba140	2.26E+01	2.16E+01	1.71E-01	5.52E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce140	1.30E+03	1.30E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03	1.32E+03
ce141	5.47E+01	5.39E+01	8.08E+00	2.30E-02	6.93E-16	8.73E-33	0.00E+00	0.00E+00	0.00E+00
ce142	1.20E+03	1.20E+03	1.20E+03	1.20E+03	1.20E+03	1.20E+03	1.20E+03	1.20E+03	1.20E+03
ce143	1.87E+00	1.25E+00	4.32E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ce144	3.30E+02	3.29E+02	2.65E+02	1.36E+02	3.89E+00	4.59E-02	1.72E-17	0.00E+00	0.00E+00
cm242	4.82E+01	4.82E+01	3.31E+01	1.03E+01	2.68E-02	6.05E-03	4.96E-03	3.88E-03	2.38E-03
cm243	1.15E+00	1.15E+00	1.14E+00	1.12E+00	1.02E+00	9.03E-01	3.48E-01	1.06E-01	9.80E-03
cm244	1.53E+02	1.53E+02	1.51E+02	1.47E+02	1.26E+02	1.04E+02	2.26E+01	3.33E+00	7.27E-02
cm245	1.44E+01	1.44E+01	1.44E+01	1.44E+01	1.44E+01	1.44E+01	1.43E+01	1.43E+01	1.42E+01
cs133	1.35E+03	1.35E+03	1.37E+03	1.37E+03	1.37E+03	1.37E+03	1.37E+03	1.37E+03	1.37E+03
cs134	1.55E+02	1.55E+02	1.43E+02	1.11E+02	2.90E+01	5.42E+00	8.08E-06	4.21E-13	1.14E-27
cs136	1.06E+00	1.01E+00	9.32E-03	4.77E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
cs137	1.48E+03	1.48E+03	1.48E+03	1.45E+03	1.32E+03	1.18E+03	4.69E+02	1.48E+02	1.48E+01
eu151	3.98E-02	4.02E-02	8.45E-02	2.21E-01	9.31E-01	1.79E+00	7.58E+00	1.27E+01	1.86E+01
eu153	1.85E+02	1.85E+02	1.86E+02	1.86E+02	1.86E+02	1.86E+02	1.86E+02	1.86E+02	1.86E+02
eu154	5.05E+01	5.05E+01	4.95E+01	4.66E+01	3.38E+01	2.26E+01	9.01E-01	1.61E-02	5.11E-06
eu155	1.38E+01	1.38E+01	1.33E+01	1.19E+01	6.66E+00	3.22E+00	9.45E-03	6.47E-06	3.03E-12
gd155	1.85E-01	1.89E-01	6.71E-01	2.06E+00	7.33E+00	1.08E+01	1.40E+01	1.40E+01	1.40E+01
i131	8.74E+00	8.25E+00	3.90E-03	1.88E-13	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i132	1.45E-01	1.21E-01	5.26E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
i133	1.60E+00	8.48E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i134	4.58E-03	1.80E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
i135	3.37E-01	4.53E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr85	1.77E+01	1.77E+01	1.74E+01	1.66E+01	1.28E+01	9.29E+00	7.07E-01	2.82E-02	4.51E-05
kr85m	9.63E-03	5.09E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr87	7.33E-04	2.32E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
kr88	9.43E-03	9.11E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la139	1.35E+03	1.35E+03	1.35E+03	1.35E+03	1.35E+03	1.35E+03	1.35E+03	1.35E+03	1.35E+03
la140	3.07E+00	3.02E+00	2.60E-02	8.37E-09	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la141	1.24E-01	4.32E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
la142	1.17E-02	1.99E-06	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
mo100	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03
mo95	6.44E+02	6.45E+02	6.98E+02	7.43E+02	7.46E+02	7.46E+02	7.46E+02	7.46E+02	7.46E+02
mo97	8.96E+02	8.96E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02	8.97E+02
mo98	9.72E+02	9.72E+02	9.72E+02	9.72E+02	9.72E+02	9.72E+02	9.72E+02	9.72E+02	9.72E+02
mo99	3.72E+00	3.04E+00	5.46E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb93m	4.21E-04	4.21E-04	4.82E-04	6.67E-04	1.56E-03	2.47E-03	5.61E-03	6.21E-03	6.29E-03
nb95	3.57E+01	3.57E+01	2.26E+01	1.49E+00	2.09E-07	5.50E-16	0.00E+00	0.00E+00	0.00E+00
nb97	5.18E-02	2.21E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nb97m	6.25E-04	2.85E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd143	8.88E+02	8.89E+02	9.10E+02	9.10E+02	9.10E+02	9.10E+02	9.10E+02	9.10E+02	9.10E+02
nd144	8.22E+02	8.22E+02	8.86E+02	1.02E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03	1.15E+03
nd145	6.89E+02	6.89E+02	6.89E+02	6.89E+02	6.89E+02	6.89E+02	6.89E+02	6.89E+02	6.89E+02
nd147	7.81E+00	7.43E+00	2.70E-02	7.79E-10	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
nd148	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02	4.35E+02
np237	1.56E+02	1.56E+02	1.59E+02	1.59E+02	1.64E+02	1.76E+02	3.88E+02	7.14E+02	1.31E+03
np239	8.49E+01	6.73E+01	2.82E-04	2.82E-04	2.82E-04	2.82E-04	2.81E-04	2.79E-04	2.77E-04
pm147	2.00E+02	2.00E+02	1.95E+02	1.60E+02	5.55E+01	1.48E+01	3.84E-04	7.09E-10	2.42E-21
pr141	1.19E+03	1.19E+03	1.23E+03	1.24E+03	1.24E+03	1.24E+03	1.24E+03	1.24E+03	1.24E+03
pr143	2.02E+01	2.00E+01	2.27E-01	1.80E-07	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
pr144	1.39E-02	1.39E-02	1.12E-02	5.72E-03	1.64E-04	1.93E-06	7.24E-22	0.00E+00	0.00E+00
pr144m	5.52E-05	5.51E-05	4.44E-05	2.27E-05	6.52E-07	7.69E-09	2.88E-24	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
pu238	1.86E+02	1.86E+02	2.01E+02	2.23E+02	2.25E+02	2.17E+02	1.58E+02	1.07E+02	4.89E+01
pu239	1.41E+04	1.41E+04	1.42E+04	1.42E+04	1.42E+04	1.42E+04	1.42E+04	1.42E+04	1.41E+04
pu240	9.70E+03	9.70E+03	9.70E+03	9.70E+03	9.72E+03	9.73E+03	9.77E+03	9.74E+03	9.64E+03
pu241	4.49E+03	4.49E+03	4.44E+03	4.28E+03	3.53E+03	2.77E+03	3.98E+02	3.53E+01	3.00E-01
pu242	1.41E+03	1.41E+03	1.41E+03	1.41E+03	1.41E+03	1.41E+03	1.41E+03	1.41E+03	1.41E+03
rb86	1.66E-02	1.61E-02	5.87E-04	2.11E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rb88	1.10E-03	1.06E-05	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh103	8.24E+02	8.25E+02	8.75E+02	8.88E+02	8.88E+02	8.88E+02	8.88E+02	8.88E+02	8.88E+02
rh103m	6.26E-02	6.17E-02	1.28E-02	9.96E-05	6.31E-16	6.34E-30	0.00E+00	0.00E+00	0.00E+00
rh105	1.78E+00	1.32E+00	8.63E-19	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
rh106	3.07E-04	3.07E-04	2.60E-04	1.56E-04	1.02E-05	3.41E-07	5.14E-19	8.58E-34	0.00E+00
ru101	9.95E+02	9.95E+02	9.95E+02	9.95E+02	9.95E+02	9.95E+02	9.95E+02	9.95E+02	9.95E+02
ru103	6.37E+01	6.28E+01	1.30E+01	1.01E-01	6.42E-13	6.45E-27	0.00E+00	0.00E+00	0.00E+00
ru105	1.18E-01	6.09E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
ru106	3.28E+02	3.28E+02	2.78E+02	1.66E+02	1.09E+01	3.64E-01	5.49E-13	9.17E-28	0.00E+00
sb125	1.59E+01	1.59E+01	1.50E+01	1.25E+01	4.56E+00	1.30E+00	5.64E-05	1.99E-10	2.48E-21
sm147	8.44E+01	8.46E+01	9.74E+01	1.33E+02	2.37E+02	2.77E+02	2.92E+02	2.92E+02	2.92E+02
sm149	4.51E+00	4.80E+00	5.83E+00	5.83E+00	5.83E+00	5.83E+00	5.83E+00	5.83E+00	5.83E+00
sm150	3.59E+02	3.59E+02	3.59E+02	3.59E+02	3.59E+02	3.59E+02	3.59E+02	3.59E+02	3.59E+02
sm151	2.33E+01	2.34E+01	2.36E+01	2.34E+01	2.27E+01	2.19E+01	1.61E+01	1.09E+01	5.07E+00
sm152	1.53E+02	1.53E+02	1.53E+02	1.53E+02	1.53E+02	1.53E+02	1.53E+02	1.53E+02	1.53E+02
sr89	1.85E+01	1.83E+01	5.41E+00	1.24E-01	2.50E-10	3.35E-21	0.00E+00	0.00E+00	0.00E+00
sr90	3.32E+02	3.32E+02	3.30E+02	3.24E+02	2.94E+02	2.61E+02	9.97E+01	2.99E+01	2.70E+00
sr91	1.51E-01	3.84E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
sr92	2.02E-02	1.56E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
tc99	9.47E+02	9.48E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.51E+02	9.50E+02
tc99m	3.13E-01	2.66E-01	4.81E-11	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te125m	1.98E-01	1.98E-01	2.01E-01	1.73E-01	6.36E-02	1.81E-02	7.87E-07	2.78E-12	3.45E-23
te127	4.45E-02	4.09E-02	2.56E-03	4.46E-04	4.14E-08	3.78E-13	0.00E+00	0.00E+00	0.00E+00
te127m	1.22E+00	1.22E+00	7.32E-01	1.27E-01	1.18E-05	1.08E-10	0.00E+00	0.00E+00	0.00E+00
te129	1.07E-02	2.21E-03	2.80E-04	9.61E-07	7.98E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te129m	1.96E+00	1.93E+00	3.08E-01	1.06E-03	8.79E-17	3.92E-33	0.00E+00	0.00E+00	0.00E+00

Nuclides	5 hours	1 day	90 days	1 year	5 years	10 years	50 years	100 years	200 years
te131	9.97E-04	6.55E-04	3.00E-23	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te131m	2.96E-01	1.99E-01	9.13E-21	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
te132	4.67E+00	3.94E+00	1.71E-08	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
u234	1.52E+01	1.52E+01	1.56E+01	1.68E+01	2.39E+01	3.25E+01	9.02E+01	1.41E+02	1.99E+02
u235	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.03E+03	1.05E+03	1.07E+03	1.11E+03
u236	2.79E+02	2.79E+02	2.80E+02	2.80E+02	2.84E+02	2.90E+02	3.30E+02	3.81E+02	4.81E+02
u238	9.27E+05	9.27E+05	9.27E+05	9.27E+05	9.27E+05	9.27E+05	9.27E+05	9.27E+05	9.27E+05
xe132	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03	1.44E+03
xe133	1.12E+01	1.08E+01	9.37E-05	1.52E-20	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe134	1.77E+03	1.77E+03	1.77E+03	1.77E+03	1.77E+03	1.77E+03	1.77E+03	1.77E+03	1.77E+03
xe135	4.11E-01	2.20E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe135m	2.24E-03	3.02E-04	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
xe136	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03	2.61E+03
y90	8.66E-02	8.62E-02	8.37E-02	8.22E-02	7.47E-02	6.62E-02	2.53E-02	7.59E-03	6.85E-04
y91	3.15E+01	3.13E+01	1.09E+01	4.20E-01	1.29E-08	5.28E-18	0.00E+00	0.00E+00	0.00E+00
y91m	8.34E-03	2.13E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y92	6.61E-02	3.02E-03	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
y93	2.48E-01	6.80E-02	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
zr93	6.12E+02	6.12E+02	6.12E+02	6.12E+02	6.12E+02	6.12E+02	6.12E+02	6.12E+02	6.12E+02
zr95	6.57E+01	6.52E+01	2.49E+01	1.27E+00	1.73E-07	4.56E-16	0.00E+00	0.00E+00	0.00E+00
zr97	6.75E-01	3.07E-01	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00	0.00E+00
Total	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06	1.00E+06
Subtotal	98.7%	98.7%	98.7%	98.7%	98.7%	98.6%	98.6%	98.6%	98.6%

APPENDIX D. ANALYSIS OF MAXIMUM ASSEMBLY DECAY HEAT

The decay heat power for the hottest assembly is required as input for maximum thermal analyses. The calculated decay heat powers presented in Section 5.3 and tabulated in Appendixes A, B, and C of this report were based on representative fuel parameters and irradiation conditions; for example, the irradiation histories used in those calculations are based on average assembly specific powers for PWR and BWR fuel derived from data in the GC-859 US inventory database: 38 MW/MTU for PWR fuel, and 24 MW/MTU for BWR fuel. This appendix focuses on the hottest fuel assemblies (the ones with maximum decay heat powers), and it studies the assemblies with burnups from 60 GWd/MTU to the maximum burnup as found in the current US spent fuel inventory through 2013. Decay heat power depends not only on the assembly burnup and cooling time, but also on the specific power during irradiation, particularly for short cooling times of interest for postulated accident analyses. Therefore, the decay heat values presented elsewhere in this report are not applicable for thermal analyses involving the hottest assemblies.

Other parameters also influence the decay heat power, but to a lesser degree than burnup, cooling time, and specific power. These other parameters include the assembly design, enrichment, exposure to integral absorber rods, discrete absorber rods and control blades, operating history (outage length etc.) and operating conditions (temperatures, boron levels etc.). For cooling times less than ~40 years, these parameters have a relatively small impact on decay heat since decay heat is dominated by fission products which are far less sensitive to these parameters than the actinides which dominate at longer cooling times.

This appendix evaluates decay heat power for assemblies that have experienced higher specific powers during operation than the reference cases used in this report, and those assemblies are expected to have higher decay heat power. This illustrates the importance of the appropriate application of the data documented in this report.

ANALYSIS OF GC-859 ASSEMBLY DATA

The specific powers for all assemblies in the GC-859 database, averaged over all cycles an assembly resided in the reactor core, are shown in Figure D.1. The maximum specific powers observed for these assemblies are about 54 MW/MTU for PWRs and 35 MW/MTU for BWRs. These operating specific powers exceed the values used to calculate the reference decay heat values presented in this report by about 45% and will result in larger decay heat powers.

This analysis of GC-859 data yields the average specific power of each assembly over the irradiation lifetime. However, the maximum specific power in any cycle during the irradiation can exceed the average value. The maximum specific power may be required in calculations for assemblies that have not achieved their expected end-of-life burnup. This can occur during an unplanned full core offload or at decommissioning. The GC-859 database does not currently include cycle-specific assembly burnup or power for all assemblies. Therefore, further analysis was performed using more detailed plant operating data to assess variations in the assembly-specific power during each cycle of operation to identify the highest (limiting) specific power for thermal analysis.

ADDITIONAL PLANT DATA

Detailed cycle operating data was reviewed from PWR plants representing 15 cycles of assembly data and more than 6,000 assembly-cycles of information. The distribution of specific power values in each cycle of operation is illustrated in Figure D.2. The maximum assembly-average specific power observed in any cycle of the PWR data available in this study was 62 MW/MTU. This power is 1.15 (62/54) times the maximum power values in Figure D.1, and 1.63 (62/38) times the 38 MW/MTU value used in the reference calculations in this report.

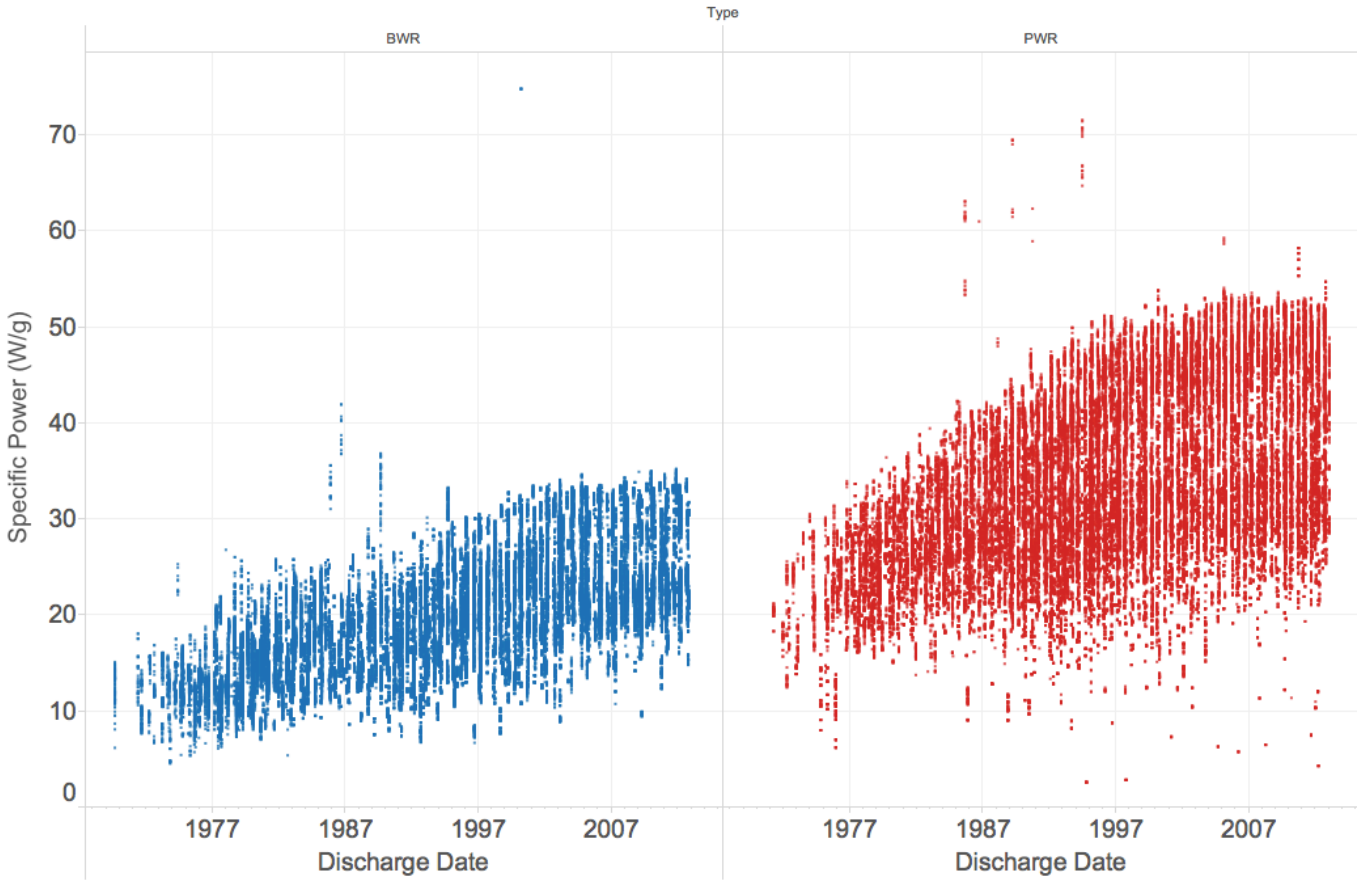

Figure D.1. Assembly-specific power (MW/MTU) for BWR (left) and PWR (right) assemblies from the US spent fuel inventory database GC-859. Values represent the average specific power of each assembly over the operating lifetime of the assembly. Outlier data points are likely attributed to errors in the database.

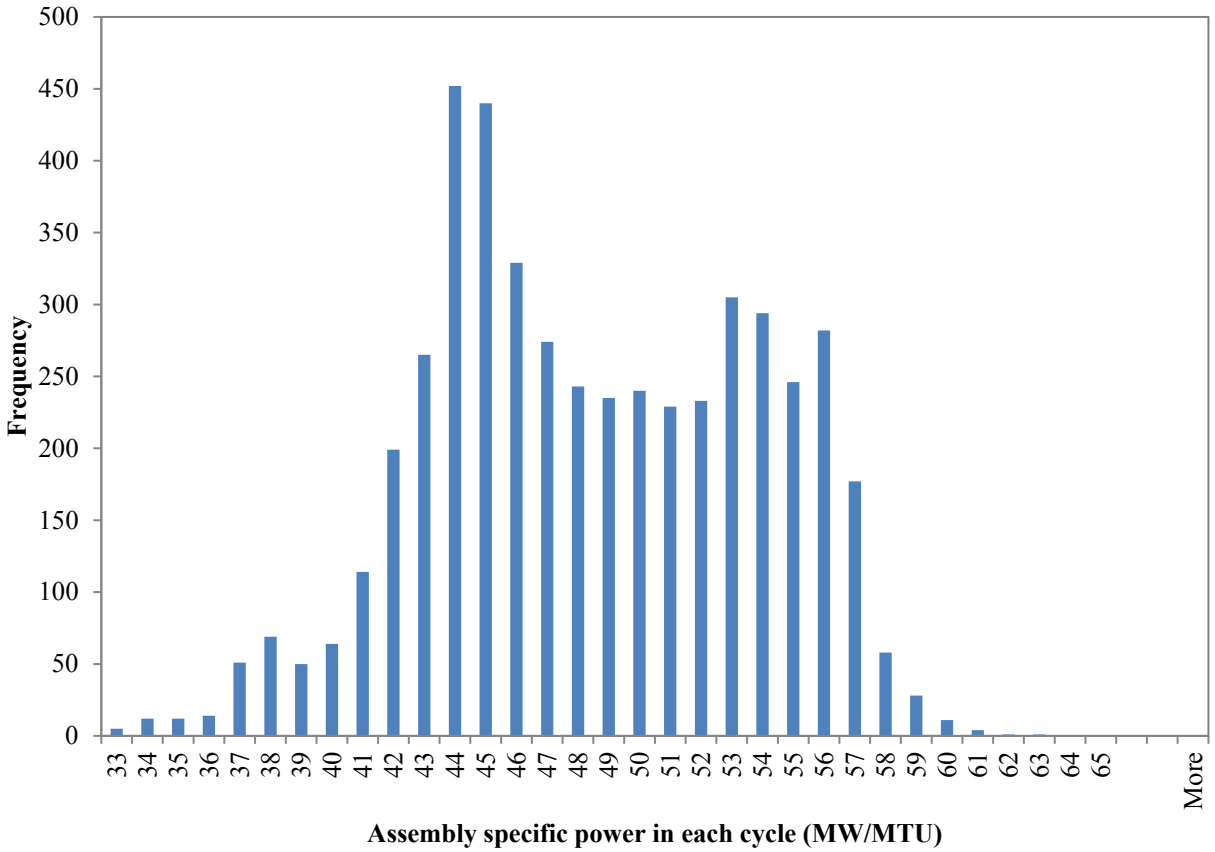

Figure D.2. Specific power distribution of PWR assemblies in each operating cycle for 15 cycles of data (data below 33 MW/MTU are omitted).

The maximum specific power experienced by BWR assemblies was estimated from a limited set of operating data for more than 600 assemblies from a modern BWR plant using a 10 × 10 assembly design. The maximum assembly specific power observed for this dataset was 39.1 MW/MTU, which is 1.12 (39/35) times the maximum power values in Figure D.1 and 1.63 (39/24) times the 24 MW/MTU value used in the reference calculations in this report.

The maximum and average specific power values are summarized in Table D.1. The maximum specific power factors relative to average values are similar for the PWR and BWR assemblies analyzed. Note that the maximum specific power in any cycle for BWR (C) was estimated using the same factor (C/B) as PWR, due to the limited set of BWR data.

MAXIMUM DECAY HEAT POWER

The decay heat power of an assembly increases with increasing specific power of the assembly. This effect is much more pronounced at shorter cooling times. After ~5 years the decay heat power is relatively insensitive to the operating power and is primarily dependent on the burnup.

Table D.1. Summary of assembly specific power values

Reactor Type	Average specific power[a] (MW/MTU)	Maximum lifetime specific power[a] (MW/MTU)	Maximum specific power in any cycle (MW/MTU)	Maximum lifetime specific power factor relative to average	Maximum specific power factor in any cycle relative to average
	(A)	(B)	(C)	(B/A)	(C/A)
PWR	38	54	62	1.42	1.63
BWR	24	35	40[b]	1.46	1.67[b]

[a] Average specific power over the operating lifetime of the assemblies
[b] Factors adopted from PWR data

Calculations were performed to determine factors that can be applied to the decay heat power values tabulated in Appendix A and B to estimate the hottest assembly. ORIGEN calculations were performed for the reference PWR specific power of 38 MW/MTU and the maximum specific power of 62 MW/MTU. Similarly, calculations were performed for the reference BWR-specific power of 24 MW/MTU and the maximum power of 40 MW/MTU. These calculations were performed for an assembly with a burnup of 60 GWd/MTU and an initial enrichment of 4.95 wt% ^{235}U. The ratio of the decay heat value from a calculation using the maximum specific power to one using the average value represents a factor that can be applied to the decay heat powers tabulated in Appendixes A, B, and C to obtain data for the hottest assembly for thermal calculations. These scaling factors are listed in Table D.2.

Table D.2. Scaling factors for the hottest assembly

Cooling time (years)	Decay heat factor for hottest PWR assembly	Decay heat factor for hottest BWR assembly
0	1.63	1.67
0.03	1.52	1.56
0.1	1.47	1.50
0.3	1.39	1.43
0.5	1.35	1.39
1	1.29	1.33
2	1.22	1.26
3	1.16	1.19
4	1.11	1.13
5	1.07	1.09
10	1.01	1.03

The results illustrate the importance of the assembly-specific power on decay heat at short cooling times (< 5 years) for estimating the hottest assemblies. Therefore, appropriate adjustments are needed if the results compiled in this report (Appendixes A, B, and C) are used in calculations involving the hottest assemblies, because those results were based on average operating conditions.

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10. SUPPLEMENTARY NOTES

11. ABSTRACT *(200 words or less)*

This report documents a survey of all US commercial SNF assemblies in the GC-859 database and provides reference SNF source terms (e.g., nuclide inventories, decay heat, and neutron/photon emission) at various cooling times up to 200 years after fuel discharge. This study reviews the distribution and evolution of fuel parameters of all spent nuclear fuel (SNF) assemblies discharged over the past 40 years. Assemblies were categorized into three groups based on discharge year, and the median burnups and enrichments of each group were used to establish representative cases. An extended burnup case was created for boiling water reactor (BWR) fuels, and another was created for the pressurized water reactor (PWR) fuels. Two additional cases were developed to represent the eight mixed oxide (MOX) fuel assemblies in the database. Burnup calculations were performed for each representative case. Realistic parameters for fuel design and operations were used to model the SNF and to provide reference fuel characteristics representative of the current inventory. Burnup calculations were performed using the ORIGEN code, which is part of the SCALE nuclear modeling and simulation code system. Results include total activity, decay heat, photon emission, neutron flux, gamma heat, and plutonium content, as well as concentrations for 115 significant nuclides. These quantities are important in the design, regulation, and operations of SNF storage, transportation, and disposal systems.

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